DEPARTMENT OF
MECHANICAL ENGINEERING

LIST OF NEW COURSES

S.No	Course Code	Course Title	Hours per week L	T	P	Credits
1	21ME2010	Fluid Power Applications	3	0	0	3
2	21ME2011	Fuel Cells Technology	3	0	0	3
3	21ME2012	MEMS and Micro System Fabrication	3	0	0	3
4	21ME2013	Design for Additive Manufacturing	3	0	0	3
5	21ME2014	Advanced Additive Manufacturing Laboratory	0	0	4	2
6	21ME2015	Design of Electric Vehicles and Battery Management	3	0	0	3
7	21ME2016	Electric Vehicles Laboratory	0	0	4	2
8	21ME3013	Integrated FMS for Industry 4.0	3	0	0	3
9	21ME3014	Tool design for Advanced Manufacturing	3	0	0	3
10	21ME3017	Digital Manufacturing	3	0	0	3
11	22ME3001	Ergonomic Design of Public Transport Systems	3	0	0	3

Course code	FLUID POWER APPLICATIONS	L	T	P	C
21ME2010		3	0	0	3

Course Objectives: To impart knowledge on

1. Underlying concepts, methods and application of different Fluid Power Engineering.
2. Actuation modes and control systems.
3. The usage of fluid power systems in Automobile and Medical fields.

Course Outcomes: At the end of this course the students will be able to

1. Interpret the standard symbols and laws used in FPC Systems
2. Identify the suitable elements of fluid power systems for a particular application.
3. Apply the various controls of Electronic and Electrical for Fluid Power Systems
4. Design a electro-pneumatic or electro-hydraulic circuit for Industrial Application.
5. Justify a fluid power circuit for Automobile Applications.
6. Develop a low cost automation circuit for medical or paramedical usage.

MODULE 1 — FLUID POWER SYSTEMS — 8 Hours

Hydraulics Vs Pneumatics, Pascal's Law, hydraulic fluids, Hydraulic power supply-Types, construction and selection of Hydraulic pumps and motors, Pneumatic power supply source - construction and selection of Compressors and air motors.

MODULE 2 — FLUID POWER CONTROL COMPONENTS — 7 Hours

Valves – Pressure, direction and flow control valves, proportional and servo valves, Accumulators, Filter Regulator Lubricator (FRL), Actuators-Linear and rotary.

MODULE 3 — ELECTRONIC AND ELECTRICAL CONTROLS — 8 Hours

Electro pneumatic & Electro hydraulic components. Design of electro–pneumatic circuit for basic Boolean logic circuits. Electro-Pneumatic control circuit for Cascade System.

MODULE 4 — FLUID POWER SYSTEMS IN INDUSTRIAL AUTOMATION — 7 Hours

Pneumatic Circuit For Material Handling System. Transfer devices, Vibratory bowl feeders, Non-vibratory feeders. Analysis of flow lines, Automated assembly systems.

MODULE 5 — FLUID POWER SYSTEMS IN AUTOMOBILES APPLICATIONS — 8 Hours

Tractors, irrigation system, earthmoving equipment, commercial vehicles, rail equipment, building and construction machineries and drilling rigs. brakes, shock absorbers, steering system, wind shield,

MODULE 6 — FLUID POWER SYSTEMS IN MEDICAL APPLICATIONS — 7 Hours

Applications of pneumatic and hydraulic systems in medical field - breathing assistors, heart assists devices, cardiac compression machines, dental drives and human patient simulator.

45 Hours

Text Books

1.	Anthony Esposito, Fluid Power Systems,: Pearson New International 7th edition, 2013. ISBN-13. 978-1292023878
Reference Books	
1.	M. P. Groover , Automation, Production System and Computer Integrated Manufacturing, Prentice Hall of India, New Delhi, 2016, ISBN 9789332572492.
2.	S.R. Majumdar , Pneumatic Systems:Principles and maintenance, McGraw Hill, 2017, ISBN 13: 978-0074602317.
3.	James R.Daines, Hydraulics and Pneumatics, 2ndEdition, The Goodheart -Willcox Company, Inc., 2013, ISBN 978-1-60525-931-4.
4.	W.Bolton, Mechatronics, Electronic control systems in Mechanical and Electrical Engineering, Pearson Education, 2018, ISBN-13: 978-1292250977.
5.	John Pippenger, Fluid Power Controls, Literary Licensing LLC, 2012, ISBN-13: 978-1258454173.
6.	Andrew Parr, Hydraulics and Pneumatics, Butterworth and Heinmann, 2011, ISBN 9780080966748.

Recommended by Board of Studies	27-08-2022
Approved by Academic Council	24th September 2022

Prepared by Dr.S.Rajesh Ruban

Course code	**FUEL CELL TECHNOLOGY**	**L**	**T**	**P**	**C**
21ME2011		3	0	0	3

Course Objectives: To impart knowledge on

1. The principle operation of a fuel cell, types and its thermodynamics and kinetics.
2. Various fuel cell systems and its performance based on the industrial requirements.
3. Hydrogen production techniques, cost effectiveness and eco-friendliness of fuel Cells.

Course Outcomes: At the end of this course the students will be able to

1. Infer the essential concepts of fuel cell.
2. Classify the fuel cells according to different materials for suitable application.
3. Apply different fuel cell systems for power conditioning and conversion applications.
4. Analyze the energy and exergy balance to improve the performance efficiency of fuel cells.
5. Compare the hydrogen production/storage technologies.
6. Design fuel cell systems for power generation applications.

MODULE 1	**FUEL CELL**	**8 Hours**
Fuel cell- principle- working - Advantage and disadvantage -thermodynamics and kinetics of fuel cell process -performance evaluation of fuel cell – comparison on battery Vs fuel cell.		

MODULE 2	**CLASSIFICATION OF FUEL CELLS**	**8 Hours**
Solid Oxide Fuel Cell (SOFC) -Alkaline Fuel Cell (AFC) - Direct Methanol Fuel Cell (DMFC) -Proton Exchange Membrane Fuel Cell (PEMFC) - Molten Carbonate Fuel Cell (MCFC) - relative merits and demerits.		

MODULE 3	**FUEL CELL SYSTEMS**	**7 Hours**
Fuel cell power conditioning systems- System issues: Power conversion cost and size- Fuel cell systems fuelled by Natural gas (PEFC, PAFC, MCFC systems) - Coal fuelled fuel cell system- Combined fuel cell and Gas turbine system- Hybrid fuel cell systems-Hybrid electric vehicles.		

MODULE 4	**FUEL CELL THERMODYNAMICS**	**7 Hours**
Heat potential of a Fuel: Enthalpy of Reactions – Work Potential of a Fuel: Gibbs Free energy - Predicting Reversible Voltage of a Fuel Cell under Non-standard state Conditions- Fuel Cell Efficiency- Efficiency calculation.		

MODULE 5	**HYDROGEN PRODUCTION TECHNIQUES AND STORAGE**	**8 Hours**
Production of hydrogen – steam reforming – water electrolysis – gasification and woody biomass conversion – biological hydrogen production – photo dissociation – direct thermal or catalytic splitting of water - Hydrogen storage options – compressed gas – liquid hydrogen – Hydride – chemical Storage – comparisons.		

MODULE 6	APPLICATION OF FUEL CELL AND ECONOMICS	7 Hours
Fuel cell usage for domestic power systems- large scale power generation- Automobile, Space. Economic and environmental analysis on usage of Hydrogen and Fuel cell- Cost of electricity- Future trends in fuel cell.		
		45 Hours

Text Books	
1.	Viswanathan. B and Aulice Scibioh. M., "Fuel Cells: Principles and applications", CRC Press.2008, ISBN-13: 978-1420060287.
2.	Noriko Hikosaka Behling, "Fuel cells", Elsevier publishers, 2012, ISBN 9780444563255
3.	Barclay F.J., "Fuel Cells, Engines and Hydrogen", Wiley, 2006, 978-0-470-01904-7.
Reference Books	
1.	Bent Sorensen "Hydrogen and Fuel cells", Academic Press, 2011,ISBN 9780123877093.
2.	Rebecca L., Busby, "Hydrogen and Fuel Cells: A Comprehensive Guide", PennWell Corporation, Oklahoma, 2005. ISBN-13: 978-1593700430.

Recommended by Board of Studies	27-08-2022
Approved by Academic Council	24th September 2022

Prepared by Dr. D. Philip Selvaraj

Course Code	MEMS AND MICRO SYSTEM FABRICATION	L	T	P	C
21ME2012		3	0	0	3

Course Objectives: To impart knowledge on

1. The principles of Micro fabrication techniques.
2. Mechanisms of micro sensors and micro actuators.
3. Designing MEMS devices for industrial applications.

Course Outcomes: At the end of this course the students will be able to

1. Illustrate the concepts of MEMS and Microsystems.
2. Identify various sensors and actuators in MEMS.
3. Select suitable material for MEMS and Microsystems.
4. Demonstrate the principles and applications of micro-fabrication processes.
5. Interpret the various micro-manufacturing processes used in MEMS industries.
6. Develop MEMS and Microsystems for industrial applications.

MODULE 1	MEMS AND MICRO SYSTEMS	8 Hours
Multidisciplinary Nature of Microsystems, Energy Domains, Scaling Laws in Miniaturization, Electrical and Mechanical Concepts, Materials for Microsystems.		
MODULE 2	**MEMS DEVICES AND SYSTEMS**	**8 Hours**
MEMS Sensors, Micro actuators, Microfluidics and Micro Optics – Electrostatic, piezoelectric, SMA, Thermoelectric, electromagnetic and MOEMS.		
MODULE 3	**MATERIALS IN MEMS**	**8 Hours**
Silicon and its compounds, GaAs, Piezoelectric and Piezo resistive Materials, polymers. Stress–strain, material properties, measurement & characterization of mechanical parameters.		
MODULE 4	**MICROSYSTEMS FABRICATION**	**7 Hours**
Photolithography, Ion Implantation, Diffusion, Oxidation, Chemical Vapour Deposition, Physical Vapour Deposition-Sputtering, Deposition by Epitaxy, Etching.		
MODULE 5	**MICRO MANUFACTURING**	**7 Hours**
Bulk Micro manufacturing, Surface Micromachining, LIGA Process, Microsystem Assembly and Testing.		
MODULE 6	**APPLICATIONS OF MEMS**	**7 Hours**
Applications of micro systems in Automobile, Aeronautical, Aerospace, Medical, Marine, Defence, Robotics and Automation.		
	Total Hours	**45 Hours**

Text Books	
1.	Tai-Ran Hsu, "MEMS and Microsystems: Design and Manufacture", McGraw Hill Education, 2001, ISBN 978-0072393910.
Reference Books	
1	Marc J. Madou, "Fundamentals of Microfabrication and Nanotechnology", CRC Press, 2011, ISBN 9780849331800.
2	Mohamed Gad-el-Hak, "The MEMS handbook: MEMS Applications", CRC press, 2006, ISBN 978-0-8493-9138-5.
3	Stephen D Senturia, "Microsystem Design", Kluwer Academic Publishers, 2001, ISBN 978-1-4757-7458-0.
4	Thomas M. Adams and Richard A. Layton, "Introductory MEMS: Fabrication and Applications", Springer, 2010, ISBN 978-0-387-09511-0.

Recommended by Board of Studies	27-08-2022
Approved by Academic Council	24th September 2022

Prepared by: Dr S J Vijay

Course code	DESIGN FOR ADDITIVE MANUFACTURING	L	T	P	C
21ME2013		**3**	**0**	**0**	**3**

Course Objectives: To impart knowledge on

1. Additive Manufacturing (AM) technologies implemented in the manufacturing industries.
2. The optimization techniques for prototyping.
3. Designing of support structures for complex geometries.

Course Outcomes: At the end of the course, the students will be able to

1. Classify various AM technologies suitable for entrepreneurial opportunities.
2. Select appropriate AM Technology for generating prototypes.
3. Apply optimization techniques for part building, support structures and tool path generation.
4. Examine vat polymerization and material extrusion processes.
5. Evaluate process variables for metal additive manufacturing.
6. Design multi type AM techniques for enhancing the design support for industrial components.

MODULE 1	CONCEPT OF DFAM	8 Hours
Evolution of AM technologies development trajectories – Techno-Economic motivation for DFAM. Benefits of AM – DFAM opportunities for digital design and data management – DFAM Principles, Strategies and Applications.		

MODULE 2	DEVELOPMENT OF AM TECHNOLOGIES	8 Hours
Rapid Prototyping and Tooling, Rapid Manufacturing, AM Process Chain and Classification – Economics of AM- Benefits and Emerging applications in industries.		

MODULE 3	DESIGN AND OPTIMIZATION	7 Hours
AM Unique Capabilities: Part Consolidation, Topology Optimization, Lightweight Structure, DfAM for Part Quality Improvement. Data Processing, Part Orientation and Support Structure Generation, Model Slicing, Tool Path Generation, Customized Design and Fabrication-Case Studies.		

MODULE 4	AM TECHNOLOGIES FOR POLYMERS	7 Hours
Vat Polymerization and Material Extrusion, Photo polymerization: Stereo Lithography Apparatus (SLA), Digital Light Processing (DLP), Extrusion Based System: Fused Deposition Modeling (FDM).		

MODULE 5	METAL ADDITIVE MANUFACTURING TECHNOLOGIES	8 Hours
Selective Laser Sintering (SLS), Selective Laser Melting (SLM), Electron Beam Melting (EBM), Laser Engineered Net Shaping (LENS), Direct Energy Deposition (DED). Powder Fusion Mechanism.		

MODULE 6	APPROACH TO DESIGN FOR ADDITIVE MANUFACTURING	7 Hours
DfAM operational model, Design thinking, Multi type, Design Process – Models and Methods and Compensate Spare Parts, Production Aids-Enhancing the design.		

	45 Hours

Text Books

1.	Martin Leary, Design for Additive Manufacturing (Additive Manufacturing Materials and Technologies) Elsevier Science Publishing Co Inc. 2019 .ISBN-13 : 978-0128167212.
2.	C.P. Paul and A.N. Jinoop, Additive Manufacturing, McGraw Hill; 1st edition, 2021. ISBN-10 : 9390727480 , ISBN-13 : 978-9390727483.

Reference Books

1.	Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani, Additive Manufacturing Technologies, Springer; 3rd edition, 2021. ISBN-13 : 978-3030561260.
2.	C.K. Chua, K.F. Leong and C.S. Lim, Rapid prototyping: principles and applications, 3rd Edition, World Scientific, 2010, ISBN-13: 978-9812778987.

Recommended by Board of Studies	27-08-2022
Approved by Academic Council	24th September 2022

Prepared by Dr.M.Wilson Kumar

Course code	ADVANCED ADDITIVE MANUFACTURING LABORATORY	L	T	P	C
21ME2014		0	0	4	2

Course Objectives: To impart knowledge on

1. Evolution of AM technologies implemented in industries.
2. Principles on optimization techniques for prototyping.
3. Techniques on multi type models and designing of support structures for complex geometries.

Course Outcomes: At the end of the course, the students will be able to

1. Build CAD models for additive manufacturing.
2. Develop support structures for generating prototypes.
3. Propose appropriate orientation to build prototypes in AM machines.
4. Create physical prototypes using liquid-based AM Techniques.
5. Construct complex models using solid-based AM Techniques
6. Combine reverse engineering with AM to make industry ready components.

List of Experiments:

1. Generation and working with STL files from the CAD models.
2. Designing complex geometries and generating STL files from CAD Models.
3. Design and 3D printing of four-stroke engine piston rod and generating the G-code file.
4. Design and 3D printing of a ship rudder and its related components.
5. Design and 3D printing of a propeller and its nose nut of a quad copter drone.
6. Design and 3D Printing of electric vehicle battery chassis.
7. Generating STL and G-codes files for printing of components through the liquid-based printer.
8. Generating local and global support structures for optimal printing through slicing softwares.
9. Design, printing, and assembly of knuckle joint
10. Design, printing, and assembly of the transmission system.
11. Applying the concept of reverse engineering to generate CAD models.
12. Evaluating the surface finish of the printed components through post-processing techniques.

Reference Books

1.	User manual

Recommended by Board of Studies	27-08-2022
Approved by Academic Council	24th September 2022

Prepared by Dr.M.Wilson Kumar

Course code	DESIGN OF ELECTRIC VEHICLES AND BATTERY MANAGEMENT	L	T	P	C
21ME2015		3	0	0	3

Course Objectives: To impart knowledge on

1. Designing Electric vehicle dynamics.
2. AC and DC motor drive configurations and characteristics.
3. Implementing the standards in battery management systems.

Course Outcomes: At the end of the course, the students will be able to

1. Demonstrate the EV kinetics and dynamics.

2. Identify appropriate motor and converter for EV applications. 3. Select suitable standards for the motor drive. 4. Estimate transmission drive configuration and characteristics of EV. 5. Analyze the different battery parameters and characteristics for specific applications. 6. Design efficient battery management system (BMS) for EV.		
MODULE 1	**VEHICLE MECHANICS**	**6 Hours**
Electric Vehicles - Roadway Fundamentals - Laws of Motion - Vehicle Kinetics - Dynamics of Vehicle Motion - Propulsion Power - Velocity and Acceleration - Propulsion System Design.		
MODULE 2	**ELECTRIC MACHINES AND POWER ELECTRONICS**	**8 Hours**
Motor and Engine Ratings - EV and HEV Motor Requirements - DC Machines - 3-Phase AC Machines - Induction Machines - Regenerative Braking – dq Modeling. Power Electronic Electric Drive Components - Power Electronic Switches - DC Drives - 2-Quadrant Chopper - Open-Loop Drive.		
MODULE 3	**DC AND AC MOTOR DRIVES AND CONTROLS**	**10 Hours**
Permanent Magnet Machines (PR) - Permanent Magnets (PM) - PM Synchronous Motors - PMSM Models - PM Brushless DC Motors - Switched Reluctance Machines (SRM) - Configuration – Principle - Design. AC Drive – Operation - Pulse Width Modulation - Current and Vector Control of AC Motors - PM Synchronous Motor Drives - SR Motor Drives.		
MODULE 4	**ELECTRIC VEHICLE DRIVETRAIN**	**8 Hours**
EV Transmission Configurations - Transmission Components (Gear, Automobile differential, Brakes, Clutch) – Gearbox - Gear Ratio - Torque-Speed Characteristics - EV Motor Sizing - Initial Acceleration - Rated Vehicle Velocity - Maximum Velocity - Maximum Gradability.		
MODULE 5	**BATTERY**	**7 Hours**
Battery Basics - Lead-Acid Battery - Construction - Alternative Batteries - Nickel-Metal-Hydride (NiMH) Battery, Li-Ion Battery, Li-Polymer Battery, Zinc-Air Battery, Sodium-Sulfur Battery, Sodium-Metal-Chloride Battery - Battery Parameters - Technical Characteristics - Targets and Properties of Batteries - Battery Modeling.		
MODULE 6	**BATTERY MANAGEMENT SYSTEM**	**6 Hours**
BMS - rule based control - optimization based control and battery life - Battery Pack Safety, Battery Standards & Tests - mode of power - behavior of motor - Advanced features.		
		45 Hours

Text Books

1.	Iqbal Hussein, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 2021, ISBN 9780367693930.
2.	James Larminie, John Lowry, “Electric Vehicle Technology Explained”, Wiley, 2012, ISBN 9781119942733.
3.	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2004, ISBN 978-0849331541.

Reference Books

1.	C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001, ISBN: 0198504160.
2.	T R Crompton, “Battery Reference Book-3 rd Edition”, Newnes- Reed Educational and Professional Publishing Ltd., 2000, ISBN 13: 9781560918059.
3.	Ibrahim Dinçer, Halil S. Hamut and Nader Javani, “Thermal Management of Electric Vehicle Battery Systems”, John Wiley& Sons Ltd., 2016, ISBN 9781118900246.
4	Guangjin Zhao, “Reuse and Recycling of Lithium-Ion Power Batteries”, John Wiley & Sons. 2017, ISBN: 978-1-1193-2185-9.

Recommended by Board of Studies	27-08-2022
Approved by Academic Council	24th September 2022

Prepared by Dr S. Mohanasundaram

Course code	ELECTRIC VEHICLES LABORATORY	L	T	P	C
21ME2016		**0**	**0**	**4**	**2**

Course Objectives: To impart knowledge on

1. Various types of sensors and batteries in electric vehicle systems.
2. The working of DC and AC Motors.
3. The performance characteristics of AC and DC Drives.

Course Outcomes: At the end of the course, the students will be able to

1. Demonstrate the working principle and various parts of sensors and Batteries.
2. Conduct the performance test of DC and AC motors at different speed.
3. Analyze the switching characteristics of Power Semiconductor Devices.
4. Estimate the speed control of Induction Motor with Solid state converters.
5. Determine the speed of DC Motor with Solid State converters.
6. Predict the performance of Synchronous Motor with Solid state converter.

List of Experiments:

1. Study of different sensors used in electric vehicles system.
2. Experiment on testing and study of different types of batteries and constructions.
3. Performance and speed control of 3-phase Induction motor using 3-phase PWM Inverter.
4. Experiment for conversion of DC to DC voltage using converter.
5. Speed Control of DC Shunt Motor.
6. Speed Control of Three Phase Squirrel Cage Induction Motor.
7. Speed Control of Three Phase Slip Ring Induction Motor.
8. Switching Characteristics of Power Semiconductor Devices (SCR, MOSFET, IGBT).
9. Performance of Chopper fed D.C. Drive
10. Three Phase Converter Fed DC Drive.
11. Cyclo-converter Fed Synchronous Motor Drive.
12. Electronics Starter and Speed Controller of DC motor.
13. Simulation for AC to AC conversion.
14. Simulation for AC to DC conversion.
15. Simulation for DC to AC conversion.

Reference Books

1. User manual

Recommended by Board of Studies	27-08-2022
Approved by Academic Council	24th September 2022

Prepare by Dr M.T. Suresh

Course code	INTEGRATED FMS FOR INDUSTRY 4.0	L	T	P	C
21ME3013		3	0	0	3

Course Objectives: To impart knowledge on

1. Flexible manufacturing systems (FMS) and its relevance to Industry 4.0.
2. The components of FMS and its performance.
3. The integration of FMS and modern manufacturing support systems.

Course Outcomes: At the end of the course, the students will be able to

1. Demonstrate the Group Technology concepts in a manufacturing environment.
2. Influence cellular manufacturing and its performance in an automated production environment.
3. Estimate utilization and performance measures of each workstation in FMS.
4. Evaluate data base simulation accuracy in a FMS system.
5. Analyze the automated manufacturing systems for FMS.
6. Implement modern manufacturing support systems for realization of Industry 4.0.

MODULE 1	GROUP TECHNOLOGY AND FMS	8 Hours

Manufacturing systems, CIM Technology, CIM models, manufacturing cell. Group technology-classification and coding, machine cell design-simple examples in design. FMS Concepts – types of flexibility and performance measures, FMS layouts, application and benefits of FMS.

MODULE 2	CELLULAR MANUFACTURING & QUANTITATIVE ANALYSIS OF FMS	8 Hours

Coding schemes – assigning machines to groups – production flow analysis, binary ordering algorithm, single pass heuristic, similarity coefficients, graph partition - assigning parts to machines. Grouping of machines problems using Rank order clustering technique, Hollier Method I and II.		
MODULE 3	**DEVELOPMENT AND IMPLEMENTATION OF FMS**	**7 Hours**
Development and implementation of FMS: Planning phases, scheduling – integration – system. Configuration – simulation – FMS project development steps, hardware and software development. Installation and implementation, Quantitative analysis of FMS-Sizing of FMS problem-Utilization of each workstation in Bottleneck model on a simple problem		
MODULE 4	**FMS DATA BASE AND SIMULATION**	**7 Hours**
Manufacturing Data systems - planning FMS data base - Modeling of FMS- analytical – heuristics – queuing - simulation modeling techniques.		
MODULE 5	**AUTOMATED MANUFACTURING SYSTEMS**	**8 Hours**
Principles of Automated manufacturing systems, application of automated production lines, analysis of transfer lines with no internal storages, , analysis of transfer lines with storage buffers, performance measures and effectiveness of these systems.		
MODULE 6	**MODERN MANUFACTURING SUPPORT SYSTEMS & INDUSTRY 4.0**	**7 Hours**
Computer aided process planning (CAPP), Lean production ,Agile manufacturing, JIT production systems, Industrial robotics-Robot anatomy and related attributes, Robot control systems, End effectors and industrial Robot applications-Salient features of Industry 4.0-Integration of FMS with Industry 4.0		
		45 Hours
Text Books		
1.	Groover, Automation, Production systems and computer integrated manufacturing, Pearson, 2016, ISBN-13: 978-9332572492.	
2.	P Radhakrishnan, CAD CAM CIM, New Age International Publishers, New Delhi ,Third Edition,2007, ISBN-13: 978-8122422368.	
Reference Books		
1.	H.K.Shivanand, Benal, Koti. Flexible Manufacturing System, New Age International Publishers, New Delhi,2021, ISBN: 9789386070227.	
3.	Zubair M Mohamed, Flexible Manufacturing System-Planning issues and Solutions, Routledge Taylor &Francis, 2018, ISBN: 9780429456718.	
Recommended by Board of Studies	27-08-2022	
Approved by Academic Council	24th September 2022	

Prepared by Dr.Sabitha Jannet

Course code	TOOL DESIGN FOR ADVANCED MANUFACTURING	L	T	P	C
21ME3014		3	0	0	3

Course Objectives: To impart knowledge on

1. Different types of cutting tools, tool geometry, forces involved and their applications.
2. Design criteria for jigs and fixtures used in machine tools.
3. Tool design for CNC machine tools

Course Outcomes: At the end of the course, the students will be able to

1. Infer the principles and procedures for tool design
2. Design single point and multipoint cutting tools
3. Develop jigs and fixtures for machine tools
4. Categorize tools for different operations
5. Maximize the performance of press tools for sheet forming operations
6. Choose appropriate tools for a CNC machine

MODULE 1	**INTRODUCTION TO TOOL DESIGN AND TOOLING MATERIALS**	**8 Hours**
Introduction – Tool Engineering – Tool Classifications – Objectives – Tool Design in manufacturing - Challenges and requirements - Standards in tool design - Tool drawings - Fits and Tolerances - Tooling		

Materials - Ferrous and Nonferrous Tooling Materials - Carbides, Ceramics and Diamond - Non-metallic tool materials Designing with relation to heat treatment.		
MODULE 2	**DESIGN OF CUTTING TOOLS**	**8 Hours**
Mechanics of Metal cutting – Oblique and orthogonal cutting - Chip formation and shear angle - Single-point cutting tools – Milling cutters – Hole making cutting tools - Broaching Tools - Design of Form relieved and profile relieved cutters - Design of gear and thread milling cutters.		
MODULE 3	**DESIGN OF JIGS AND FIXTURES**	**7 Hours**
Introduction – Fixed Gages – Gage Tolerances - selection of material for Gages – Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs - General considerations in the design of drill jigs – Drill bushings – Methods of construction –Thrust and Turning Moments in drilling - Drill jigs and modern manufacturing- Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures – Modular Fixtures – Cutting Force Calculations.		
MODULE 4	**DESIGN OF PRESS TOOLS FOR BULK FORMING OPERATIONS**	**7 Hours**
Bulk metal forming tools – Forging dies – Definition – Influence of temperature and external pressure – Types of forging dies, open die forming closed die forging – Methods of open die forging – Allowance and tolerances applicable to closed die forging – Factors to be considered – Forging equipment.		
MODULE 5	**DESIGN OF PRESS TOOLS FOR SHEET METAL OPERATIONS**	**8 Hours**
Press tools - Dies: Types of Dies –Method of Die operation - Clearance and cutting force calculations - Blanking and Piercing die design – Pilots – Strippers and pressure pads- Presswork materials – Strip layout – Short-run tooling for Piercing – Bending dies – Forming dies – Drawing dies - Design and drafting.		
MODULE 6	**TOOL DESIGN FOR CNC MACHINE TOOLS**	**7 Hours**
Introduction –Tooling requirements for Numerical control systems - Fixture design for CNC machine tools - Sub plate and tombstone fixtures - Universal fixtures - Cutting tools - Tool holding methods - Automatic tool changers and tool positioners – Tool pre-setting – General explanation of the Brown and Sharp machine.		
		45 Hours

Text Books	
1.	Cyril Donaldson, George H. LeCain, V.C. Goold, “Tool Design”, 5th Edition, McGraw Hill Publishing Company Ltd., 2017, ISBN-13: 978-9352605798.
2.	Prakash Hiralal Joshi, “Tooling data”, Wheeler Publishing, 2001, ISBN: 8175441720, 9788175441729.
Reference Books	
1.	Venkataraman K., “Design of Jigs, Fixtures and Press tools”, John Wiley and Sons Ltd, 2015, ISBN 9781119155676 .
2.	B. L Juneja, G. S Sekhon, Nitin Seth, Fundamentals of Metal Cutting and Machine Tools, , New Age international (P) Ltd., New Delhi, 2017, ISBN-13: 978-8122414677.
3.	Milton C Shaw, Metal Cutting Principles, Oxford University Press, 2nd Edition, 2004, ISBN 9780195142068.

Recommended by Board of Studies	27-08-2022
Approved by Academic Council	24th September 2022

Prepared by Dr. K. Leo Dev Wins

Course Code	ERGONOMICS AND STANDARDS FOR DESIGNING PUBLIC TRANSPORT VEHICLES	L	T	P	C
22ME3001		3	0	0	3

Course Objectives: To impart knowledge on

1. The Ergonomic design of public transport vehicles in Indian context and special populations.
2. Biomechanics of human body movements and design standards.
3. Standards, regulations and patents related to automobile design.

Course Outcomes: At the end of the course, the students will be able to

1. Demonstrate the philosophies of design for special population
2. Relate the principles of Ergonomics for industrial personnel.
3. Apply the laws of biomechanics of human body movement.
4. Analyze the elements of automobile structure.
5. Design ergonomically safe automobile structure.
6. Develop appropriate standards and regulations related to automobile design.

MODULE 1	APPLIED ERGONOMICS	8 Hours

The Human body- Skeletal system, Body planes, Body somatotypes, Anthropometry, Development of anthropometry, Incompatible anthropometric design implications in Indian context, Need for Indian anthropometric data, State-of-the-art anthropometry in India. Anthropometry-Structural (Static) dimensions and functional (Dynamic) dimensions.

MODULE 2	DESIGN FOR SPECIAL POPULATION	8 Hours

Special designs for men and women, Sensory abilities, Motor skills, coping with environmental stress- Designing for children, Changes in Somesthetic Sensitivity, Changes in Psychometric Performance- Ergonomic design for the disabled persons, Design for one, Ergonomic-means to enable the disabled, Classification of impairments.

MODULE 3	BIOMECHANICS OF HUMAN BODY	8 Hours

Biomechanics: Human skeletal System-Bone, joints, artificial joints, spinal column, muscles. Biomechanical description of the human Body-Links, Joints and Masses, Body kinetics and describing the human motion. Human System and Human System Modelling. Biostatic Mechanics-Statics of the musculoskeletal system, upper extremity and hand, lower extremity and foot. Biodynamic mechanics- human body kinematics, human body kinetics.

MODULE 4	AUTOMOTIVE BODY STRUCTURAL ELEMENTS	7 Hours

Overview of Classical Beam Behavior, Design of Automotive Beam Sections, Torsion of Thin-Wall Members, Thin-Wall Beam Section Design in Automobiles, Buckling of Thin-Walled Members, Automobile Body Panels: Plates, Membranes. Metals and materials used for fabricating different parts of the automobile body and structure

MODULE 5	DESIGN OF AUTOMOBILE BODY STRUCTURE	7 Hours

The Automobile Body- Description of the Automobile Body Types, Body Nomenclature, Design for Crashworthiness- Standardized Safety Test Conditions and Requirements, Design for Vehicle and Styling Integration- Designing the Best Body Structure, Vehicle Layout, Body Structure Topology, Load Path Design at Suspension Attachments.

MODULE 6	AUTOMOTIVE INDUSTRY STANDARDS & PATENTS	7 Hours

Introduction, Scope & Definitions, General Requirements, standards and testing of Bus Body Design, Technical & Safety Requirements and Testing standards. Lighting & Illumination, Electrical Equipment & Wiring, Test Methods, Type Approval & COP Conformity of Production and Procedure. Patents related to bus stair-case mechanisms.

Total Hours	**45 Hours**

Text Books

1. Karl Kroemer, Henrike Kroemer and Katrin Kroemer-Elbert, Ergonomics-How to Design for Ease and Efficiency, Academic Press; 3rd edition, 2018, ISBN 9780128132968.

2.	Donald E. Malen, Fundamentals of Automobile Body Structure Design. 2nd edition. SAE International. 2011, ISBN-13: 978-0768021691.
Reference Books	
1	Deb Kumar Chakravarthy, Indian Anthropometric Dimensions-for Ergonomic Design Practice, National Institute of India,1997. (Data book) ISBN 81-86199-15-0.
2	Mark S. Sanders, Ernest J. McCormick, Human Factors in Engineering and Design, McGraw Hill. 1993, ISBN: 0071128263, 9780071128261.
3	Joseph D Miller, Automotive system safety- Critical Conditions for Engineering and Management,1st Edition. Wiley Publications. 2019, ISBN 978-1119579625.
4	Julius Panero, Martin Zelnik - Human Dimension and Interior Space - A Source Book of Design Reference Standards-Watson-Guptill.2014, ISBN-13:978-0823072712.
5	Code of Practice for Bus Body Design and Approval. AIS-052 (Revision 1): 2008. https://www.araiindia.com/cpanel/Files/PUB_10~4~2011~10~12~04~AM~AIS-052_Rev_1_and_Amd_1.pdf

Recommended by Board of Studies	27-08-2022
Approved by Academic Council	24th September 2022

Prepared by: Dr. G. Babu Rao & Dr Wilson Kumar

DEPARTMENT OF MECHANICAL ENGINEERING

LIST OF NEW COURSES

S. No	Course Code	Course Title	Hours per Week			Credits
			L	T	P	
		B.Tech. Mechanical Engineering				
1	20ME2001	Engineering Design and Analysis Laboratory	0	0	4	2
2	20ME2002	CNC Programming	3	0	0	3
3	20ME2003	Production and Metrology Laboratory	0	0	4	2
4	20ME2004	Design of Medical Devices and Implants	3	0	0	3
5	20ME2005	Computational Fluid Dynamics Laboratory	0	0	2	1
6	20ME2006	Engineering Economics and Operation Research	3	0	0	3
7	20ME2007	Automation of Product Life Cycle Management	3	0	0	3
8	20ME2008	Application of Machine Learning for Mechanical Engineering Systems	3	0	0	3
9	20ME2009	Intelligent Robotic System	3	0	0	3
10	20ME2010	Kinematics and Dynamics of Machinery	3	1	0	4
11	20ME2011	Finite Element Methods in Engineering	3	0	0	3
12	20ME2012	Internet of Things for Mechanical Systems	3	0	0	3
13	20ME2013	Sensor Technology for Machines	3	0	0	3
14	20ME2014	Industrial Safety and Quality Standards	3	0	0	3
15	20ME2015	Applied Thermodynamics Laboratory	0	0	4	2
16	20ME2016	Fluid Mechanics and Fluid Machines	2	1	0	3
17	20ME2017	Automotive Materials and Electronics	3	0	0	3
18	21ME2001	Fluid Mechanics and Strength of Materials Laboratory	0	0	4	2
19	21ME2002	Strength of Materials	3	0	0	3
20	21ME2003	Design of Machine Elements	3	0	0	3
21	21ME2004	Computer Aided Manufacturing Laboratory	0	0	2	1
22	21ME2005	Heat Transfer Laboratory	0	0	2	1
23	21ME2006	Heat and Mass Transfer	3	0	0	3
24	21ME2007	Computational Fluid Dynamics	3	0	0	3
25	21ME2008	Biomechanics and Biomaterials	3	0	0	3
26	21ME2009	Application of AI for Mechanical Engineering Systems	2	0	2	3
		M.Tech. Advanced Manufacturing Technology				
1	20ME3008	Non-Destructive Testing and Inspection	3	0	0	3
2	20ME3009	New-Age Materials	3	0	0	3
3	20ME3010	Process Safety Management in Industry	3	0	0	3
4	20ME3011	Materials and Characterisation Techniques	3	0	0	3
5	20ME3012	Materials Fracture and Failure Analysis	3	0	0	3
6	21ME3001	Finite Element Methods in Engineering	3	0	0	3
7	21ME3002	Total Quality Management	3	0	0	3
8	21ME3003	Design For Manufacturing and Assembly	3	0	0	3
9	21ME3004	Manufacturing System and Simulation	3	0	0	3
10	21ME3005	Computer Applications in Design	3	0	0	3
11	21ME3006	Advanced Computer Aided Manufacturing Laboratory	0	0	4	2
12	21ME3007	Design of Fluid Power Systems	3	0	0	3
13	21ME3008	Control of CNC Machine tools	3	0	0	3
14	21ME3009	Advanced Metal Cutting Theory	3	0	0	3
15	21ME3010	Quality Concepts in Design	3	0	0	3
16	21ME3011	Analysis and Simulation Laboratory	0	0	4	2
17	21ME3012	Mechatronics and Robotics Laboratory	0	0	4	2
		PhD Courses				
1	21ME3015	Ergonomics in Bio-Medical Instrumentation	3	0	0	3
2	21ME3016	Microcontrollers for Sensor Control and Interfaces	3	0	0	3

Course Code	ENGINEERING DESIGN AND ANALYSIS LABORATORY	L	T	P	C
20ME2001		0	0	4	2

Course Objective: To impart knowledge on

1. Modelling products of the industrial system.
2. Application of structural and thermal analysis.
3. Solving a variety of flow situations

Course Outcome:

The student will be able to

1. Prepare 3D models and drafting for various mechanical components.
2. Build the Assembly model and create a bill of materials.
3. Create 3D models using surface modelling.
4. Solve structural, thermal, modal and dynamics problems.
5. Understand the flow through the duct and elbow.
6. Conduct coupled structural and thermal analysis

List of Experiments

1.	Part modeling using Extrude, Revolve, hole and pattern commands and Drafting
2.	Part modeling using Sweep, variable section sweep and helical sweep and Drafting
3.	Assembly of part drawings and Drafting of the assembly with the bill of materials - revolveetc drawing commands, editing or modifying commands
4.	Assembly of part drawings and Drafting of the assembly with the bill of materials
5.	Surface Modeling – introduction.
6.	Structural analysis of 2D Truss and Bicycle frame.
7.	2D static analysis of the bracket etc.
8.	Modal and harmonic analysis of cantilever beam.
9.	Thermal analysis of 3D Fin Analysis.
10.	Flow-through a duct and elbow.
11.	Kinematic analysis of the mechanism.
12.	Coupled structural and thermal analysis.
Total Lectures	**48 Hours**

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by: Mr. S. Mohanasundaram

Course Code	CNC PROGRAMMING	L	T	P	C
20ME2002		3	0	0	3

Course Objectives:

To impart knowledge on

1. CNC programming, hydraulic system
2. CNC interpolation, DDA integrator
3. CNC control loops and architecture

Course Outcomes:

The student will be able to

1. Understand the control systems for CNC machine tool and Select the components of CNC architecture
2. Articulate the principles of motors, Feedback devices and hydraulic system
3. Compare the interpolation methods in CNC control system
4. Propose the PLC programming Languages.
5. Recommend PID controllers, servo controller, Numerical control Kernel types
6. Design and evaluate CNC programming techniques for various industrial applications.

Module: 1	**CNC ARCHITECTURE**	**10 Hours**

NC elements - CNC systems - CNC Driving System, CNC Control Loop and components. Interpreter – Part Program, Coordinate systems. CNC Architecture - Numerical control kernel- types, Programmable Logic Control, CNC programming, languages, Human-Machine Interface functions, structure, Introduction to Open CNC architecture.

Module: 2	**CNC DRIVES AND FEEDBACK DEVICES**	**6 Hours**

CNC drives Hydraulic systems, servo and stepping motors, response analysis, Feedback devices like encoders, Resolvers, potentiometers etc. and counter.

Module: 3	**CNC HARDWARE AND SOFTWARE INTERPOLATORS**	**8 Hours**
CNC Interpolation – Hardware interpolators- DDA integrator, linear, circular, complete interpolators. Software interpolators, Tustin method, NURBS and polynomial interpolators.		
Module: 4	**CNC PROGRAMMING TECHNIQUES AND LANGUAGES**	**7 Hours**
G & M-code Interpreter, Interpolation Functions, feed, tool and spindle functions, fixed-cycle, skip, program verification, preparatory functions, miscellaneous functions, tool length compensation, canned cycles, cutter radius compensation. APT Language.		
Module: 5	**CNC CONTROL LOOPS**	**7 Hours**
Introduction, Servo Controller, Servo Control for Positioning, Position Control, Analysis of the Following Error. Simple Problems. Acceleration and deceleration control techniques.		
Module:6	**CNC PROGRAMMING APPLICATIONS**	**7 Hours**
Turning Centre programming – cut planning, thread cutting, canned cycles. Advanced part programming methods – looping & jumping, subroutines, mirror imaging and scaling, special canned cycles. Case studies. Advanced Problems.		
	Total Lectures	**45 Hours**

Text Books	
1.	Suk-Hwan Suh and Ian Stroud, Gloud, Theory and Design of CNC Systems, Springer, 2008
2.	P.N. Rao., CAD/CAM: Principles and applications, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2010
Reference Books	
1.	YoramKoren, “Computer Control of Manufacturing Systems” McGraw-Hill, 1985.
2.	Yusuf Altintas, “Manufacturing Automation Metal Cutting Mechanics, Machine Tool, Vibrations, and CNC Design”, Second edition, Cambridge University Press, 2012.
3.	Groover Mikell P., Automation, Production Systems, and Computer Integrated Manufacturing, Prentice Hall of India, New Delhi, 2008
4.	Radhakrishnan P., Computer Numerical Control Machines, New Central Book Agency (P) Ltd., Kolkata, 2004.
5.	Yoram Koren and Joseph Ben Uri, Numerical Control of Machine Tools, Khanna Publishers, 2000.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by: Dr. Mona Sahu

Course Code	**PRODUCTION AND METROLOGY LABORATORY**	**L**	**T**	**P**	**C**
20ME2003		**0**	**0**	**4**	**2**

Course Objective:

Impart knowledge on

1. Microstructure and performance of materials.
2. The principles of linear and angular measurements.
3. Fundamental systems of fluid power controls.

Course Outcome:

The student will be able to

1. Prepare samples for metallurgical studies by following appropriate metallographic procedure and extract metallographic images.
2. Analyze various phases of Iron-Carbon alloys.
3. Demonstrate measurements using linear and angular measuring instruments.
4. Calibrate linear and angular measuring instruments.
5. Assess the components of pneumatic systems.
6. Build logic circuits for industrial problems.

List of Experiments	
1.	Boring a gear blank and bore diameter measurement using micro meter and telescopic gauge.
2.	Spur gear cutting using gear hobbing and measurement of gear elements using Tool Maker’s Microscope.
3.	Machining rectangular block using milling machine and measurement of cutting force during milling operation.

4.	Surface grinding and measurement of surface finish measurement using Perthometer.
5.	Use of dial gauge as a mechanical comparator and measurement of angle using sine bar and sine centre.
6.	Flatness and Angular measurement using Autocollimator.
7.	Inspection of internal and external diameter of cylindrical samples using pneumatic comparator
8.	Establishing the control charts for the given sample work pieces.
9.	Determination of strength and permeability of foundry sand and sieve analysis.
10.	Identification of Cast Iron specimen (a) Grey Cast Iron(b) Spheroidal Graphite Iron (c) Malleable Cast Iron.
11.	Identification of Heat-treated steels: (a) Annealed (b) Normalized (c) Hardened (d) Tempered steels and Case-Hardened Steel.
12.	Identification of brasses, bronzes and aluminium.
	Total Lectures **30 Hours**

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by: Dr. K. Leo Dev Wins

Course Code	**DESIGN OF MEDICAL DEVICES AND IMPLANTS**	**L**	**T**	**P**	**C**
20ME2004		**3**	**0**	**0**	**3**

Course Objectives:

To impart knowledge on

1. The classification of medical devices and the design process.
2. The generation of ideas and design implementational procedures.
3. Quality n design and the risk management of new medical devices.

Course Outcomes:

The student will be able to

1. Understand the class of medical devices and design cycle.
2. Apply the design process and different design models.
3. Evaluate the design procedures.
4. Have in-depth knowledge about blood interfacing implants
5. Evaluate the design quality and realization.
6. Test the design and evaluate the risk management involved in the design of new medical device.

Module: 1	**CLASSIFYING MEDICAL DEVICES AND DESIGN PROCESS**	**8 Hours**

The Design Life Cycle. Medical Devices Definitions. FDA based Medical Device categorization - three classes – Class I, II, or III. Classification Rules. Classification Case Study. Classification Models. Classification and the Design Process. Design Process versus Design Control. Design Models- Pahl and Beitz, and Pugh Model. Concurrent Design/Concurrent Engineering, Cross-Reference with Regulatory Requirements. Basic understanding of ISO13485 regulations.

Module: 2	**DESIGN PARAMETERS**	**8 Hours**

Design Specifications: Biomaterials Survey. Biocompatibility: Local and Systemic Effects of implants. Bio-adhesion. Design Specifications: Tissue Bonding and Modulus Matching. Toxicity – Titanium, Zirconia implants. Degradation of Devices: Natural and Synthetic Polymers. Biocompatibility: Scar Formation and Contraction. Degradation of Devices: Corrosion and Wear.

Module: 3	**BASICS OF DESIGN OF MEDICAL DEVICES**	**8 Hours**

Artificial heart: engineering design & concerns, circulatory assist devices, cardiac valve prostheses. Cardiopulmonary bypass (heart-lung machine) - principle, block diagram and working, artificial lung versus natural lung, Design of mechanical ventilator. Design of Dialysis equipment. design of Portable Oxygen Concentrator – POCs and basic operation of Continuous Positive Airway Pressure (CPAP), Bilevel Positive Airway Pressure (BiPAP) devices.

Module: 4	**PRINCIPLES OF IMPLANT DESIGN**	**7 Hours**

Mechanical-Strength and Modulus of Elasticity: Modulus Matching, Tribology of Implants. Functional Performance of the Device. Case study of organ regeneration. Scaffolds for Cartilage Repair. Implants for Bone. Implants for Plastic Surgery. Musculoskeletal Soft Tissues: Meniscus, Intervertebral Disk. Dental and Otologic Implants. Other Devices: Spinal Cord, Heart Lung.

Module: 5	DEGRADATION OF DEVICES AND IMPLANTS	7 Hours
Degradation of devices, natural and synthetic polymers - Hydrolysis and oxidation - Two classes of reactions that lead to the breaking down of polymers, corrosion, wear and tear. Devices for nerve regeneration. Gastrointestinal system, Dentistry, Maxillofacial and craniofacial replacement, Soft tissue repair, replacement and augmentation, recent advancement and future directions such as IoT based medical device management – Insulin management, Sleep Management.		
Module: 6	**RISK MANAGEMENT FOR A NEW MEDICAL DEVICE**	**7 Hours**
Failure analysis of orthopedic implants/ dental implants and Active implantable materials. Risk analysis. Risk Management planning and execution process flow. Risk analysis techniques - Failure mode and effect analysis, Fault tree analysis. Biocompatibility tests. Hemocompatibility. Biodegradation. Sterility tests. Mechanical tests etc. Management of Non-Conforming Products.		
	Total Lectures	**45 Hours**

Text Books	
1.	Peter J. Ogrodnik, Medical Device Design: Innovation from Concept to Market, Academic Press, 2013.
2.	Ramakrishna, S., Tian, L., Wang, C., Liao, S., & Teo, W. E., Medical Devices:regulations, standards and practices, Woodhead Publishing ,2015.
Reference Books	
1.	Theodore R. Kucklick, The Medical Device R&D Handbook, CRC Press; 1st edition ,2005.
2.	Michael E. Wiklund P.E., Jonathan Kendler, Allison Y. Strochlic, Usability Testing of Medical Devices, CRC Press; 2nd edition,2016.
3.	Rommel Garcia, Medical Device: A Primer Based on Best Practices, Publisher: Xlibris US, 2017.
4.	Shayne C. Gad, Safety Evaluation of Pharmaceuticals and Medical Devices: International Regulatory Guidelines, Publisher: Springer,2011.
5.	Kopff W.J, Artificial Organs, John Wiley and sons, New York, 1st edition, 1976.
6.	Park J.B., Biomaterials Science and Engineering, Plenum Press, 1984.
7.	R S Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw Hill, 2003
8.	https://www.fda.gov/medical-devices/overview-device-regulation/classify-your-medical-device
9.	http://mit.sustech.edu/NR/rdonlyres/Mechanical-Engineering/2-782JSpring-2006/2A951533-DBF7-4695-BD00-C84F291C928D/0/ch2_outline.pdf
10.	https://patientexperience.wbresearch.com/blog/iot-is-revolutionizing-medical-device-service

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by: Dr.G.Babu Rao

Course Code	COMPUTATIONAL FLUID DYNAMICS LABORATORY	L	T	P	C
20ME2005		0	0	2	1

Course Objectives:

To impart knowledge on

1. Finite volume computational fluid dynamics codes working strategies.
2. Actual setting up of the problem and solution procedure.
3. 3. Data extraction, post processing and comparison with experimental/theoretical data.

Course Outcomes:

The student will be able to

1. Recognize applications of computing tools in fluid dynamics.
2. Model and analyze various heat transfer and fluid flow problems.
3. Select appropriate mesh type and boundary conditions.
4. Apply suitable solvers for problem solution.
5. Extract post processing data and compare them with available data.
6. **6.** Infer the pictorial results after post-processing.

List of Experiments

1. Introduction to Ansys-Fluent
2. One dimensional heat conduction problem
3. Heat conduction with source terms
4. Laminar fluid flow
5. Conjugate heat transfer
6. Mixing of fluids

7. Double pipe heat exchanger analysis						
					Total Lectures	**15 Hours**
Text Books						
1.	An Introduction to Computational Fluid Dynamics, H K Versteeg and W Malalasekera, Second edition, Pearson Education Limited 2007					
2.	Numerical Heat Transfer and Fluid Flow, Suhas V Patanker, Mcgraw hill					
Reference Books						
1.	Ansys-Fluent User Manuel					
Recommended by Board of Studies	12.03.2021					
Approved by Academic Council	25.09.2021					

Prepared by Dr A. Brusly Solomon

Course Code	**ENGINEERING ECONOMICS AND OPERATION RESEARCH**	**L**	**T**	**P**	**C**
20ME2006		**3**	**0**	**0**	**3**

Course Objectives:

To impart knowledge on

1. Make or buy decision and economic analysis on investment proposals,
2. Linear Programming Problem (LPP), Job sequencing problems, Transportation and assignment problems.
3. Network representation of projects, Project Evaluation and Review Technique (PERT) model on Research and Development Projects

Course Outcomes: The student will be able to

1. Correlate this subject knowledge with the engineering problems and solve them
2. Assess the economic feasibility of the engineering projects with reference to time value of money
3. Apply Linear Programming Problem (LPP) knowledge to optimize real life manufacturing and service industry problems
4. Analyze the transportation problem and optimize the utilization of resources and output.
5. Develop their skills in decision making analysis by allocation of resources.
6. Apply network analysis to schedule engineering projects

Module: 1	**ECONOMICS & COST ANALYSIS**	**8 Hours**
Economics- Law of supply and demand– Elasticity of Demand, Scope of engineering economics – Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis – Fixed cost, Variable cost -V ratio. Make or buy decision,		
Module: 2	**VALUE ENGINEERING & INVESTMENT PROPOSALS**	**8 Hours**
Value engineering – Function, aims, Value engineering procedure. Interest formulae and their applications – Time value of money, Single payment present worth factor, Equal payment –Average Rate of Return (ARR) method - Internal Rate of Return (IRR) Method.		
Module: 3	**LINEAR PROGRAMMING PROBLEM & SEQUENCING**	**8 Hours**
Evolution of Operations Research and its applications in Industries, Formulation of LPP from raw data – Graphical Method – Simplex Method –Simplex problem with only slack variables Sequencing: Job sequencing –multiple jobs through two machines and three machines.		
Module: 4	**TRANSPORTATION PROBLEM**	**8 Hours**
Transportation Model, Conversion of description of a problem into a transportation matrix finding initial basic feasible solutions using least cost method, Vogells's approximation method and North–West corner method, Finding the Optimal solution through MODI method, Resolving degeneracy in transportation		
Module: 5	**ASSIGNMENT PROBLEM**	**8 Hours**
Conversion of a description of a problem into a Assignment matrix- Solution of an assignment problem, Multiple Solution, Hungarian Algorithm, Maximization in Assignment Model, Impossible Assignment.		
Module: 6	**NETWORK ANALYSIS**	**8 Hours**
Network Terminologies & Network construction Rules Network diagram – probability of achieving completion date PERT model– crash time –cost analysis –& CPM-Forward and backward scheduling-calculation of Total float/Slack and free float/Slack.		
	Total Lectures	**45 Hours**

Text Books	
1.	R. Paneerselvam, " Engineering Economics", Prentice -Hall Of India- New Delhi 2015
2.	S. Bhaskar, "Operations Research", Anuradha Agencies, Chennai Reprint 2016.
Reference Books	
1.	James L Riggs, " Engineering Economics", 4th Edition, Tata McGraw Hill, New Delhi 2014
2.	Hamdy Taha A., "Operations Research", 9th Edition Prentice – Hall of India Private Limited, New Delhi, 2014.
3.	Kanti Swarup, Manmohan, Gupta P.K., "Operations Research" Sultan Chand & Sons., 14th Edition 2014.
4.	Srinivasan G., "Operations Research 3rd Edition", Prentice – Hall of India Private Limited, New Delhi, 2017.
5.	Winston, "Operations Research, Applications and Algorithms" – Cengage Learning, Edition, 2004.
Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by: Dr.R.Raja

Course Code	AUTOMATION OF PRODUCT LIFE CYCLE MANAGEMENT	L	T	P	C
20ME2007		3	0	0	3

Course Objectives:

Impart knowledge on

1. Fundamentals and principles of Automation.
2. Concepts and various strategies of Product Life Cycle Management.
3. The product design, simulation, product building and product configuration.

Course Outcomes:

The student will be able to

1. Explain various strategies and technologies adapted in industrial automation.
2. Select appropriate evaluation methods used in the automation.
3. Apply modern tools like AI, ANN and Fuzzy logics in the building of automation systems.
4. Apply the concept of New Product Development and its structuring.
5. Analyse the virtual product development.
6. Develop new product development, product structure and supporting systems.

Module: 1	AUTOMATED MANUFACTURING SYSTEMS	8 Hours

Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations, introduction to automation productivity, Manufacturing Cells, GT and Cellular Manufacturing, FMS, FMS and its Planning and Implementation, Flow lines & Transfer Mechanisms, Fundamentals and Analysis of Transfer Lines, product design for automatic assembly. Applications and Case studies on various industrial automation sectors.

Module: 2	EVALUATION OF AUTOMATIC PRODUCTION	8 Hours

Product manufacturability, orientation devices- active and passive devices, parts orientation and escapement. Pneumatic and hydraulic components and circuits, Boolean algebra, pneumatic sensors and amplifiers, jet destruction devices, logic devices, Schimit triggering devices, developing pneumatic circuits for automatic die casting machine.

Module: 3	MODELING AND SIMULATION OF PLANT AUTOMATION	8 Hours

Fundamentals of system Modeling, Building Mathematical Model of a manufacturing Plant, Modern Tools-Artificial neural networks in manufacturing automation, AI in manufacturing, Fuzzy decision and control, robots and application of robots for automation.

Module: 4	PRODUCT LIFE CYCLE MANAGEMENT (PLM)	7 Hours

Background, Overview, Need, Benefits, Concept of Product Life Cycle. Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement. Product Data and Product Workflow, Company's PLM vision, The PLM Strategy, Principles for PLM strategy, preparing for the PLM strategy, developing a PLM strategy, Strategy identification and selection, Change Management for PLM.

Module: 5	PRODUCT DESIGN, MODELLING AND ANALYSIS TOOLS	7 Hours

Engineering design, organization and decomposition in product design, concurrent engineering, design for X' and design central development model, product recycling, human factors in product design. Modelling and simulation in product, Design for assembly and disassembly - probabilistic design concepts - FMEA - QFD - Taguchi Method for design of experiments -Design for product life cycle. Estimation of Manufacturing costs, Reducing the component costs and assembly costs, Minimize system complexity. Product optimization, Case studies on new product design using brain storming.		
Module: 6	**PRODUCT BUILDING, STRUCTURES AND PDM TECHNOLOGY**	**7 Hours**
Virtual product development tools for components, machines, and manufacturing plants: 3D CAD systems, digital mock-up, model building, model analysis, production (process) planning, and product data technology, Product structures: Variant management, product configuration, material master data, product description data, Data models, Life cycles of individual items, status of items. PDM functions, definition and architectures of PDM systems, product data interchange, portal integration, PDM acquisition and implementation.		
	Total Lectures	**45 Hours**

Text Books	
1	Mikell P Groover, Automation Production Systems and Computer Integrated Manufacturing 4th Edition by Pearson, 2016.
2	A K Gupta, Industrial Automation and Robotics, Third edition, Laxmi Publications Pvt Ltd, 2007.
3	Stark, John., Product Lifecycle Management: Paradigm for 21st Century Product Realization, Springer-Verlag, 2004.
4	Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis, 2006.
Reference Books	
1.	Saaksvuori Antti, ImmonenAnselmie, Product Life Cycle Management; Springer-Verlag Berlin Heidelberg publisher, 3rd Edition, 2008.
2.	Michael Grieves, Product Lifecycle Management, Tata McGraw Hill, 2006.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr. Wilson Kumar

Course Code	**APPLICATION OF MACHINE LEARNING FOR MECHANICAL ENGINEERING SYSTEMS**	**L**	**T**	**P**	**C**
20ME2008		3	0	0	3

Course Objectives:

Impart knowledge on

1. The basic concepts of artificial intelligence and machine learning.
2. The various machine learning algorithms.
3. Apply various machine learning algorithms to real world mechanical engineering problems.

Course Outcomes:

The student will be able to

1. Obtain the basics terminologies of artificial intelligence and machine learning.
2. Formulate and evaluate the prediction models using supervised learning algorithms.
3. Design and analyze the models using unsupervised learning algorithms.
4. Understand the basics of clustering and develop prediction model.
5. Learn the fundamentals of deep learning.
6. Applying the concept of machine learning and deep learning in mechanical engineering related problems.

Module: 1	**OVERVIEW OF MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE**	**7 Hours**
Artificial Intelligence - Definition - Problems - Problem Spaces and Search Techniques - Machine Learning - Basic of Data Statistics.		
Module: 2	**SUPERVISED LEARNING ALGORITHMS**	**8 Hours**
Simple linear regression – multiple regression – ridge regression – feature selection and lasso – nearest neighbours and Kernel regression - assessing performance of regression models		
Module: 3	**UN-SUPERVISED LEARNING ALGORITHMS**	**8 Hours**
Linear classifiers and logistic regression – decision tress – handling missing data - over-fitting and regularization in logistic regression.		

Module: 4	**CLUSTERING ALGORITHMS**	**8 Hours**
Nearest Neighbour search – clustering with k-means – mixture models - Hierarchical Clustering - K-means Algorithm - Spectral Clustering - Affinity Propagation - Probabilistic Clustering		
Module: 5	**DEEP NEURAL NETWORKS**	**7 Hours**
Preparing features and labels – prediction with deep neural network – recurrent neural network - long short-term memory networks – convolution neural networks		
Module: 6	**CASE STUDIES**	**7 Hours**
Introduction - Prognostics – Rotary machines – Reciprocating machines – condition monitoring for various machining process.		
	Total Lectures	**45 Hours**

Text Books

1.	Pedro Larrinaga, David Atienza, Javier Diaz-Rozo, Alberto Ogbechie, Carlos Esteban Puerto-Santana, Concha Bielza, "Industrial Applications of Machine Learning", First Edition, CRC Press, 2018. ISBN 9780815356226.
2.	Guido Reiman, "Quick Guide Machine Learning in Mechanical and Plant Engineering", VDMA Software and Digitalization, Germany, 2018.

Reference Books

1.	Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", Third Edition, Prentice Hall, 2010.
2.	Elaine Rich, Kevin Knight, Shivashankar B. Nair, "Artificial Intelligence", Third Edition, McGraw-Hill, 2009. ISBN -13: 973-0-07-008770-5.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by: Mr. Ajay Vasanth. X

Course Code	INTELLIGENT ROBOTIC SYSTEM	L	T	P	C
20ME2009		3	0	0	3

Course Objectives:

To impart knowledge on

1. Introduce the most popular methods for controlling autonomous mobile robots
2. Provides hands on experience of engineering design
3. Encourage the independent thought on possible cognitive architectures for autonomous agents

Course Outcomes:

The student will be able to

1. Design, build and program simple autonomous robots.
2. Implement standard signal processing and control algorithms.
3. Describe and analyze robot processes using appropriate methods.
4. Solve simple control problems by hand using appropriate methods.
5. Write a detailed report on a robot project.
6. Carry out and write up investigations using appropriate experimental methods

Module: 1	**OVERVIEW ABOUT ROBOTICS**	**8 Hours**
Overview about the robotics-robotics and artificial intelligence- embedded systems with robots- Agent-Task-Environment Model-embodied systems-synthetic approaches to science-common sensors and their properties-1 D signal processing-vision-sensors-etc.		
Module: 2	**PLANNING APPROACH FOR ROBOTIC CONTROL**	**8 Hours**
STRIPS and SHAKEY, Robot manipulator kinematics, Limitations of planning approaches, Control Theory-Feedback, feed forward and open loop control, Linear first order lag processes, Limitations of control theory.		
Module: 3	**PROBABILITY BASED APPROACHES**	**7 Hours**
Markov Decision Processes (MDPs), Partially Observable Markov, Partially Observable Markov Decision Processes, Navigation.		
Module: 4	**BEHAVIOUR-BASED CONTROL**	**6Hours**
The subsumption architecture, Hybrid architectures, Formalizing behavior-based control (SMDPs)		

Module: 5	**ADAPTIVE APPROACHES AND DYNAMIC ALGORITHMS**	**8 Hours**
Reinforcement learning for control, Model based learning approaches to control, learning maps, Evolutionary approaches. Formulation of dynamic model (equations of motion); Newton-Euler algorithm; Use of computer-orientated approaches, e.g., Decoupled Natural Orthogonal Complement (DeNOC) based; Inverse dynamics; Forward dynamics; Mechanical design (choice of material, cross-section, etc.) Application oriented case studies.		
Module: 6	**DESIGN AND FABRICATION OF INTELLIGENT ROBOT**	**8 Hours**
Design of mechanical and electrical components-Modeling-Robot components requirements-power supply-Actuators-Electric motors (AC/DC)-Pneumatic Air Muscles-Muscle wires -Piezo Motors and Ultrasonic motors -Sensors-Robot Locomotion-Legged-Wheeled-Combination of Legged and Wheeled Locomotion-Tracked slip/skid-Computer vision-AI based programs. Applications		
	Total Lectures	**45 Hours**

Text Books

1.	LaxmidharBehara, Swagat Kumar, Prem Kumar Patchaikani, Ranjith Ravindranathan Nair, Samrat Dutta, "Intelligent Control of Robotic Systems", First Edition, CRC Press, 2020
2.	Witold Jacak, "Intelligent Robotic Systems : Design, Planning, and Contol", Kluwer Academic Publisher, 2002

Reference Books

1.	S Mahadevan and J Connel, "Robot Learning", Kluwer Academic, 1993
2.	J Jones, B Seiger, and A Flynn, "Mobile Robots: Inspiration to Implementation", AK Peters, Second Edition, 1999
3.	R Arkin, "Behavior Based Robotics", MIT Press, 1998
4.	U Nehmzow," Mobile Robotics: A practical introduction", Springer Verlag, 2000.
5.	Craig, J.J., “Introduction to Robotics: Mechanics and Control”, Pearson, Delhi, 3rd Edition, 2009

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr Arul Kirubakaran

Course Code	**KINEMATICS AND DYNAMICS OF MACHINERY**	**L**	**T**	**P**	**C**
20ME2010		3	1	0	4

Course Objectives:

To impart knowledge on

1. Understand the concept of machines, mechanisms and related terminologies.
2. Analysis of a mechanism for displacement, velocity and acceleration at any point in a moving link.
3. Study the undesirable effects of unbalances in rotors and engines and vibratory systems.

Course Outcomes:

The student will be able to

1. Understand the basic concepts of Mechanisms, Machines and their relative motions, then apply it to appropriate environments.
2. Carry out kinematic analysis (Displacement, Velocity and Acceleration) of simple mechanisms (Single slider Crank Mechanism and four bar Mechanisms) by graphical and analytical method.
3. Construct & Design different CAM profiles for given conditions using graphical & Theoretical methods.
4. Apply the concept of balancing and use it for reducing the unbalanced forces in rotating masses and reciprocating engines under operating conditions exposure to IS standards.
5. Acquire knowledge on types of vibrations in different systems and damping methods to minimize vibrations.
6. Understand, apply and analyze the control mechanisms in Governors and Gyroscopes.

Module: 1	**BASICS OF MECHANISMS AND MACHINES**	**6 Hours**
Types of Motion, Links, Kinematic Pair, Types of Joints, Degree of Freedom, Classification of Kinematic Pairs, Kinematic Chain, Linkage, Mechanism and Structure, Inversions of Four-bar and Slider Crank Mechanism, Transmission Angle, Pantograph, Exact and Approximate Straight Line Mechanisms.		
Module: 2	**VELOCITY AND ACCELERATION ANALYSIS OF MECHANISMS**	**10 Hours**

Absolute and Relative Motion, Velocity and Acceleration Diagrams for simple mechanisms, Velocity by Instantaneous Centre Method, Coriolis Acceleration, Klein Construction. Static force analysis of quick return mechanism, planar mechanisms and piston of reciprocating engine mechanism.		
Module: 3	**BELTS AND CHAINS**	**10 Hours**
Belt Drives, Open and Cross Belt Drives, Velocity Ratio, Slip, Material of Belts, Types of Pulleys, Law of Belting, Length of Belts, Ratio of Friction Tensions, Power Transmitted, Centrifugal Effect on Belts, Maximum Power Transmission by Belt, Initial Tension. Chains, Chain Length, Speed Ratio, Kinematic of Chain drive, Power transmission.		
Module: 4	**GEARS AND GEAR TRAINS**	**10 Hours**
Classification of Gears, Gear Terminology, Law of Gearing, sliding velocity, Gear Teeth Profile, Path of Contact, Arc of Contact, Contact Ratio, Interference of Involute Gears, Minimum Number of Teeth. Different Types of Gear Trains - Epicyclic Gear Train.		
Module: 5	**CAMS, GYROSCOPE AND GOVERNORS**	**14 Hours**
Types of Cams and Followers, Cam Terminology, Derivatives of Follower Motion, Cam Profile Layout. Angular Velocity, Angular acceleration of Cams. Gyroscopic - Torque, Gyroscopic Effect on Naval Ships, Aero plane. Governors- types, Centrifugal Governor, Watt Governor, Proell Governor, Stability of Governors, Effort and Power of Governors.		
Module: 6	**BALANCING AND VIBRATIONS**	**10 Hours**
Static Balancing and Dynamic balancing of Rotating Masses, Balancing of Several Masses in Different Planes, Balancing of Reciprocating Mass. Vibration - Types, Free Vibration and Damped Vibration, Forced Vibration of Single Degree of Freedom System.		
	Total Lectures	**60 Hours**

Text Books	
1.	S S Rattan, “Theory of Machines”, Tata McGraw-Hill, Inc., 4th Edition, 2020.
2.	John J. Uicker, Gordon R. Pennock & Joseph E. Shigley., "Theory of Machines and Mechanisms", Oxford University Press., 5th Edition, 2017.
Reference Books	
1.	Ramamurti, V., “Mechanism and Machine Theory”, 3rd Edition, Narosa Publishing House, 2011.
2.	Sadhu Singh "Theory of Machines" Pearson Education, 3rd Edition, 2012.
3.	Ambekar A. G., "Mechanism and Machine Theory", Prentice Hall of India, New Delhi, 2007.
4.	Rao J.S. and Dukkipati R.V., "Mechanism and Machine Theory ", New Age International Publishers, 2006.
5.	Ghosh A. and Mallick A.K., "Theory of Mechanisms and Machines", East West Press, New Delhi, 3rd Edition, 2006.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by: Dr. R. Malkiya Rasalin Prince

Course Code	**FINITE ELEMENT METHODS IN ENGINEERING**	**L**	**T**	**P**	**C**
20ME2011		3	0	0	3

Course Objectives:

To impart knowledge on

1. Fundamental concepts of Finite Element Analysis
2. Various types of elements used in FEA.
3. 3. Ability to model and solve complex problems in engineering.

Course Outcomes:

The student will be able to

1. Acquire the fundamental theory of finite element analysis and develop characteristic equation.
2. Derive element matrix equation by applying basic laws in mechanics and integration by parts.
3. Apply suitable boundary conditions to a global equation for field problems
4. Analyse scalar and vector variable problems
5. Understand the application and use FE method for solving heat transfer, fluid mechanics and structural problems.
6. Use professional level finite element software to solve engineering problems

Module: 1	CONCEPTS OF FEA	8 Hours
Historical Background – General applicability of FEA -Governing Differential Equations – -Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Rayleigh Ritz Technique-Finite element softwares.		
Module: 2	**ONE DIMENSIONAL ELEMENT**	**8 Hours**
FEA Process– Discretization – Element types- Boundary Conditions- aspect ratio- Pascal's Triangle-Derivation of Shape functions and Stiffness matrices and force vectors for spar and beam elements- Assembly of Matrices - Solution of structural problems- Global, local and natural coordinate systems.		
Module: 3	**2-D SCALAR VARIABLE PROBLEMS**	**8 Hours**
Second Order 2D Equations involving Scalar Variable Functions – Variational formulation – Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems – Quadrilateral elements- Convergence and Continuous criteria- Area Coordinate system.		
Module: 4	**2-D VECTOR VARIABLE PROBLEMS**	**7 Hours**
Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements.		
Module: 5	**HIGHER ORDER ELEMENTS**	**7 Hours**
Introduction to Higher Order Elements- Shape Function for Quadratic Element- Shape Function for Cubic Element- Isoparametric elements- Lagrangean and Serendipity elements.		
Module: 6	**THERMAL AND FLOW ANALYSIS USING FEA**	**7 Hours**
Heat Transfer Problems- Basic equations of 1D heat transfer using finite element Method -composite material. Fluid mechanics problem- Basic equations- Solutions procedure-Incompressible fluid flow.		
	Total Lectures	**45 Hours**

Text Books

1.	S.S.Rao, The finite element method in Engineering, 6th Ed., Butterworth-Heinemann Press, Oxford, 2018.
2.	J.N.Reddy, An Introduction to the finite element method, 4^{rth} Edition, Tata McGrawHill, 2018

Reference Books

1.	P. Seshu, Text Book of Finite Element Analysis, Prentice-Hall of India Pvt. Ltd., New Delhi, 2007
2.	Robert D.Cook, David S. Malkus, Michael *E*. Plesha, Robert J. Witte, Concepts and Applications of Finite Element Analysis, John Wiley & Sons, Inc. Singapore, 2007.
3.	TirupathiR.Chandrupatla and Ashok D. Belegundu., Introduction to Finite Elements in Engineering, Prentice Hall of India Private Limited., New Delhi, 2004.
4.	D.L.Logan, A first course in Finite Element Method, Thomson Asia Pvt. Ltd., 2002
5.	S. Rajasekaran, Finite Element Methods in Engineering Design, S.Chand& Co Ltd., NewDelhi, 2003.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by: Dr. P. Sam Paul

Course Code	INTERNET OF THINGS FOR MECHANICAL SYSTEMS	L	T	P	C
20ME2012		3	0	0	3

Course Objectives:

To impart knowledge on

1. The requirements of Industrial automation standards
2. The concepts of IoT connecting the mechanical systems
3. The applications of IoT for mechanical systems

Course Outcomes:

The student will be able to

1. Interpret the Essentials of IoT for Modern Engineers
2. Examine the importance of Smart and Digital Factories
3. Make use of IoT in Manufacturing Process and Applications
4. Model IoT for Cyber-Physical Systems, Virtual Reality and Data Analytics
5. Interpret the IoT Challenges in Mechanical Systems
6. Apply IoT concepts in various applications

Module: 1	ESSENTIALS OF IoT FOR MODERN ENGINEERS	7 Hours

The IoT revolution, The smart product mechanical engineer, Consumer IoT, Industrial IoT, Sensor, Analysis, Connectivity, Exchange. Data characteristics, Product components, External sources, Data Visualization, Closed loop design, Edge/Cloud computing.		
Module: 2	**SMART AND DIGITAL FACTORIES**	**8 Hours**
Big data, Predictive Analytics, Virtualized Processes, Modelling and Simulation, High-performance computing, Robotics, Code Halo Thinking, 3D Printing, Additive Manufacturing		
Module: 3	**IoT IN MANUFACTURING PROCESS AND APPLICATIONS**	**8 Hours**
Supply Chain Management, Operating Efficiency, Predictive Maintenance, Inventory Optimization, Intelligent Supply, Maturity Scale for Smart Manufactured Products. Intelligent Product Enhancements, Dynamic Response to Market Demands, Optimized Resource Use, Waste Reduction, Product Safety.		
Module: 4	**IoT MODEL FOR CYBER-PHYSICAL SYSTEMS**	**8 Hours**
Industry4.0, Cyber Physical Systems, synchronized planning, Digital Threads, Augmented and Virtual Reality, sensing and control, system design.		
Module: 5	**IoT CHALLENGES IN MECHANICAL SYSTEMS**	**7 Hours**
Resource Constraints, Appropriate Information Models, Standardization of Device Models, Bridging to the Cloud, Security, AI/Autonomy, Cyber Security.		
Module: 6	**INDUSTRIAL IoT - APPLICATION CASE STUDIES**	**7 Hours**
Robotics Remote Service, Electrical Vehicle Charging, Container Ship Trim Optimization, Condition Monitoring for Industrial Drives.		
	Total Lectures	**45 Hours**

Text Books	
1.	"Internet of Things",Copyright 2016 by Tutorials Point (I) Pvt. Ltd.
2.	"IoT Challenges for Smart Manufacturing", Heiko Koziolek, Senior Principal Scientist, ABB Corporate Research Germany
Reference Books	
1.	"The Essentials of IoT for Modern Engineers", Autodesk, Inc., 2016.
2.	"IoT and Smart Manufacturing", Stephen EzellVice President, Global Innovation PolicyInformation Technology and Innovation Foundation
3.	"Cyber-Physical Systems and IoT Research Challenges", Gurdip Singh, National Science Foundation
4.	"From Mechatronic Components to Industrial Automation Things: An IoT Model for Cyber-Physical Manufacturing Systems", Journal of Software Engineering and Applications

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by: Dr. Ajay Vasanth. X

Course Code	**SENSOR TECHNOLOGY FOR MACHINES**	**L**	**T**	**P**	**C**
20ME2013		3	0	0	3

Course Objectives:

To impart knowledge on

1. Measurement principles through the sensor technology.
2. Working principles of different types of sensors.
3. Various sensor materials and technology used in Industries.

Course Outcomes:

The student will be able to

1. Recognize the concept of sensors and its characteristics.
2. Summarize the practical approach in design of technology based on different sensors
3. Categorize various sensor materials and technology used in designing sensors
4. Describe the working principle of resistive, inductive and capacitive sensors and their applications.
5. Determinethe thermocouples, piezoelectric and pyro-electric sensors and their applications.
6. Apply the digital and proximity sensors in Industries.

Module: 1	**FUNDAMENTALS AND CHARACTERISTICS OFSENSORS**	**8 Hours**
Measurement systems – Significance of Measurements, Methods of Measurements – Direct		

and Indirect Methods, Sensors, Signals and Systems; Sensor Classification; Units of Measurements; General Sensor Characteristics. MEMS and NEMS		
Module: 2	**PRINCIPLES OF SENSING TECHNOLOGY**	**8 Hours**
Electric Charges, Fields, and Potentials; Capacitance; Magnetism; Induction; Resistance; Piezoelectric Effect; Hall Effect; Ultrasonic, Noise, Vibration sensor. Oder Sensor. Temperature and Thermal Properties of Material; Heat Transfer; Light; Dynamic Models of Sensor Elements. applications -marine, precision measurement etc.		
Module: 3	**SENSOR MATERIALS AND DESIGN OF SENSORS**	**7 Hours**
Sensor Materials, Occupancy and Motion Detectors; Position, Displacement, and Level; Velocity and Acceleration; Force, Strain, and Tactile Sensors, Electrolytic sensors, optical sensor, fiber optic sensors. Biosensors in clinical chemistry, medicine and health care. Surface Processing,		
Module: 4	**SENSORS FOR ROBOTICS**	**7 Hours**
Proximity Sensors: Typical Sensor Characteristics, Technologies for Proximity Sensing, Electro-Optical Sensors, Capacitive Sensors, Magnetic Sensors. Machine Vision - CCD - Image Processing & Analysis-Image Data Reduction-Feature Extraction-Object Recognition.		
Module: 5	**PRESSURE AND TEMPERATURE SENSORS**	**8 Hours**
Pressure measurement – Construction and working of capacitive pressure sensor – Inductive pressure sensor– Strain gauge – Pressure sensor – Diaphragm – Bourdon tube – Differential pressure cell – Temperature sensors – Construction and working of RTD – Thermistors – Thermocouples– Bimetallic strips. Applications of thermocouples, piezoelectric and pyro-electric sensors.		
Module: 6	**SENSOR TECHNOLOGY FOR INDUSTRIES**	**7 Hours**
Process Control Systems and Structure in the Food Industry – Process Control Methods. Sensors for automated systems – Special Considerations – Measurement Methods – Device Integration – Applications - Machine Vision- Optical Sensors – SCADA in food industry. Uncertainty analysis of sensors.		
	Total Lectures	**45 Hours**

Text Books	
1.	Patranabis D., "Sensors and Transducers", Prentice-Hall India, 2nd Ed., 2009.
2.	Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs and Applications", Springer, 3rd Ed., 2004.
3.	Transducers for Biomedical Measurements: Principles and Applications, Richard S.C. Cobbold, John Wiley & Sons, 2004.
Reference Books	
1.	Mikell P. Groover etal, “Industrial Robots – Technology Programming & Applications” McGraw Hill Ltd., 2012
2.	Ramon Pallas & John G. Webster, "Sensors and Signal Conditioning", John Wiley & Sons, 2nd Ed., 2001.
3.	Darwin Caldwell, Robotics and Automation in the Food Industry – Current and Future Technologies” Woodhead Publishing, 2013.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by: Dr. Mona Sahu

Course Code	**INDUSTRIAL SAFETY AND QUALITY STANDARDS**	**L**	**T**	**P**	**C**
20ME2014		3	0	0	3

Course Objectives:

Impart knowledge on

1. Safety principles ,procedure ,protocols, Personnel protective equipment (PPE), and Standards
2. Safety precautions during industrial operations and Risk identification ,measurement and mitigation
3. Quality principles, control charts, quality costs, failure analysis, Design Of Experiments, Reliability, Total Quality management and ISO standards

Course Outcomes:

The student will be able to

1. Apply safety principles, protocols and Personnel Protective Equipments (PPE) to engineering processes.

<table>
<tr><td colspan="4">2. Assess risk in manufacturing processes in term of Risk Priority Number (RPN), manage and mitigate them
3. Apply quality principles and control charts to maintain quality of the processes and products
4. Appraise quality costs in products and minimize failure and reworks
5. Experimenting failure analysis thereby improve the production process and develop fool proof manufacturing processes
6. Adapting Total Quality Management tools such as Quality function deployment, Benchmarking and Business process reengineering to realize quality standards</td></tr>
<tr><td>Module: 1</td><td colspan="2">STANDARDS TO BE SAFETY PRINCIPLES & ACTS</td><td>8 Hours</td></tr>
<tr><td colspan="4">General safety rules, Responsibility and objective of safety management, Safety Program and its organization, Function of safety engineer, director and management, Safety In Metal Working Machinery. Safety and protocols principles followed during Maintenance. Introduction to OSHA standards and Health provisions under the factories act of India 1948.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Module: 2</td><td colspan="2">STANDARDS OF SAFETY GUARDS</td><td>8 Hours</td></tr>
<tr><td colspan="4">Machine guarding, Classification of Guards, guarding during maintenance, Methods of Guarding, Various types of Guarding techniques, Process monitoring of guarding during machining process, Safety rules followed during material handling, Zero Mechanical State – Definition and applications Numerical problems on Down time and Achieved, Operational and inherent Availability</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Module: 3</td><td colspan="2">STANDARDS PPE& RISK MEASUREMENTS</td><td>8 Hours</td></tr>
<tr><td colspan="4">Personnel Protective Equipment (PPE), Safety Precautions practice during welding, Storage and usage of hazardous metals, Safety during heat treatment process, Safety during electroplating process, Safety practice in sand and shot blasting, Safety practice in paint shops. Risk measurements- Risk Priority Number (RPN) – Mitigation and Management of Risks-Numerical Problems to find RPN.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Module: 4</td><td colspan="2">QUALITY PRINCIPLES, CONTROL CHARTS & QUALITY COSTS</td><td>7 Hours</td></tr>
<tr><td colspan="4">Dimensions of quality, seven traditional tools of quality, Statistical process control -Variable and attribute control charts-Process capability Ratio- Six sigma quality control-Internal failure cost, External failure cost, Appraisal cost and prevention cost</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Module: 5</td><td colspan="2">ISO 9000 STANDARDS FAILURE ANALYSIS, DOE & RELIABILITY</td><td>7 Hours</td></tr>
<tr><td colspan="4">Failure Mode Effect and Criticality Analysis (FMECA), Component and system level FMECA-Fault Tree Analysis (FTA)-Design of Experiments-Full factorial design and fractional factorial deign-Experimentation procedure -Reliability of Series, Parallel and mixed configuration-Active and stand by redundancy-Reliability improvement.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Module: 6</td><td colspan="2">TOTAL QUALITY MANAGEMENT TOOLS & ISO STANDARDS</td><td>8 Hours</td></tr>
<tr><td colspan="4">Quality Function Deployment (QFD)-House of quality, DMAIC process for process and design improvement –Business Process Reengineering (BPR)- Bench marking- gap analysis and procedure- 5S Technique-ISO 9000 series of quality standards-ISO 9001: 2015, ISO 14000 Quality standards-Bureau of Indian Standards (BIS).</td></tr>
<tr><td colspan="3" align="right">Total Lectures</td><td>45 Hours</td></tr>
<tr><td colspan="4">Text Books</td></tr>
<tr><td>1.</td><td colspan="3">L.M.Deshmukh, Industrial Safety Management, Tata McGraw Hill, New Delhi 2015</td></tr>
<tr><td>2.</td><td colspan="3">Dale.H.Besterfield, “Total Quality Management”, Pearson Education , New Delhi 2015</td></tr>
<tr><td colspan="4">Reference Books</td></tr>
<tr><td>1.</td><td colspan="3">Frank R. Spellman, Safety Engineering: Principles and Practices, Rowman &Littlefield publishers, Maryland 2015</td></tr>
<tr><td>2.</td><td colspan="3">Daniel A Crowl, “ Chemical Process safety”, Pearson New Delhi Third Edition 2016</td></tr>
<tr><td>3.</td><td colspan="3">J.M.Juran, “Quality planning and Analysis ” Tata McGraw Hill, New Delhi 2016</td></tr>
<tr><td>4.</td><td colspan="3">James R Evans, “ The management and control of quality”, Lindsay West publishing Mason, Ohio – 2015</td></tr>
<tr><td>5.</td><td colspan="3">V.Jeyakumar and Raju, “Total Quality Management”, Lakshmi publications, Chennai 2016</td></tr>
<tr><td colspan="2">Recommended by Board of Studies</td><td colspan="2">12.03.2021</td></tr>
<tr><td colspan="2">Approved by Academic Council</td><td colspan="2">25.09.2021</td></tr>
</table>

Prepared by: Dr.R.Raja

Course Code	APPLIED THERMODYNAMICS LABORATORY	L	T	P	C
20ME2015		0	0	4	2

Course Objectives:

To impart knowledge on

1. The performance evaluation of refrigeration, air conditioning systems and heat pumps
2. Performance evaluation of blower and compressor
3. Performance analysis of internal combustion engines

Course Outcomes:

The student will be able to

1. Evaluate the performance of vapor compression refrigeration cycle and air conditioning cycle
2. Evaluate performance of heat pump
3. Evaluate performance of air blower and reciprocating air compressor
4. Evaluate performance of steam turbine
5. Evaluate the performance of single cylinder and twin cylinder diesel engines
6. Perform heat balance test on four stroke engines.

List of Experiments

1. Determination of the performance characteristics of a vapour compression system
2. Determination of coefficient of performance in a heat pump apparatus
3. Determination of coefficient of performance in air–conditioning cycle
4. Determination of performance parameters on air blower
5. Determination of performance parameters on two stage reciprocating air compressor
6. Performance test and study on the steam turbine apparatus
7. Performance test on variable compression ratio, 4 stroke petrol engine
8. Performance test on four–stroke twin cylinder vertical Diesel engine
9. Heat balance test on four stroke single cylinder Diesel engine
10. Performance test on four stroke single cylinder Diesel engine
11. Heat balance test on four–stroke twin cylinder vertical Diesel engine
12. Retardation test on four stroke single cylinder vertical Diesel engine

Total Lectures	**30 Hours**

Reference Books

1. R.K. Rajput, "A Textbook of Engineering Thermodynamics", Laxmi Publications, 2016.
2. P.K. Nag, "Engineering Thermodynamics", Tata McGraw-Hill, 2013
3. V. Ganesan., 'Internal Combustion Engines', 4th edition, Tata McGraw Hill Publishing Company Ltd, 2012

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr.Joseph John Marshal

Course Code	FLUID MECHANICS AND FLUID MACHINES	L	T	P	C
20ME2016		3	0	0	3

Pre-requisite: Basic Mathematics for Engineering (14MA1001), Engineering Mechanics (14ME2001)

Course Objectives:

To impart knowledge on

1. The fluid properties and understand conservation of mass, momentum and energy in fluid flows.
2. The nternal flows and dimensional analysis
3. The working of Pumps, Turbines and construct the velocity triangles.

Course Outcomes:

The student will be able to

1. Recognize the important fluid properties and determine forces acting on immersed bodies.
2. Solve fluid flow problems using Conservation principles.
3. Analyse the characteristics of boundary layer and relationship between different physical quantities of fluid flow.
4. Determine rate of flow and calculate flow losses through pipes.
5. Evaluate the performance of pumps
6. Evaluate the performance of turbines**.**

Module: 1	**FLUID PROPERTIES AND FLUID STATICS**	**8 Hours**

Density – Specific weight - Specific gravity – Viscosity – Surface tension – Capillarity –Perfect gas- Compressibility – Vapour pressure. Fluid Statics: Pascal's law –Measurement of pressure – Manometers, Forces on submerged surfaces- plane and curved surfaces, Buoyancy and stability of floating bodies.		
Module: 2	**EQUATIONS OF FLUID FLOW**	**8 Hours**
Types of flow, Velocity and acceleration, Stream line - streak line – path line, velocity potential and Stream function. Differential equations of continuity and momentum, Free and forced vortex flow, Euler's equation, Application of Bernoulli's equation- Venturi meter-Orifice meter-Pitot tube.		
Module: 3	**BOUNDARY LAYER CONCEPTS & DIMENSIONAL ANALYSIS**	**8 Hours**
Flat plate, conduits, curved solid bodies, universal velocity profile, and momentum eddy concept. Dimensional Analysis and Dynamic Similitude - Application of dimensionless parameters- Reynolds Number, Froude Number, Mach Number, Weber Number and Euler Number; Buckingham's π-Theorem – Model analysis.		
Module: 4	**FLOW THROUGH CIRCULAR CONDUITS**	**7 Hours**
Laminar flow through circular conduits- elementary turbulent flow, Loss of energy in pipes – Major and Minor energy losses – Hydraulic gradient line and Total energy line- Pipes in series and parallel-Equivalent pipe-Water hammer.		
Module: 5	**PUMPS**	**7 Hours**
Impact of Jets: plane and curved- stationary and moving plates. Centrifugal pumps - operation - velocity triangles - performance curves - Cavitation - Multi staging - Selection of pumps. Reciprocating pumps - operating principles -slip - indicator diagram - separation- air vessels.		
Module: 6	**TURBINES**	**8 Hours**
Classification-working principles -Pelton wheel- Francis- Kaplan turbines - Velocity triangles - Similarity laws - Specific speed - Governing of turbines- Surge tanks. Miscellaneous pumps - Jet pump, Gear oil pump, Submersible pump.		
	Total Lectures	**45 Hours**

Text Books	
1.	P.N.Modi and S.M.Seth., "Hydraulics and Fluid Mechanics Including Hydraulics Machines", Standard Book House, twentieth edition, 2015.
2.	R.K.Bansal., "A Textbook of Fluid Mechanics and Hydraulic Machines", Laxmi Publications, Revised Ninth Edition, 2017.
Reference Books	
1.	S.KSom, G.Biswas and S.Chakraborty., "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw Hill, 3rd edition, 2012.
2.	R.K.Rajput., "A Text book of Fluid Mechanics and Hydraulic Machines", S.Chand, Sixth Edition 2015.
3.	V.L.Streeter, E.B.Wylie and K.W.Bedford., "Fluid Mechanics", Tata McGraw-Hill, ninth edition, 2010.
4.	Frank M White., "Fluid Mechanics", Tata McGraw Hill, Eighth Edition, 2016.
5.	Fox and McDonald., "Introduction to Fluid Mechanics", Wiley India, ninth edition, 2016.
6	Yunus A Cengel and John M Cimbala., "Fluid Mechanics: Fundamentals and applications", Tata McGraw-Hill, Third Edition 2014.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr.Joseph John Marshal

Course Code	**AUTOMOTIVE MATERIALS AND ELECTRONICS**	**L**	**T**	**P**	**C**
20ME2017		3	0	0	3

Course Objectives:

To impart knowledge on

1. The properties of engineering materials and able to select suitable materials for design.
2. The materials selection criteria for engine and transmission systems, starting systems and ignitions systems of automotive
3. The working principles of instrumentation, electronic control, engine management system, lighting and security systems.

Course Outcomes:

The student will be able to

1. Familiar with different materials used for automotive component manufacturing. 2. Select proper material for Automobile applications. 3. Choose a suitable material for selected part of the engine components. 4. Know the working of electronic starting and ignition systems. 5. Use the instrumentations and electronic controls. 6. Understand the engine managements system, lighting and security systems.			
Module: 1	**ENGINEERING MATERIALS AND THEIR PROPERTIES**		**8 Hours**
Classes of engineering materials – the evolution of engineering materials, Definition of materials properties, displaying material properties using materials selection charts, Forces for change in materials selection and design, Materials and the environment-selection of materials for automotive, aerospace, marine and defence applications.			
Module: 2	**BASIS OF MATERIAL SELECTION**		**8 Hours**
Selection strategy, Attribute limits and Material indices, structural index Selection procedure: Design process – types of design, design requirements, Function, Material attributes, Shape and Manufacturing processes – Materials processing and design processes and their influence on design, Process attributes, Systematic process selection, Process selection diagrams, Process cost, Material costs, Availability, Recyclability, Environmental consideration. Computer aided selection.			
Module: 3	**MATERIALS FOR ENGINES AND TRANSMISSION SYSTEMS**		**8 Hours**
Materials selection for IC engines: Piston, piston rings, cylinder, Engine block, connecting rod, Crank shaft, Fly wheels, Gear box, Gears, Clutches.			
Module: 4	**STARTING SYSTEMS AND IGNITIONS SYSTEMS**		**7 Hours**
Introduction: Automotive component operation - Electrical wiring terminals and switching, Multiplexed wiring systems - Circuit diagrams and symbols. Charging Systems and Starting Systems: Charging systems principles alternations and charging circuits - New developments requirements of the starting system - Basic starting circuit. Ignition systems: Ignition fundamentals, Electronic ignition systems. Programmed ignition distribution - direct ignition spark plugs. Electronic Fuel Control Basics of combustion - Engine fueling and exhaust emissions - Electronic control of carburetion - Petrol fuel injection - Diesel fuel injection.			
Module: 5	**INSTRUMENTATION SYSTEMS AND ELECTRONIC CONTROL OF AUTOMATIC TRANSMISSION**		**7 Hours**
Instrumentation systems: Introduction to instrumentation systems - Various sensors used for different parameters sensing - Driver instrumentation systems - vehicle condition monitoring - trip computer different types of visual display. Electronic control of braking and traction: Introduction - control elements and control methodology - Electronic control of Automatic Transmission: Introduction - Control of gear shift and torque converter lockup - Electric power steering - Electronic clutch.			
Module: 6	**ENGINE MANAGEMENT SYSTEMS AND LIGHTING AND SECURITY SYSTEMS**		**8 Hours**
Engine management systems: Combined ignition and fuel management systems - Exhaust emission control - Digital control techniques - Complete vehicle control systems - Artificial intelligence and engine management – use of microprocessor in Automotive. Lighting and security systems: Vehicles lighting Circuits - Signaling Circuit Central locking and electric windows security systems - Airbags and seat belt tensioners - Miscellaneous safety and comfort systems.			
		Total Lectures	**45 Hours**
Text Books			
1.	Gladius Lewis, “Selection of Engineering Materials”, Prentice Hall Inc. New Jersey USA, 1999.		
2.	Denton T. - ‘Automobile Electrical and Electronic Systems’ - Edward Arnold Publications - 2001		
Reference Books			
1.	James A. Jacobs, Thomas F. Kilduff., “Engineering Materials Technology: Structure, Processing, Properties & Selection”, Prentice Hall, USA, 1996.		
2.	ASM Handbook, “Selection of Materials Vol. 1 and 2”, ASM Metals Park, Ohio. USA, 1991.		
3.	M F Ashby, “Materials Selection in Mechanical Design”, Third Edition, Butterworth- Heineman, New York, 2005.		
4.	Knowles D. - ‘Automotive Electronic and Computer controlled Ignition Systems’ - Don, Prentice Hall, Englewood Cliffs, New Jersey – 1988.		

5.	William T. M. - 'Automotive Electronic Systems' - Heiemann Ltd., London - 1978
Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr. P. Jayaseelan

Course Code	FLUID MECHANICS AND STRENGTH OF MATERIALS LABORATORY	L	T	P	C
21ME2001		0	0	4	2

Course Objectives:

To impart knowledge on

1. Calibration of flow measurement devices, impact of jets, calculation of losses due to friction and pipe fittings.
2. Understand the working principles of turbine and Pump.
3. Evaluation of mechanical properties, tensile strength, hardness, impact and shear strengths of specimens.

Course Outcomes:

The student will be able to

1. Determine friction factor and coefficient of discharge.
2. Estimate the performance of turbine and pump.
3. Optimization of performance of a Pelton wheel.
4. Evaluate tensile strength, compressive strength of mild steel specimen.
5. Analyze the mechanical properties of mild steel specimen.
6. Evaluate the tensile strength by using machine learning technique.

List of Experiments:

1. Determination of Darcy's friction factor.
2. Calibration of Venturi meter.
3. Calibration of Orifice meter.
4. Determination of minor losses in pipes.
5. Impact of Jet on vanes
6. Performance test on Francis turbine.
7. Performance test on Centrifugal pump.
8. Experimentally determine the mechanical properties of mild Steel specimen under tension load and modulus of rigidity of springs (open coiled springs).
9. Estimation of hardness by using Brinell hardness test and impact resistance of mild steel specimen.
10. Experimentally determine the mechanical properties of mild steel specimen under compression and torsion.
11. Optimization of performance of Pelton wheel turbine.
12. Prediction of tensile strength for an alloy using Machine Learning techniques.

Total lecture hours **30**

Reference books: LAB Manual

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr.K.Gnana Sundari

Course Code	STRENGTH OF MATERIALS	L	T	P	C
21ME2002		3	0	0	3

Course Objectives:

To impart knowledge on

1. Different types of stresses, strain and deformation induced in the mechanical components due to external loads.
2. Distribution of various stresses in the mechanical elements or bodies of finite dimensions that deform under loads.
3. The effects of component dimensions, materials and shapes on stresses and deformations

Course Outcomes:

The student will be able to

1. Demonstrate fundamental knowledge about various types of loading and stresses induced.
2. Draw the SFD and BMD for different types of loads and support conditions.
3. Analyze the stresses induced in basic mechanical components.
4. Estimate the strain energy in mechanical elements.

5. Analyze the deflection in beams.
6. Evaluate buckling and bending phenomenon in columns, struts and beams.

Module: 1	**STRESSES AND STRAINS**	**8 Hours**

Simple stresses & strains viz. tensile, compressive, Shear, Crushing-Thermal stresses, & corresponding strains, Hook's Law –Problems on Direct Stress & Linear Strain, Stress- Strain curve for Ductile material and Brittle material with all parameters, factor of Safety, Elastic Constants, Principal stresses and strains, Mohr's circle.

Module: 2	**SHEAR FORCE AND BENDING MOMENT IN BEAMS**	**8 Hours**

Axial force, shear force and bending moment diagrams for statically determinate beams including beams with internal hinges for different types of loading, relationship between rates of loading, shear force and bending moment.

Module: 3	**STRESSES IN BEAMS**	**8 Hours**

Theory of pure bending, Assumptions, Flexural formula for straight beams, moment of resistance, bending stress distribution, section modulus for different sections, beams for uniform strength, Fletched beams.

Module: 4	**TORSION AND STRAIN ENERGY**	**7 Hours**

Torsion of circular shafts- solid and hollow, stresses in shafts when transmitting power. Strain Energy: Resilience, Proof Resilience, strain energy stored in the member due to gradual, sudden and impact loads, Strain energy due to shear, bending and torsion.

Module: 5	**DEFLECTION OF BEAMS**	**7 Hours**

Deflection of Cantilever, simply supported and overhang beams using double integration and Macaulay's Method for different types of loadings. Thin Cylindrical and Spherical Shells: Cylinders and Spheres due to internal pressure, Cylindrical shell with hemi spherical ends.

Module: 6	**COLUMNS AND STRUTS**	**8 Hours**

Buckling load, Types of end conditions for column, Euler's column theory and its limitations, Rankine and Johnson formula.

	Total Lectures	**45 Hours**

Text Books

1.	Strength of Materials by R. Subramanian, Oxford University Press, Third Edition 2016.
2.	Egor P. Popov, Engineering Mechanics of Solids 2 nd Edition, Prentice Hall of India, New Delhi, 2009.

Reference Books

1.	Mechanics of Materials by Gere and Timoshenko, CBS 2nd EditionBoresi, Arthur P. and Schmidt, Richard J., Advanced Mechanics of Materials, 6 th Ed., John Wiley & Sons, 2009.
2.	Strength of Materials by Basavrajaiah and Mahadevappa, Khanna Publishers,New Delhi
3.	Elements of Strength of Materials by Timoshenko and Youngs, Affiliated East -West Press
4.	L. S. Srinath, "Advanced Mechanics of Solids", 3 rd Edition, TMH Publishing Co. Ltd., New Delhi, 2009.
5.	William Nash, "Schaum's Outline of Strength of Materials, 6 th Edition", McGraw-Hill Education, 2013.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr.Lijin George

Course Code	**DESIGN OF MACHINE ELEMENTS**	**L**	**T**	**P**	**C**
21ME2003		2	1	0	3

Course Objectives:

To impart knowledge on

1. Design principles and basic design procedures.
2. Using design data for the design of mechanical elements.
3. Applying design concepts and develop computer code for various machine elements.

Course Outcomes:

The student will be able to

1. Understand the standard design procedure for design of machine elements.
2. Analysestressesactingoncomponentsanddeterminethesizebasedontheoriesoffailure.

3. Designmachinecomponentsforagivenloadconditionusingdesigndatahandbook.
4. Decide specifications as per standards given in design data and select standard components to improve interchangeability.
5. Design and develop non standard machine components.
6. Prepare a detail design layout, drawing and computer coding of machine elements.

Module: 1	**STRESSESINMACHINEMEMBERS**	**8 Hours**
Introduction to the design process, Design considerations- limits, fits and standardization, Factors influencing machine design, selection of materials based on physical and mechanical properties. Direct , bending ,torsional and combined stress equations ,Impact and shock loading. Failure theories.		
Module: 2	**VARIABLEANDCYCLICLOADSANDBEARINGS**	**8 Hours**
Principal Stresses, Variable and cyclic loads – fatigue strength and fatigue limit – S-N curve, combined cyclic stress, Soderberg and Goodman equations– Design of sliding and rolling contact bearing.		
Module: 3	**SHAFTS, COUPLINGS AND BELT**	**8 Hours**
Design of solid and hollow shaft based on strength, rigidity and critical speed. Design of keys, key-ways ,Bolts and Nut. Design of Rigid and Flexible couplings. Design of Flat belt and V-Belt.		
Module: 4	**JOINTSANDSPRINGS**	**7 Hours**
Design of riveted and welded joints, Design and drawing of Cotter joints, Design and drawing of Knuckle joints, Design of helical leaf discard torsional springs under constant loads and varying loads.		
Module: 5	**DESIGNOFENGINECOMPONENTS AND GEAR BOX**	**7 Hours**
Design and drawing of piston, Design and drawing of connecting rod, crankshaft, flywheel, Design of Chain and Design of gear boxes.		
Module: 6	**POWER SCREW, BRAKES ANDCLUTCHES**	**8 Hours**
Design of Power Screws, Design of brakes ,clutches–Single plate, Multiplate & Cone. Computer coding of design of transmission elements.		
	Total Lectures	**45 Hours**

Text Books

1	S.Md.Jalaludeen,“MachineDesign”,AnuradhaPublications,Chennai2019.
2.	JosephShigley,CharlesMischke,RichardBudynasandKeithNisbett,“MechanicalEngineeringDesign”, 8thEdition,TataMcGraw–Hill, 2015.

Reference Books

1	BhandariV,“DesignofMachineElements”,4th Edition,TataMcGraw–HillBookCo.,2016.
2	SundarrajamoorthyT.V.andShanmugam,‘MachineDesign’,KhannaPublishers,2018.
3	HallandAllen,“MachineDesign”,SchaumSeries,2018.
4	Design Data– DataBookforEngineers,PSGCollegeofTechnology,Coimbatore,KalaikathirAchchagam2019 &Approved DataSheets.
5	T.J.Prabhu, “Design of Transmission Systems” ,2018.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr. Robinson Smart

Course Code	**COMPUTER AIDED MANUFACTURING LABORATORY**	**L**	**T**	**P**	**C**
21ME2004		0	0	2	1

Course Objectives:

To impart knowledge on
1. NC programming for CNC turning, drilling and milling operation.
2. Selection of tools for a machining operation.
3. Simulation and verification of machining processes.

Course Outcomes:

The student will be able to
1. Know features and applications of CNC machining centers.
2. Understand the CNC control in modern manufacturing system. Prepare CNC Programming for

different mechanical parts using G codes and M codes. 3. Implement the communication procedure for transmitting the CNC part program from an external computer to the control of the CNC machine tool. 4. Generate automated tool paths for a given engineering component. 5. Operate a modern industrial CNC machine tool for actual machining of simple and complex mechanical.	
LIST OF EXPERIMENTS	
1. Step turning and Taper turning in CNC 2. Thread cutting in a CNC Turning Centre. 3. Face milling and step milling in Machining Centre. 4. Profile cut using linear and circular interpolation. 5. Pocketing and slotting in CNC. 6. Mirror using Subprogram in CNC mill. 7. 8. Drilling in a CNC drilling machine	
Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr.Lawrance

Course Code	HEAT TRANSFER LABORATORY	L	T	P	C
21ME2005		0	0	2	1

Course Objectives:

To impart knowledge on

1. The heat transfer characteristics of various heat transfer apparatus
2. Heat exchanger design and analysis
3. Heat transfer in boiling and condensation

Course Outcomes:

The student will be able to

1. Calculate and compare the thermal conductivity of different materials
2. Predict the convective heat transfer coefficient by free & forced convection
3. Estimate the critical heat flux and condensation heat transfer coefficient
4. Calculate the performance and the efficiency of fins.
5. Evaluate the radiation heat transfer between the black and Gray bodies.
6. 6. Analyse the performance parameters of double pipe heat exchanger

List of Experiments

1.	Thermal conductivity Measurement of insulting medium in a lagged pipe.
2.	Determination of heat transfer coefficient in pin-fin (forced convection) apparatus.
3.	Measurement of heat transfer coefficient in a vertical cylindrical rod by free convection
4.	Determination of emissivity of the given test surface.
5.	Determination of condensation heat transfer coefficient.
6.	Determination of heat transfer coefficient in a counter flow heat exchanger.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	

Prepared by Dr.Joseph john Marshal S & Dr. Jefferson Raja Bose

Course Code	HEAT AND MASS TRANSFER	L	T	P	C
21ME2006		3	0	0	3

Course Objectives:

To impart knowledge on

1. The three basic modes of heat transfer namely conduction, convection and radiation.
2. Governing equations and solution procedures for the three modes, along with solution of practical problems using empirical correlations.
3. Two phase flow heat transfer (boiling and condensation), design of heat exchangers and mass transfer.

Course Outcomes:

The student will be able to

1. Formulate and analyze a heat transfer problem involving conduction heat transfer.
2. Estimate the heat transfer rates due to convection phenomena in external and internal flows.
3. Evaluate radiation heat transfer between black, gray surfaces and the surroundings.

4. Design heat exchangers and also estimate the pressure drop and pumping power. 5. Apply boiling and condensation correlations to two phase flow processes. 6. Estimate the mass transfer by applying suitable correlations.		
Module: 1	**CONDUCTION**	**8 Hours**
Introduction to three modes of heat transfer, General differential Equation of heat conduction- Cartesian, cylindrical and spherical coordinate systems, Initial and Boundary conditions, One dimensional steady state Heat Conduction- concept of conduction and film resistances, Composite systems, critical radius of insulation, Systems with heat sources, heat transfer through fins, Methods for analysing multidimensional steady state conduction systems, lumped system approximation and Biot number, Chart solution of transient heat conduction problems.		
Module: 2	**CONVECTION**	**8 Hours**
The convective heat transfer coefficient, Basic equations, Concept of boundary layers. Forced convection-external and internal flows. Natural convection – transition and turbulence in free convection. Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection-Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow- Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.		
Module: 3	**RADIATION**	**8 Hours**
Concept of black body, Laws of black body radiation, Interaction of radiation with materials, Stefan Boltzmann's law, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity, Radiation shields, Effect of radiation on temperature measurement.		
Module: 4	**HEAT EXCHANGER**	**7 Hours**
Types of heat exchangers, overall heat transfer coefficient, fouling, effect of turbulence, Analysis and design of heat exchangers using both LMTD and NTU methods, Pressure drop and pumping power.Applications of artificial intelligence techniques in heat exchanger systems.		
Module: 5	**BOILING AND CONDENSATION**	**7 Hours**
Boiling heat transfer phenomena, pool boiling curve, flow boiling, correlations, and condensation heat transfer, Laminar film wise condensation, turbulent film wise condensation.		
Module: 6	**MASS TRANSFER**	**8 Hours**
Diffusion mass transfer- concentrations, velocities and fluxes, Fick's law of diffusion, equimolar counter diffusion, Convective mass transfer- coefficient, Momentum, heat and mass transfer analogies, evaporation of water into air.		
	Total Lectures	**45 Hours**

Text Books	
1.	Yunus A Cengel, 'Heat and Mass Transfer - Fundamentals and Applications', McGraw Hill, 2020.
2.	R. C. Sachdeva, 'Heat and Mass Transfer', Wiley Eastern, 2017.
Reference Books	
1.	J.P.Holman, Heat Transfer, 10th Edition, McGraw Hill, 2017
2.	P.K. Nag, "Heat Transfer", Tata McGraw Hill, New Delhi, 2011.
3.	Welty, Wicks, Wilson and Rorer, 'Fundamentals of momentum, heat and mass transfer' 5th edition, Wiley, 2010
4.	F.P.Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley,Sixth Edition, 2007
5.	MassoudKaviany, Principles of Heat Transfer, John Wiley, 2002
Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr.Joseph John Marshal S &Dr. Jefferson Raja Bose

Course Code	**COMPUTATIONAL FLUID DYNAMICS**	**L**	**T**	**P**	**C**
21ME2007		3	0	0	3
Course Objectives:					
To impart knowledge on 1. Basic equations that govern the fluid flow, heat transfer and combustion processes.					

2. Various discretization methods and solving methodologies to solve complex problems in the field of heat transfer and fluid dynamics. 3. Formulation of explicit and implicit algorithms for solving the Navier Stokes equations.			
Course Outcomes:			
The student will be able to 1. Formulate the required governing equations for flow and heat transfer problems. 2. Identify the suitable grids for computing 3. Discretize the governing equations of flow and heat transfer problems. 4. Solve the diffusion equations 5. Develop a suitable Finite Volume Method for the convection-diffusion problems 6. Use appropriate algorithms to solve the discretized equations.			
Module: 1	**BASIC GOVERNING EQUATIONS IN CFD**		**8 Hours**
Introduction to CFD – working of CFD code – Problem solving with CFD – basic governing equations of fluid flow and heat transfer – mass conversation equation (3d) – momentum equation in three dimension – energy equations in three dimensions – Naiver stoke equations for a Newtonian fluid- Classification of partial differential equations- Initial and Boundary value problems. Turbulence model.			
Module: 2	**GRID GENERATION**		**8 Hours**
Introduction, Structured and Unstructured Grids, Hybrid Grids, Algebraic, Elliptic, Hyperbolic Grid generation. Unstructured grids of triangular and Tetrahedral, Unstructured grids of Quadrilateral and Hexahedral, Cartesian Mesh, Adaptive Mesh.			
Module: 3	**DIFFUSION PROCESSES**		**8 Hours**
Discretization techniques using finite difference methods – Taylor's Series. Finite volume method for one, two and three - dimensional steady state diffusion problems, Discretization of unsteady diffusion problems – Explicit, Implicit and Crank-Nicholson's schemes, Stability of schemes. Generating and solving one dimensional steady state diffusion problem			
Module: 4	**CONVECTION – DIFFUSION PROCESSES**		**7 Hours**
One dimensional convection – diffusion problem, Central difference scheme, upwind scheme – Hybrid and power law discretization techniques – QUICK scheme.			
Module: 5	**IMPLEMENTATION OF BOUNDARY CONDITIONS**		**7 Hours**
Introduction – inlet boundary condition – outlet boundary condition – wall boundary conditions – constant pressure boundary conditions –symmetry boundary conditions – advanced boundary conditions.			
Module: 6	**SOLUTION ALGORITHMS**		**8 Hours**
Tri-diagonal matrix algorithms (TDMA), Pressure based algorithms, SIMPLE, SIMPLER & PISO algorithms.			
		Total Lectures	**45 Hours**
Text Books			
1.	Anderson, J.D., "Computational fluid dynamics – the basics with applications", 2012.		
2.	Versteeg, H.K, and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", Longman, 2010.		
Reference Books			
1.	Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw- Hill Publishing Company Ltd., 1998.		
2.	Patankar, S.V., "Numerical Heat Transfer and Fluid Flow", McGraw-Hill, Ane Books Indian Edition. 2004.		
3.	Bose, T.K., "Numerical Fluid Dynamics", Narosa publishing House, 1997		
Recommended by Board of Studies	12.03.2021		
Approved by Academic Council	25.09.2021		

Prepared by Dr. A. Brusly Solomon/ Mr. Alfred Sunny

Course Code	**BIOMECHANICS AND BIOMATERIALS**	**L**	**T**	**P**	**C**
21ME2008		3	0	0	3
Course Objectives:					
Impart knowledge on 1. The application of principles of statics and kinematics to biomechanics.					

2. The biological tissues and various types of biomaterials. 3. The application of biomaterials and practical aspects of them.		
Course Outcomes:		
The student will be able to 1. Understand the applicability of statics to biomechanics. 2. Apply the principles of kinematics dynamics to biomechanics. 3. Apprehend the mechanical properties of biological tissues. 4. Know different types of biomaterials available in the market. 5. Choose appropriate biocompatible materials for medical use. 6. Recognize the practical aspects of biomaterials for various implants.		
Module: 1	**ENGINEERING MECHANICS**	**8 Hours**
Mechanics, Biomechanics, Force systems, Moment and torque, Conditions of equilibrium, free body diagram**.**		
Module: 2	**APPLICATIONS OF STATICS TO BIOMECHANICS**	**8 Hours**
Applications of Statics to Biomechanics: Skeletal Joints, Skeletal Muscles, Basic Considerations, Basic Assumptions and Limitations, Mechanics of the Elbow, Mechanics of the Shoulder, Mechanics of the Spinal Column, Mechanics of the Hip, Mechanics of the Knee, Mechanics of the Ankle and Problems.		
Module: 3	**LINEAR KINETICS**	**8 Hours**
Equations of motions, special cases of translational motion, Procedure for problem solving in kinetics, work and energy methods, mechanical work, work-energy theorem, conservation of energy principle, Power, applications of energy methods.		
Module: 4	**OVERVIEW OF BIOMATERIALS**	**7 Hours**
Construction materials, Impact of biomaterials, strength of biomaterial tissues, performance of implants, tissue response to implants, Safety and efficacy testing. Basics of Human Biology: Structure and function of human body, Chemical level, cellular level, tissue level, organ level, system level.		
Module: 5	**CLASSES OF BIOMATERIALS**	**7 Hours**
Classification of Biomaterials. Metallic, Ceramic, polymeric, Composite, surface modification, Nano biomaterials: Processing of nano bio materials.		
Module: 6	**APPLICATION AND PRACTICAL ASPECTS OF BIOMATER1ALS**	**7 Hours**
Cardiovascular Applications, Dental Implants, Adhesives and Sealants, Ophthalmologic Applications, Orthopedic Applications, Bioelectrodes, Biomedical Sensors and Biosensors Implant and Device Failures. Correlations of Material Surface Properties with Biological Responses, Implant Retrieval and Evaluation.		
	Total Lectures	**45 Hours**

Text Books	
1.	Nihat O¨ zkaya, David Goldsheyder, Margareta Nordin and Dawn Leger, "Fundamentals of Biomechanics Equilibrium, Motion, and Deformation," Springer International Publishing Switzerland 2017.
2.	Buddy D. Ratner and Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons "Biomaterials Science-An Introduction to Materials in Medicine," Academic Press Limited,2017.
Reference Books	
1.	Bahl Ajay, Basics of Biomechanics, Jaypee Brothers Medical Publishers; first edition ,2010.
2.	Donald R. Peterson, Joseph D. Bronzino, Biomechanics: Principles and Applications, Second Edition, CRC Press, 2007.
3.	Brian Love, Biomaterials - A Systems Approach to Engineering Concepts, Academic Press, University of Michigan, Ann Arbor, MI, United States, 2017.
4.	C. Mauli Agrawal, Introduction to Biomaterials, Cambridge English, 2015.
5.	BikramjitBasu, Biomaterials Science and Tissue Engineering: Principles and Methods, Cambridge University Press; First edition,2017.
6	Sujata V. Bhatt, "Biomaterials", Second Edition, Narosa Publishing House, 2005.
7	Sreeram Ramakrishna, MuruganRamalingam, T. S. Sampath Kumar, and Winston O. Soboyejo, "Biomaterials: A Nano Approach", CRC Press, 2010.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by: Dr.MonaSahu & Dr.G.Babu Rao

<table>
<tr><td>Course Code</td><td rowspan="2">APPLICATION OF MACHINE LEARNING FOR MECHANICAL ENGINEERING SYSTEMS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>21ME2009</td><td>2</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td colspan="6">Course Objectives:</td></tr>
<tr><td colspan="6">To impart knowledge on
1. The basic concepts of artificial intelligence and machine learning.
2. The various machine learning algorithms.
3. Apply various machine learning algorithms to real world mechanical engineering problems.</td></tr>
<tr><td colspan="6">Course Outcomes:</td></tr>
<tr><td colspan="6">The student will be able to
1. Obtain the basics terminologies of artificial intelligence and machine learning.
2. Formulate and evaluate the prediction models using supervised learning algorithms.
3. Design and analyses the models using unsupervised learning algorithms.
4. Understand the basics of clustering and develop prediction model.
5. Understand the basics of deep learning.
6. Applying the concept of machine learning and deep learning in mechanical engineering related problems.</td></tr>
<tr><td>Module: 1</td><td colspan="4">OVERVIEW OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING</td><td>7 Hours</td></tr>
<tr><td colspan="6">Artificial Intelligence - Definition - Problems - Problem Spaces and Search Techniques - Machine Learning - Basic of Data Statistics</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Module: 2</td><td colspan="4">SUPERVISED LEARNING ALGORITHMS</td><td>8 Hours</td></tr>
<tr><td colspan="6">Simple linear regression – multiple regression – ridge regression – feature selection and lasso – nearest neighbors and Kernel regression - assessing performance of regression models</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Module: 3</td><td colspan="4">UNSUPERVISED LEARNING ALGORITHMS</td><td>8 Hours</td></tr>
<tr><td colspan="6">Linear classifiers and logistic regression – decision tress – handling missing data - over-fitting and regularization in logistic regression.</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Module: 4</td><td colspan="4">UNSUPERVISED LEARNING AND CLUSTERING ALGORITHMS</td><td>8 Hours</td></tr>
<tr><td colspan="6">Nearest Neighbor search – clustering with k-means – mixture models - Hierarchical Clustering - K-means Algorithm - Spectral Clustering - Affinity Propagation - Probabilistic Clustering</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Module: 5</td><td colspan="4">DEEP NEURAL NETWORKS</td><td>7 Hours</td></tr>
<tr><td colspan="6">Preparing features and labels – prediction with deep neural network – recurrent neural network - long short term memory networks – convolution neural networks</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Module: 6</td><td colspan="4">CASE STUDY</td><td>7 Hours</td></tr>
<tr><td colspan="6">Introduction - Prognostics – Rotary machines – Reciprocating machines – condition monitoring for various machining process.</td></tr>
<tr><td colspan="5" align="right">Total Lectures</td><td>60 Hours</td></tr>
<tr><td colspan="6">List of experiments using Python</td></tr>
<tr><td colspan="6">1. Pre-processing of data (Python libraries)
2. Simple Linear regression and Multiple linear regression (Optimization)
3. Nearest Neighbor and KNN algorithm (Classification)
4. Handling missing data using Machine Learning
5. Overfitting and regularization of data for Machine Learning
6. Convoluted Neural Network for time series model
7. Renal Neural Network for time series model
8. Condition monitoring for real world problem (rotary machines)</td></tr>
<tr><td colspan="6">Text Books</td></tr>
<tr><td>1.</td><td colspan="5">Pedro Larrinaga, David Atienza, Javier Diaz-Rozo, Alberto Ogbechie, Carlos Esteban Puerto-Santana, Concha Bielza, “Industrial Applications of Machine Learning”, First Edition, CRC Press, 2018. ISBN 9780815356226.</td></tr>
<tr><td>2.</td><td colspan="5">Guido Reiman, “Quick Guide Machine Learning in Mechanical and Plant Engineering”, VDMA Software and Digitalization, Germany, 2018.</td></tr>
<tr><td>3.</td><td colspan="5">Lab manual</td></tr>
<tr><td colspan="6">Reference Books</td></tr>
</table>

1.	Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", Third Edition, Prentice Hall, 2010.
2.	Elaine Rich, Kevin Knight, Shivashankar B. Nair, "Artificial Intelligence", Third Edition, McGraw-Hill, 2009. ISBN -13: 973-0-07-008770-5.
Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by: Dr. Ajay Vasanth. X

Course Code	**NON-DESTRUCTIVE TESTING AND INSPECTION**	**L**	**T**	**P**	**C**
20ME3008		3	0	0	3

Course Objectives:

To impart knowledge on

1. The basic understanding on different surface NDE techniques
2. Variety of practical applications associated with NDE techniques such as UT and RT
3. Advanced and emerging NDE techniques

Course Outcomes:

The students will be able to

1. Have a basic knowledge of surface NDE techniques which enables to carry out various inspection in accordance with the established procedures.
2. Have a basic knowledge of ultrasonic testing which enables them to perform inspection of samples.
3. Have a complete theoretical and practical understanding of the radiographic testing, interpretation and evaluation.
4. Differentiate various defect types and select the appropriate NDT method for inspecting the component.
5. Understand the recent developments in NDE and their application in various industries.
6. Apply all the NDE methods on a component and compare the best technique for specific applications.

MODULE: 1	**SURFACE NON-DESTRUCTIVE EXAMINATION TECHNIQUES**	**8 Hours**

Visual Testing (VT) –Fundamentals of Visual Testing, Applications, Codes and Standards. Liquid Penetrant Testing (LPT) - Applications, Codes and Standards. Magnetic Particle Testing (MPT) –basics of MPT, Inspection techniques, Applications. Eddy Current Testing (ECT) –Fundamentals of ECT, Inspection techniques, Applications

MODULE: 2	**ULTRASONIC TESTING**	**8 Hours**

Fundamentals of Ultrasonic Waves, Generation of Ultrasonic Waves – Equipment and working principles, Ultrasonic Inspection Methods and Equipment, Ultrasonic testing and evaluation, Ultrasonic test indications, Variables affecting ultrasonic test results, types, origin and typical orientation of discontinuities, Safety precautions, Test Procedure, Codes and standards, Specifications

MODULE: 3	**RADIOGRAPHIC TESTING AND RADIATION SAFETY**	**8 Hours**

Basic Principles of Radiography, Shadow sharpness, Radio isotopic sources, Radiographic cameras, X-ray source generation and properties, Film Radiography, Characteristic curves, Processing defects and their appearance on films, Radiographic Image Quality and Radiographic Techniques, Radiation Detectors and Safety, Interpretation of Radiographs, Advantages and limitations.

MODULE: 4	**ADVANCED NDE I**	**7 Hours**

Phased Array Techniques – Introduction, Fundamental and Principles of phased array inspection, Applications. Time of Flight Diffraction - Theory and principles of Time-of-Flight Diffraction (TOFD, Equipment Requirements, Advantages, Limitations of Detection and Resolution, Codes and Standards, Interpretation, Evaluation, Applications.

MODULE: 5	**ADVANCED NDE II**	**7 Hours**

Ultrasonic Guided Waves - Basics of guided waves, Advantages and Limitations, Applications. Optical methods in Ultrasonics - Laser Ultrasonics, Laser Stereography, Advantages and Limitations, Applications. Structural Health Monitoring Methods, Strain Gauging, Genetic Algorithm- AI, ANN, AE, Neural Network, Condition Monitoring, Thermography, Applications and Case Studies.

MODULE: 6	**ADVANCED NDE III**	**8 Hours**

Acoustic emission inspection - Principles and Theory, The AE Measurement Chain, Advantages and Limitations. Leak Testing - Introduction to leak testing, Measurement of Leakage –Types of Leak – Types of flow in Leaks. Thermographic NDE, Digital Radiography and Computed Tomography (CT), Strain measurement and analysis		
	Total Lectures	**45 Hours**

Text Books	
1.	Non-Destructive Examination and Quality Control, ASM International, Vol.17,2018.
2.	J.Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition, 2011.
3.	A.S. Paipetis,T. E Matikas and D. G. Aggelis, Emerging Technologies in Non-Destructive Testing, CRC Press, 2012.
Reference Books	
1.	C. Hellier, Handbook of Non-Destructive Evaluation, McGraw-Hill Professional, 1st edition 2001.
2.	R. K.Miller and V.K.Hill, Non-Destructive Testing Handbook; Acoustic Emission Testing, Vol-6, series V, American Society for Non-Destructive Testing, 3rd edition, 2005.
3.	ASME Sec V 2001 (Boiler& Pressure Vessel Code), ASMEIntl. 2017.
4.	J. Krautkramer and H. Krautkramer, Ultrasonic Testing of Materials, Springer, 4th edition 1990.
5.	L. E. Bryant and P. Mclntire, Non-Destructive Testing Hand Book: Radiography and Radiation Testing, Vol.3, American Society for Non-Destructive Testing, 2nd edition, 1985.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr.S.J.Vijay

Course Code	**NEW-AGE MATERIALS**	**L**	**T**	**P**	**C**
20ME3009		3	0	0	3

Course Objectives:

To impart knowledge on

1. The fundamental knowledge on advanced and new-age materials.
2. The possible applications of new-age and advanced materials.
3. Structure, composition, development and behaviour of new-age and advanced materials.

Course Outcomes:

Students will be able to

1. Understand the physical principles underlying the behaviour of advanced and new-age materials.
2. The basic principles and mechanisms of the stimuli-response for the most important smart materials.
3. Propose improvement on the design, analysis and manufacturing of advanced and new-age materials.
4. Command on Shape memory materials fabrication and shape memory effects.
5. Smart polymers and new-age materials usage in space applications
6. Identify the application issues involved in integrating advanced and new-age materials to engineering smart structures and products.

Module: 1	**SMART MATERIALS**	**8 Hours**
Properties of advanced and New-age materials, Overview of Smart Materials, Classification of Smart Materials, common smart materials and associated stimulus-response, Application areas of smart systems, advanced manufacturing techniques such as VIM, VAR, SPS, additive manufacturing, etc.		
Module: 2	**PIEZOELECTRIC MATERIALS**	**8 Hours**
Piezoelectric effect: Principles of Direct and Indirect Piezoelectric Effect, Mechanisms and Applications; Structure of Perovskite (ABO_3) ceramics. Important piezoelectric materials: piezoceramics like PZTs, piezopolymers and piezocomposites. Use of piezoelectric materials in sensors, actuators, biomorphs and energy-harvesting applications.		
Module: 3	**SHAPE MEMORY MATERIALS**	**8 Hours**
Shape Memory Alloys: Shape Memory Effect and Superelastic Effect: Principles, Mechanisms and Applications. One-way and two-way shape memory effect. Ni-Ti shape memory alloys. Industrial and medical applications of shape memory alloys. Brief overview on shape memory ceramics, shape memory polymers, shape memory alloy foams - preparation techniques, properties, and applications.		

Module: 4	**SPECIAL PURPOSE MATERIALS**	**7 Hours**
Chromogenic Materials -Thermochromism, Photochromism, Electrochromism, Halochromism, Solvatochromism- principle and design strategies, CNT, Graphene, Metallic glasses, High entropy alloys, Magneto Rheological materials - Introduction, Concepts and applications.		
Module: 5	**SMART POLYMERS**	**7 Hours**
Thermally-responsive polymers, Electroactive polymers microgels, Synthesis, Properties and Applications, Protein-based smart polymers, pH-responsive and photo-responsive polymers, Self-assembly, Molecular imprinting using smart polymers, Approaches to molecular imprinting, Drug delivery using smart polymers. Biocompatible materials.		
Module: 6	**SMART SYSTEMS FOR SPACE APPLICATIONS**	**7 Hours**
Concept of composite materials, Elastic memory composites, Smart corrosion protection coatings, Self-healing materials, Sensors, Actuators, Transducers, MEMS, Deployment devices, Molecular machines, SMA-based Mars pathfinder/Rover.		
	Total Lectures	**45 Hours**

Text Books	
1.	Michelle Addington and Daniel L. Schodek, “Smart Materials and Technologies”, Elsevier 2005.
2.	K.Otsuka, C.M.Wayman(Eds.),“Shape Memory Materials”, Cambridge University Press, 2010
3.	Williams D, Callister “Material Science and Engineering” John Wiley and Sons Inc. 2015.
Reference Books	
1.	M. Schwartz, “New Materials, Processes, and Methods Technology”, CRC Press, 2006.
2.	P. Ball, “Made to Measure: Materials for the 21st Century”, Princeton University Press,2001.
3.	I. Galaev, B. Mattiasson (Eds.), “Smart Polymers: Applications in Biotechnology and Biomedicine”, 2nd edition, CRC Press, 2008.
4.	D.J. Leo, “Engineering Analysis of Smart Material Systems”, Wiley 2007.
5.	M.V. Gandhi, B. S. Thompson, “Smart Materials and Structures”, Chapman & Hall, 2001.
6.	V. Raghavan, “Materials Science and Engineering – Prentice Hall of India (P) Ltd., New Delhi. 2016

Recommended by Board of Studies	12-03-2021
Approved by Academic Council	25.09.2021

Prepared by: Dr.Robinson Smart

Course Code	**PROCESS SAFETY MANAGEMENT IN INDUSTRY**	**L**	**T**	**P**	**C**
20ME3010		3	0	0	3

Course Objectives:

To impart knowledge on

1. Modern safety concept.
2. Ergonomic principles and physiology of workers.
3. Monitoring the safety performance and training.

Course Outcomes:

The student will be able to

1. Understand the importance of safety.
2. Practice ergonomic principles to reduce accidents.
3. Apply latest safety techniques
4. Investigate and report the causes and remedies of industrial accidents.
5. Monitor the safety performance
6. Ensure safety through safety education and training.

Module: 1	**CONCEPT OF SAFETY**	**8 Hours**
Evolution of modern safety concept- Employee awareness - Workers’ participation in safety management - Safety policy - Safety Organization - line and staff functions for safety- Safety Committee- budgeting for safety.		
Module: 2	**ERGONOMICS AND PHYSIOLOGY OF WORKERS**	**8 Hours**
Definition – applications of ergonomic principles in the shop floor – work benches – seating arrangements – layout of electrical panels- switch gears – principles of motion economy – location of controls – display		

locations – machine foundations – work platforms, fatigue, physical and mental strain – incidents of accident – physiology of workers.		
Module: 3	**TECHNIQUES**	**8 Hours**
Incident Recall Technique (IRT), disaster control, Job Safety Analysis (JSA), safety survey, safety inspection, safety sampling, Safety Audit.		
Module: 4	**ACCIDENT INVESTIGATION AND REPORTING**	**7 Hours**
Concept of an accident, reportable and non-reportable accidents, unsafe act and condition – principles of accident prevention, Supervisory role- Role of safety committee - Accident causation models - Cost of accident. Overall accident investigation process - Response to accidents, India reporting requirement, Planning document, Planning matrix, Investigators Kit, functions of investigator, four types of evidences, Records of accidents, accident reports-Class exercise with case study.		
Module: 5	**SAFETY PERFORMANCE MONITORING**	**7 Hours**
permanent total disabilities, permanent partial disabilities, temporary total disabilities -Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety "t" score, safety activity rate – problems.		
Module: 6	**SAFETY EDUCATION AND TRAINING**	**8 Hours**
Importance of training- education and enforcement (3 E's) of safety - identification of training needs-training methods – programme, seminars, conferences, competitions – method of promoting safe practice - motivation – communication - role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training.		
	Total Lectures	**45 Hours**

Reference Books

1.	Guidelines for Implementing Process Safety Management, Second Edition, 2016
2.	Shrawan Kumar, "Biomechanics in Ergonomics", Second Edition, CRC Press 2007
3.	Accident Prevention Manual for Industrial Operations", N.S.C.Chicago, 1982
4.	Dan Petersen "Techniques of Safety Management: A Systems Approach, Amer Society of Safety Engineers; 4th edition (2003).
5.	Krishnan N.V. "Safety Management in Industry" Jaico Publishing House, Bombay, 1997.
6.	Phil Hughes MBE, Ed Ferrett, Introduction to Health and Safety at Work For the NEBOSH National General Certificate in Occupational Health and Safety, Taylor & Francis, 2020.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr. K. Leo Dev Wins

Course Code	**MATERIALS AND CHARACTERISATION TECHNIQUES**	**L**	**T**	**P**	**C**
20ME3011		3	0	0	3

Course Objectives:

To impart knowledge on

1. Different melting practices and casting methods.
2. Biomaterials, RP techniques and microscopy.
3. The structural characterization of materials using different techniques.

Course Outcomes:

The student will be able to

1. Familiarize the various melting practices
2. Understand the different special casting processes
3. Know the implication of biomaterials and RP techniques
4. Understand the principles of light microscopy and quantity microscopy
5. Appreciate the operating principle of X-Ray Diffraction and Diffractometry
6. Comprehend the operating principle of SEM & TEM.

Module: 1	**MELTING PRACTICES**	**8 Hours**
Melting furnace used in foundry; foundry considerations in melting non-ferrous metals such as Al, Cu and Zn alloys; melting process and problems encountered during melting of steels and cast irons; family of cast irons and their founding, Traditional Methods of Casting.		

Module: 2	**SPECIAL CASTING PROCESSES**	**8 Hours**
Pressure die casting, centrifugal casting, investment casting and continuous casting processes, Stir Casting Method. Casting defects and fettling:Common casting defects their causes and remedies, fettling and inspection, heat treatment of castings.		
Module: 3	**BIOMATERIALS AND RAPID PROTOTYPING TECHNIQUES**	**8 Hours**
Synthetic and natural biodegradable polymers, such as polylactic acid (PLA), poly (lactic/glycolic) acid (PLGA), collagen hyaluronic acid and chitosan. Working principles of various rapid prototyping systems - AM or solid freeform fabrication (SFF). 3D micro-periodic structures by colloidal templating, interference lithography, direct-writing, inkjet printing, and two-photon polymerization (2PP). Electrospinning.		
Module: 4	**QUANTITATIVE LIGHT MICROSCOPY**	**7 Hours**
Introduction to light microscopy, concept of resolution, Airy rings, numerical aperture, magnification, depth of field, depth of focus, lens defects and their corrections, principles of phase contrast – bright-field and dark-field contrast, polarized light microscopy, Quantitative microscopy, estimation of grain size, grain boundary area, relevance of light microscopy ideas to electron microscopy.		
Module: 5	**X-RAY DIFFRACTION AND DIFFRACTOMETRY**	**7 Hours**
Production of X-rays, crystal geometry, lattice directions and planes, zone axis, interplanar spacing and angle, Stereographic projection, Bragg's condition of diffraction, X-ray scattering, application of X-ray diffraction - estimation of grain size, particle size, macro texture, residual stress.		
Module: 6	**SEM and TEM**	**8 Hours**
Scanning electron microscopy (SEM)-Principle, construction and operation of SEM, micro texture, Electron Backscattered Diffraction (EDX), study of fractured surfaces, electron probe microanalysis. **Transmission electron microscopy (TEM)-**Principle, construction and operation of TEM, Interaction of electrons with specimen, camera constant, reciprocal space and lattice, Ewald sphere, diffraction from finite crystal, preparation of specimens, bright and dark field imaging, selected area diffraction, indexing of diffraction patterns, contrast from precipitates, dislocations and stacking faults.		
	Total Lectures	**45 Hours**

Reference Books

1	Heine, R.W., Loper, C.R. and Rosenthal, P.C., "Principles of Metal Casting", Tata McGraw-Hill. 2002.
2	B. Ravi, Metal Casting: Computer-Aided Design and Analysis, Prentice-Hall of India, New Delhi, 2005.
3	Mukhrjee, P.C., "Fundamentals of Metal Casting Technology" Oxford & IBH Publishing Co.1996.
4	Metals Handbook "Casting", Vol.15, 9th Ed., ASM. 1986.
5	Xiaohong Wang, Jukka Tuomi, Antti A. Mäkitie, Kaija-StiinaPaloheimo, Jouni Partanen and MarjoYliperttula, "Advances in Biomaterials Science and Biomedical Applications", Rosario Pignatello, Intech-Open, DOI: 10.5772/53114. 2013.
6	Joseph Goldstein , Dale E. Newbury, David C. Joy , Charles E. Lyman , Scanning Electron Microscopy and X-ray Microanalysis: Springer Publishers, 3rd Edition-2007.
7	Goodhew, P.J., Humphreys J. and Beanland, R., "Electron Microscopy and Analysis", Taylor and Francis. 2001.
8	Goldstein, J., Newbury, D.E., Joy, D.C., Lyman, C.E., Echlin, P.Lifshin, E., Sawyer, L., Michael, J.R Scanning Electron Microscopic and X-ray Microanalysis, Springer Publishers-3rd Edition-2003.
9	P. N. Rao, Manufacturing Technology, Vol. 1: Foundry, Forming And Welding, McGraw-Hill Education India, New Delhi, First Edition, 1987.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr. Praveen Kumar &Dr.G Babu Rao

Course Code	**MATERIALS FRACTURE AND FAILURE ANALYSIS**	**L**	**T**	**P**	**C**
20ME3012		3	0	0	3

Course Objectives:

To impart knowledge on

1. Elasto-plastic deformation and LEFM and EPFM
2. Microstructural aspects and analysis of failure
3. Environmental assisted failures and fatigue failure

Course Outcomes:

The student will be able to

1. Understand the mechanics of failure under static loading.
2. Apply the techniques of testing of LEFM and EPFM.
3. Analyze the microstructural aspects of failure.
4. Know the general approach to analysis of failure.
5. Examine the environment assisted failures
6. Evaluate the failure **analysis of fatigue fracture**

Module: 1	**MECHANICS OF FRACTURE- STATIC LOADING**	**8 Hours**

The geometry of stress and strain, elastic and plastic deformation, Brittle and Ductile fracture, Probabilistic aspects of fracture mechanics – Microstructure. Elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation – plastic zone size – Dugdaale model – J integral and its relation to crack opening displacement. Strain energy release and stress intensity factor.

Module: 2	**LEFM TESTING AND EPFM**	**8 Hours**

Linear Elastic Fracture Mechanics (LEFM) - use of the energy balance approach, introduction of the critical strain energy release rate (G1C). LEFM Testing – introduction to ASTM E399 standard for fracture toughness evaluation, use of various specimen configurations e.g Compact tension (CT) specimens, single edge notched bend (SENB) specimens, circumferential notched tensile (CNT) specimens for plane stress and plane strain fracture toughness evaluation. Elastic Plastic Fracture Mechanics (EPFM) – Introduction, history and limitations of EPFM, the use of the J integral (J1C) and the crack tip opening displacement (CTOD) as criteria for evaluating propensity to crack induced fracture under elastic-plastic conditions.

Module: 3	**MICROSTRUCTURAL ASPECTS**	**6 Hours**

Critical appraisal of the role of microstructure in failure, application of quantitative metallography, role of grain size and second phase particles, grain boundary and segregation, temper and hydrogen embrittlement, macro and micro examination.

Module: 4	**ANALYSIS OF FAILURE**	**8 Hours**

Deformation and general approach to analysis of failure; Fracture aspects: Type of fracture, ductile, brittle and mixed mode fractures, models of nucleation and growth of cracks, fractography.

Determination of chemical composition by various analytical techniques; determination of mechanical properties like tensile, hardness, bend tests of failed components, comparison with Bureau of Indian Standards, quality assurance.

Module: 5	**ENVIRONMENT ASSISTED FAILURES**	**8 Hours**

Basic principles of aqueous corrosion and high temperature corrosion and oxidation, causes and their remedies. Stress corrosion cracking (SCC)- introduction and history of SCC, material/environment combinations where SCC occurs, characteristics of SCC, introduction to various models of SCC mechanism, evaluating SCC rates using time-to-failure (TTF) tests and the fracture mechanics approach (crack growth rate) tests, significance of the K_{ISCC} in SCC evaluation.

Module:6	**FAILURE ANALYSIS OF FATIGUE FRACTURE**	**7 Hours**

Fundamental sources of failures- Deficiency in design, Empirical Relation describing crack growth by fatigue – Life calculations for a given load amplitude – effects of changing the load spectrum – Effects of Environment. Micro structural analysis of fatigue failures, some case studies in analysis of fatigue failures.

	Total Lectures	**45 Hours**

Reference Books

1	Raghavan, V., "Physical Metallurgy: Principles and Practice", 2nd Ed. Prentice-Hall of India. 2007.
2	Raghavan, V., "Materials Science and Engineering: A First Course", 5th Ed, Prentice-Hall of India. 2004.
3	Callister, W.D. Jr., "Material Science and Engineering – An Introduction", 5th Ed. John Wiley and Sons 2000.
4	Askland, R.A., "The Science and Engineering of Materials", 2nd Ed., PWS-KENT Publishing Company. 1989.
5	V. J. Colangelo and F. A. Heiser, "Analysis of Metallurgical Failures", 2nd Edition Wiley-Interscience ; 2Ed. 1987.

6	Hertz berg R W, "Deformation and fracture mechanics of Engineering Materials" Second Edition John Wiley sons inc, New York 1983.
7	Knott. J.F, "Fundamentals of Fracture Mechanics" Butterworth London, 1973.
8	T.H. Courtney: Mechanical Behaviour of Materials, 2nd edition, Overseas Press, India; 2006.
9	ASTM E399-06, Standard Test Method for Linear-Elastic Plane-Strain Fracture Toughness KIC of Metallic Materials, ASTM International, 2007.
10	ASTM E647-05, Standard Test Method for Measurement of Fatigue Crack Growth Rates, ASTM International, 2005.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr. Praveen Kumar & Dr.G Babu Rao

Course Code	**FINITE ELEMENT METHODS IN ENGINEERING**	**L**	**T**	**P**	**C**
21ME3001		3	0	0	3

Course Objectives:

To impart knowledge on

1. Fundamentals of Finite Element Analysis
2. Various types of elements used in FEA.
3. Implementation of galerkin's formulation in finite element method.

Course Outcomes:

The student will be able to

1. Acquire fundamental theory of finite element analysis and develop element characteristic equation.
2. Derive element matrix equation using different methods by applying basic laws of mechanics.
3. Analyze problems subjected to dynamic conditions.
4. Attain knowledge in error norms, convergence rates and refinement.
5. Use professional-level finite element software to solve engineering field problems.
6. Solve the real world engineering problems using IoT based finite element simulation.

Module: 1	**APPLICABILITY OF FINITE ELEMENT**	**8 Hours**

Basic concepts- General applicability of the method to structural analysis, heat transfer and fluid flow problems with case studies - classical analysis techniques-Boundary value problem and initial value problem - Solution of equilibrium, Eigen value, propagation problems- Finite element based softwares- Concept of Big data and Machine learning in Finite Element simulation.

Module: 2	**PROCEDURE OF FINITE ELEMENT**	**8 Hours**

Finite element Procedure-Discretization of Domain- basic element shapes- natural, local and global coordinates- formulation of element characteristic matrices and vectors-Pascal's Triangle -direct approach - variational approach - Weighted residual approach -Continuity conditions.

Module: 3	**ELEMENTS CHARACTERISTIC EQUATION**	**8 Hours**

Formulation of one dimensional, two dimensional, three dimensional elements - isoparametric elements- curve sided elements-higher order elements-Lagrangian element-serendipity element- Error norms and Convergence rates h-refinement with adaptivity – adaptive refinement.

Module: 4	**FIELD PROBLEMS**	**7 Hours**

Heat Transfer Problems- Basic finite element equations for 1D and 2D problems. Fluid mechanics problems- compressible flows- Basic equations- Solutions procedure- Galerkin approach. Structural Problems- Equations of elasticity- plane elasticity problems - Bending of elastic plates

Module: 5	**TORSION OF NON-CIRCULAR SECTION**	**7 Hours**

Two dimensional field equation- governing differential equations- Integral Equations for the element matrices- Element matrices- Triangular element, Rectangular element. Torsion of Non circular sections: General theory- Twisting of a square bar - shear stress components- Evaluation of the twisting torque.

Module: 6	**DYNAMIC ANALYSIS**	**7 Hours**

Dynamic equations of motion- consistent and lump mass matrices- Free vibration analysis – dynamic response calculation- Longitudinal vibration frequencies and mode shapes.

Total Lectures	**45 Hours**

Reference Books

1	Larry .J. Segerland. Applied Finite Element Analysis,Wiley India Pvt.Ltd.,2011.
2	Rao. S.S. The Finite element method in Engineering, 5th Ed., Pergamon Press, Oxford, 2010
3	David. V. Hutton, Fundamentals of Finite Element Analysis, Tata McGraw Hill, 2017.
4	Tirupathi. R. Chandrupatla, Ashok. D. Belegundu. Introduction to Finite Elements in Engineering', Pearson Education Limited, 2012.
5	J. N. Reddy. An Introduction to the Finite Element Method, 3rd ed., McGraw-Hill Education, 2005.
6	Seshu, P, Text Book of Finite Element Analysis, Prentice-Hall of India Pvt. Ltd., New Delhi, 2007

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr. Sampal

Course Code	TOTAL QUALITY MANAGEMENT	L	T	P	C
21ME3002		3	0	0	3

Course Objectives:

To impart knowledge on

1. Concepts, principles and applications of TQM.
2. Tools and techniques of TQM.
3. Control charts and process capability.

Course Outcomes:

The student will be able to

1. Apply the tools and techniques of TQM in manufacturing and service sectors.
2. Assess the barriers of TQM implementation.
3. Formulate and implement quality circles in their workplace.
4. Apply six sigma concepts in manufacturing and service sectors.
5. Apply TPM principles in manufacturing sectors.
6. Validate the role of Quality 4.0 in Industry 4.0

Module: 1	**QUALITY DEFINITIONS**	**8 Hours**

Need for quality, evolution of quality; Definitions of quality, product quality and service quality; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. Barriers to TQM; Quality statements, customer focus, customer orientation & Satisfaction, customer complaints, customer retention; costs to quality.

Module: 2	**TQM PRINCIPLES**	**8 Hours**

TQM principles; leadership, strategic quality planning; Quality councils- employee Involvement, Motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, Performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier Partnership, Partnering, Supplier rating & selection.

Module: 3	**SIX SIGMA CONCEPTS**	**8 Hours**

Tools of Quality: The seven traditional tools of quality; New management tools; Six sigma- concepts, Methodology, applications to manufacturing, service sector including IT, Bench marking process; FMECA-stages, types -Fault Tree Analysis

Module: 4	**STATISTICAL PROCESS CONTROL**	**7 Hours**

Statistical Process Control, control charts, process capability, Process capability index-Application of control concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM- concepts, improvement needs, performance measures.

Module: 5	**INTERNATIONAL QUALITY SYSTEMS**	**7 Hours**

Quality systems, need for ISO 9000 certification , ISO 9000 Series ISO 9001; 2015Quality system- elements, Documentation, Quality auditing, QS 9000, ISO 14001 - standard for occupational health and safety management. Concepts of ISO 45001, requirements and benefits; TQM implementation in manufacturing and service sectors.

Module: 6	**QUALITY 4.0:SMART QUALITY MANAGEMENT**	**7 Hours**

Quality 4.0 Investments to Support Industry 4.0 -Axes of Quality 4.0-Data driven decision making-Enterprise Quality Management Systems (EQMS)-Digitization of Quality-Cloud computing and data scalability in

Quality Management-Augmented Reality (AR) and Virtual Reality (VR) adaptation in Quality 4.0-Cobots in Quality Assurance.		
	Total Lectures	**45 Hours**

Reference Books	
1	Bester field D.H. et al., Total Quality Management, 3rd ed., Pearson Education Asia, 2006.
2	Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.
3	Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
4	Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr. R Raja

Course Code	**DESIGN FOR MANUFACTURE AND ASSEMBLY**	**L**	**T**	**P**	**C**
21ME3003		3	0	0	3

Course Objectives:

To impart knowledge on

1. The real engineering design mechanisms and processes.
2. In-depth practice in design, the use of a structured approach to design, an introductory knowledge of business practices.
3. Critical thinking, creativity, and independent learning.

Course Outcomes:

The student will be able to

1. Select a suitable mechanism, process and tolerances for various manufacturing processes.
2. Classify and Identify appropriate materials and process capabilities.
3. Describe various cutting tools and estimate the manufacturing cost for machined components.
4. Apply the fundamental design and assembly rules to complete an assembly of parts.
5. Select appropriate die casting models or designs for a new product to be manufactured.
6. Apply CAD principles in DFMA for creating new ideas and products into reality.

Module: 1	**FUNDAMENTALS OF DFMA**	**8 Hours**
Design for Manufacture and Assembly, History, Reasons for implementing DFMA Implementation of Design for Assembly, Design for Manufacture, Producibility Guidelines, Advantages of Applying DFMA during Product Design.		
Module: 2	**SELECTION OF MATERIALS AND PROCESSES**	**8 Hours**
General Requirements for Early Materials and Process, Selection, Selection of Manufacturing Processes, Process Capabilities, Selection of Materials, Primary Process/Material Selection, Systematic Selection of Processes and Materials, Problems.		
Module: 3	**DESIGN FOR MACHINING**	**8 Hours**
Machining Using Single-Point Cutting Tools, Machining Using Multipoint Tools, Machining Using Abrasive Wheels, Standardization, Choice of Work Material, Shape of Work Material, Assembly of Components, Accuracy and Surface Finish, Summary of Design Guidelines, Cost Estimating for Machined Components.		
Module: 4	**DESIGN FOR ASSEMBLY**	**7 Hours**
The assembly process, Characteristics and applications, Example of common assembly, Economic significance of assembly, General taxonomies of assembly operation and systems, Assembling a product, Design for Assembly: Introduction, Design consideration, Design for Fasteners: Introduction, Design recommendation for fasteners.		
Module: 5	**DESIGN FOR DIE CASTING AND POWDER METAL PROCESSING**	**7 Hours**
Die casting alloys, cycle, machines, dies, finishing, Die Casting Cycle Time Estimation, Determination of the Optimum number of Cavities Assembly techniques, Design principles, Powder metallurgy processing, stages, compaction characteristics, Tooling, Sintering, Design guidelines.		
Module: 6	**COMPUTER AIDED DESIGN AND ASSEMBLY**	**7 Hours**

Geometric Representation in CAD, Extraction of part feature information from CAD Model, Feature recognition techniques, Free Form Features, Hybrid Techniques, Extraction of assembly feature information from CAD Model, Assembly features, Characterization of assembly feature, Overview of procedure to extract assembly features from CAD model, Description of steps in the assembly feature extraction procedure, Examples of assembly feature extraction: Aircraft wing and automotive chassis assembly.		
	Total Lectures	**45 Hours**

Reference Books	
1	Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight, Product Design for Manufacture and Assembly, 3rd Edition, CRC Press, 2010.
2	Harry Peck, Designing for Manufacture, Pitman Publications, 2015.
3	Jayanta Sarkar Computer Aided Design: A Conceptual Approach, CRC Press, 2017.
4	George Dieter & Linda Schmidt, Engineering Design, Fifth Edition, McGraw-Hill, 2013.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr.Wilson Kumar

Course Code	**MANUFACTURING SYSTEM AND SIMULATION**	**L**	**T**	**P**	**C**
21ME3004		3	0	0	3

Course Objectives:

To impart knowledge on

1. Various modeling techniques.
2. Random number generation.
3. Manual and computer assisted simulation techniques.

Course Outcomes:

The student will be able to

1. Create model of the real manufacturing system.
2. Generate random numbers for simulation experiments.
3. Resolve practical problems in manufacturing sectors using simulation.
4. Analyze material handling problem and to give solutions.
5. Optimize the performance of a discrete system.
6. Verify and validate the simulation model.

Module: 1	**BASICS OF SIMULATION**	**8 Hours**
Simulation- advantages and limitations, areas of application, systems and system environment, components of a system, discrete and continuous system, models of a system, general systems theory, variety of modelling approach, concept of simulation, simulation as a decision making tool, types of simulation, Discrete event system simulation, steps in simulation study.		
Module: 2	**INFORMATION SYSTEMS**	**8 Hours**
Fundamentals of information technology, information networking, parts oriented production information systems, Basics of assembly lines, line balancing algorithms, COMSOL random sequence generation, job shop scheduling, dispatching rules and schedule generation, numerical problems/simulation exercises, Computer based production management systems, principles and effectiveness of CIM, factory automation, FMS.		
Module: 3	**SIMULATION OF INVENTORY AND MAINTENANCE PROBLEMS**	**8 Hours**
Random numbers generation- methods and techniques - Montecarlo simulation to solve inventory problem and maintenance problem. Experimental design consideration, output analysis, verification and validation of simulation models. Queuing models: Review of terminology and concepts, Transient and steady state behavior-long run measures of performance of queuing systems.		
Module: 4	**DISCRETE EVENT SIMULATION**	**7 Hours**
Concepts in discrete event simulation: Development of simulation models for queuing systems, production systems, inventory systems, maintenance and replacement systems, Event scheduling/Time advance algorithm-manual simulation using event scheduling-list processing Programming for discrete event systems in GPSS.		
Module: 5	**MANUFACTURING SIMULATION**	**7 Hours**
Simulation of manufacturing & material handling system, manufacturing models - Types and uses, material handling –Goal and performance measures-Issues in Manufacturing &Material handling simulation-case		

studies- Comparison and selection of simulation languages, study of simulation language, concepts of SIMFACTORY, AIM, ARENA and TAYLOR II softwares.		
Module: 6	**VERIFICATION AND VALIDATION**	**7 Hours**
Simulation experiments, Verification and validation of simulation models. –Face validity-Validation of model assumptions, Problem formulation – data collection and reduction –experimental design consideration – interpretation and validation – application of simulation in engineering industry.		
	Total Lectures	**45 Hours**
Text Books		
1.	Guy L. Curry, Richard M. Feldman, "Manufacturing Systems Modeling and Analysis 2nd ed. Springer, 2011 Edition" (ISBN-13: 978-3642166174)	
2.	Geofery Gordan, Systems Simulation, Prentice Hall, 2013.	
Reference Books		
1.	Jerry Banks and John S. Carson, "Discrete –Event System Simulation", Prentice Hall Inc, 2009.	
2.	Gordon G, "System Simulation", Prentice Hall of India Ltd, 2009	
3.	D.S.Hira, "System Simulation", S.Chand& Company Ltd, 2010.	
4.	Law.M.Kelton, "Simulation Modeling and Analysis", McGraw Hill, NY, 2007	
5.	Ronald G. Askin, Charles R. Standridge, "Modeling and Analysis of Manufacturing Systems 1st Edition" Wiley 1993. (ISBN-13: 978-0471514183)	
Recommended by Board of Studies	12.03.2021	
Approved by Academic Council	25.09.2021	

Prepared by Dr. R. Malkiya Rasalin Prince

Course Code	COMPUTER APPLICATIONS IN DESIGN	L	T	P	C
21ME3005		3	0	0	3

Course Objectives:

To impart knowledge on

1. How computers can be used in mechanical engineering design.
2. Basics of CAD modelling (surface and solid) and assembly of parts
3. Writing interactive programs for mechanical design problems

Course Outcomes:

The student will be able to

1. Summarize the applications of computers Mechanical Engineering Design.
2. Categorize and use various curve techniques for 3D modelling.
3. Make use of surface and solid modelling techniques for complex part designs.
4. Create part assemblies and develop complex parts based on Visual realism techniques.
5. Developing programs for machine elements.
6. Understanding the various aspects in expanding CAD capability.

Module: 1	**BASICS OF CAD**	**9 Hours**
Design Process - Product cycle - Sequential and concurrent engineering - Graphics displays - Graphics standards - Open GL Data Exchange standards – IGES, PDES etc - line, circle and arc drawing algorithms - viewing - 2D & 3D transformations (Translation, scaling, reflection, rotation)		
Module: 2	**GEOMETRIC MODELING AND WIREFRAME MODELING**	**7 Hours**
Geometric models - Geometric construction methods - wireframe entities - curve representation methods - parametric representation of analytical curves (line, circle, conics, tangent vector and tangent line, normal vector) - parametric representation of synthetic curves (Hermite, Bezier, B-spline, rational curves) - curve manipulations - design and engineering applications		
Module: 3	**SURFACE MODELING AND SOLID MODELING**	**8 Hours**
Surface entities - surface representation - parametric representation of analytic surfaces (plane, ruled, surface of revolution, tabulated cylinder) - parametric representation of synthetic surfaces (Hermite, Bezier, B-Spline, Coons, rational surfaces) - surface manipulations - design and engineering applications. Solid entities - B-rep - CSG - ASM - design and engineering applications - problems sweep representation - Solid manipulations - design and engineering applications		
Module: 4	**ASSEMBLY OF PARTS AND VISUAL REALISM**	**6 Hours**

Assembly modeling - interferences of positions and orientation - tolerances analysis - mass property calculations - mechanism simulation. Hidden line, surface and solid removal - shading - rendering. Introduction to parametric and variational geometry-based software's and their principles creation of prismatic and lofted parts using these packages.		
Module: 5	**COMPUTER AIDED DESIGN OF MACHINE ELEMENTS**	**8 Hours**
Writing interactive programs to solve design problems - systems customization - Features of various solid-modelling packages. Development of programs in design of shafts gears, pulleys, flywheel, connecting rods.		
Module: 6	**EXPANDING THE CAPABILITY OF CAD**	**8 Hours**
Parametric and variation modelling - Feature based modelling - Feature recognition - Design by features - Analysis - Rapid prototyping - AI in Design - Concept of predictive engineering analytics.		
	Total Lectures	**45 Hours**

Reference Books

1. Ibrahim Zeid, CAD/CAM- Theory and Practice, Tata McGraw Hill, Edition,2013
2. Donald Hearn and M Pauline Baker 'Computer Graphics', Prentice Hall Inc. III Edition2006.
3. Chris McMahon and Jimmi Browne, 'CAD CAM Principles, practice and Manufacturing Management', Pearson Education Asia, 2000.
4. Jean Gallier., 'Curves and Surfaces in Geometric Modeling: Theory and Algorithms', Morgan Kaufmann; 1st edition, 1999.
5. Michael Mortenson, 'Geometric Modelling', Industrial Press, 3rd edition,2006
6. David Salomon, 'Computer Graphics and Geometric modelling', Springer; 1st edition 1999.
7. MarttiMantyla, 'An Introduction to Solid Modelling' W.H. Freeman and Company, 1988.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr. S. Mohanasundaram

Course Code	ADVANCED COMPUTER AIDED MANUFACTURING LABORATORY	L	T	P	C
21ME3006		0	0	4	2

Course Objectives:

To impart knowledge on

1. Usage of manufacturing software in writing the codes for CNC, VMC and Turning centres to produce components
2. Concepts of CNC programming in machining center
3. Concepts of simulation on CNC machining center

Course Outcomes:

The student will be able to

1. Machine complex profiles using CNC machines with the aid of auto generated CNC codes
2. Generate CNC program for turning and milling of component using Master CAM / Edge CAM softwares
3. Write CNC codes for linear, circular interpolation step turning ball turning and external threading.
4. Write CNC codes for creating holes on components using CNC drilling machine and square pockets using vertical milling centre.
5. Write CNC program for creating.
6. Operate a modern industrial CNC machine tool for actual machining.

LIST OF EXPERIMENTS

1. Study of different control systems and CNC codes
2. Programming using linear interpolation codes
3. Programming using circular interpolation codes
4. Circular drilling in a CNC drilling machine
5. Square pocketing and drilling in a CNC VMC
6. Boring in CNC turning center
7. Circular pocketing in CNC mill
8. Ball tuning in a CNC Lathe
9. Programming using canned cycles
10. Spiral cutting in a CNC four axis trainer mill
11. Complex profile in a CNC XL mill

12. 12. Triangular mirror using CNC mill	
Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr.Lawrance

Course Code	DESIGN OF FLUID POWER SYSTEMS	L	T	P	C
21ME3007		3	0	0	3

Course Objectives:

To impart knowledge on

1. Laws and governing equations for hydraulics and pneumatics with ISO symbolic representations.
2. Working principles of hydraulic and pneumatic drives and develop circuits for engineering applications.
3. Troubleshooting the hydraulic and pneumatic systems.

Course Outcomes:

The student will be able to

1. Interpret the standard symbols and laws used in FPC Systems.
2. Infer the working principles of hydraulic pumps and motors.
3. Build the logical hydraulic circuits
4. Build the hydraulic circuits for an industrial application.
5. Design a pneumatic circuit for industrial applications.
6. Understand the fault functioning and maintenance of the fluid power systems.

Module: 1	**FLUID POWER ELEMENTS**	**8 Hours**

Industrial Prime Movers, basic laws, applications, types of fluid power systems, fluid types and properties. Comparison of power systems, Fluid power symbols. fluid reservoir, Cylinders, Mechanics of cylinder loading, Pressure accumulators-types, DCV, FCV of hydraulics, relief valve, hydraulic servo systems, Series and parallel pressure compensation flow control valves. Flapper valve analysis and Design Cartridge valves, Hydraulic fuses, Temperature and pressure switches, electromechanical devices like relays and solenoids.

Module: 2	**HYDRAULIC PUMPS AND MOTORS**	**8 Hours**

Types – design and construction, gear pumps, vane pumps, piston pumps and pump performance, numerical problems, Hydraulic Motors –Types, Analysis of valve-controlled motor, Analysis of pump-controlled motor, theoretical torque, power and flow rate, performance and numerical problems, pump selection factors.

Module: 3	**DESIGN OF HYDRAULIC CIRCUITS**	**8 Hours**

Reciprocation, quick return, Speed control circuits, sequencing, synchronizing circuits, clamping and accumulator circuits, press circuits and hydro-pneumatic circuit, Fail Safe and Counter balancing circuits, Filtration systems and maintenance of system.

Module: 4	**DESIGN OF PNEUMATIC CIRCUITS**	**8 Hours**

Basic elements -Compressor, Cylinders, DCV, FCV, PCVs and other special valves, Boolean algebra, truth tables, reciprocation, quick return circuit, cascade circuits/ sequencing circuits like A+B+ A- B-, electropneumatic circuits Examples of typical circuits using Displacement-Time and Travel-Step diagrams.

Module: 5	**INDUSTRIAL APPLICATIONS**	**8 Hours**

MPL control of Fluid power circuits, fluidic elements and fluidic sensors, Basic concepts of Programmable Logical Control, Fail-safe Circuits, Intensifier circuits, Box-sorting System, Electrical Control of Regenerative Circuit, Hydro-pneumatic circuit. Applications in Assembly, Feeding, Metalworking, materials handling and plastics working. PLC controlled industrial circuits.

Module: 6	**FAULT FINDING AND MAINTENANCE**	**6 Hours**

Trouble Shooting in Fluid Power Systems, Preventive Maintenance, Piping Design for Fluid Power Systems.

Total Lectures	**45 Hours**

Text Books

1.	M.K. Medhat, Dr.Khalil "Electro-Hydraulic Components and Systems: Hydraulic Systems Volume 2" Hardcover 2017
2.	Majumdar S.R., "Oil Hydraulics", Tala Mc GRawHIlL, 2002.
3.	Majumdar S.R., "Pneumatic systems - Principles and Maintenance", Tata McGraw-Hill, New Delhi, 2005

Reference Books

1.	John Watton, “Fundamentals of fluid power control”, Cambridge University press, 2012.
2.	R.Srinivasan “Hydraulic and Pneumatic Controls” 2nd Edition ,Tata McGraw - Hill Education 2008.
3.	Anthony Esposito,” Fluid Power with Applications”, Pearson Education Inc., Seventh Edition, 2014. ISBN 9780135136904.
4.	John Watton, Fundamentals of Fluid Power Control, Cambridge University Press, 2009
5.	Hand book for Pneumatic and Hydraulics – by Festo Didactic, Germany.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr.S.RajeshRuban

Course Code	CONTROL OF CNC MACHINE TOOLS	L	T	P	C
21ME3008		3	0	0	3

Course Objectives:

To impart knowledge on

1. CNC programming, hydraulic system
2. CNC interpolation, DDA integrator
3. 3. CNC control loops and architecture

Course Outcomes:

The student will be able to

1. Design control systems for CNC machine tool
2. Understand the principles of motors and hydraulic system
3. Compare the interpolation methods in CNC control system
4. Recommend PID controllers, servo controller, Numerical control Kernel types
5. Select the components of CNC architecture
6. Propose the PLC programming Languages

Module: 1	**CNC SYSTEMS AND PROGRAMMING**	**8 Hours**

CNC systems, Coordinate systems of CNC machines, Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines. Absolute and relative positioning Economics. CNC programming Interpolation, CNC programming - feed, tool and spindle functions (G-codes and M-codes).

Module: 2	**CNC DRIVES AND CONTROLLERS**	**8 Hours**

CNC drives Hydraulic systems, servo and stepping motors, feed system, response analysis, Feedback devices and counter, Axis measuring system – synchro, synchro-resolver, gratings

Module: 3	**CNC HARDWARE INTERPOLATORS**	**8 Hours**

CNC Hardware, Characteristics, CNC Interpolation – Hardware interpolators- DDA integrator, linear, circular, complete interpolators

Module: 4	**CNC SOFTWARE INTERPOLATORS**	**7 Hours**

Software interpolators, Tustin method, NURBS and polynomial interpolators, Acceleration and deceleration control techniques.

Module: 5	**CNC CONTROL LOOPS**	**7 Hours**

CNC control loops, PID control, servo controller, gain tuning, feed forward control, Mathematical analysis of control loops, Computer Aided Inspection

Module: 6	**CNC ARCHITECTURE**	**8 Hours**

CNC Architecture - Numerical control kernel- types, programming languages, Human-Machine Interface functions, structure. CAM package: Fanuc, Heidenhain, Sinumeriketc. , computer aided part programming, maintenance of CNC machines

Total Lectures | **45 Hours**

Text Books

1.	Yoram Koren, “Computer Control of Manufacturing Systems” McGraw-Hill, 1985
2.	Yoram Koren and Joseph Ben Uri, “Numerical Control of Machine Tools”, Khanna Publishers, 2000.

Reference Books

1.	Suk-Hwan Suh and Ian Stroud, Gloud “Theory and Design of CNC Systems”, Springer, 2008.

2.	Yusuf Altintas, “Manufacturing Automation Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design”, Second edition, Cambridge University Press, 2012
3.	Stanton, George C. Numerical Control Programming. Available URL: http://faculty.etsu.edu/hemphill/entc3710/nc-prog/index.htm
4.	Rao P.N., “CAD/CAM”, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2002.
5.	Radhakrishnan P, “Computer Numerical Control Machines”, New Central Book Agency, 2002.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr. Tapas Debnath

Course Code	ADVANCED METAL CUTTING THEORY	L	T	P	C
21ME3009		3	0	0	3

Course Objectives:

To impart knowledge on
1. Mechanics of metal cutting and nomenclature of cutting tools.
2. Measurement of cutting force and cutting temperature.
3. 3. Tool materials, tool life, tool wear and chatter in machining.

Course Outcomes:

The student will be able to
1. Understand mechanism and theories of metal cutting.
2. Select the cutting tool based on the operation to be done.
3. Understand thermal aspects in machining.
4. Analyze tool materials and tool life.
5. Measure cutting forces during machining processes.
6. Diagnose tool wear, vibration and chatter.

Module: 1	**MECHANICS OF METAL CUTTING**	**8 Hours**

Mechanics of chip formation-types of chips- Chip breakers- Built-Up-Edge and its effect in metal cutting, Orthogonal and Oblique cutting- Merchant’s circle - force and velocity relationship, shear angle, shear stress, shear strain - Energy consideration in machining- Ernst & Merchant theory, Modified Merchant’s theory, Lee & Shaffer Theory. numerical problems.

Module: 2	**TOOL NOMENCLATURE OF CUTTING TOOLS**	**8 Hours**

Nomenclature of single point tool - Significance of various angles of single point cutting tools, American Standards Association (ASA) system, Orthogonal Rake System (ORS), Normal Rake System (NRS) & Conversion of rake angles - Nomenclature of multi point tools like drills, milling cutters and broaches.

Module: 3	**THERMAL ASPECTS OF MACHINING**	**8 Hours**

Thermodynamics of chip formation - Heat distributions in machining-Effects of various parameters on temperature - Shear plane temperature in orthogonal cutting - Determination of cutting temperature using analytical method – Experimental methods of temperature measurement in machining - Hot machining - Cutting fluids - types. Methods of application and selection of cutting fluids.

Module: 4	**TOOL MATERIALS AND TOOL LIFE**	**7 Hours**

Desirable properties of tool materials - Developments in tool materials-Tool Coating- ISO specifications for inserts and tool holders-Tool life - Taylor’s tool life equation, optimum tool life - Conventional and accelerated tool life tests – numerical problems.

Module: 5	**CUTTING FORCES AND ECONOMICS OF MACHINING**	**7 Hours**

Forces in turning, drilling and milling - specific cutting pressure- measurement of cutting forces. Concepts of machinability and machinability index - Economics of machining – Costs for single pass turning operations – Optimum cutting speed for minimum cost in turning.

Module: 6	**TOOL WEAR MECHANISMS AND CHATTER IN MACHINING**	**8 Hours**

Reasons for failure of cutting tools and forms of wear-mechanisms of wear - chatter in machining - Factors effecting chatter in machining - types of chatters-Mechanism of chatter based on Force Vs Speed graph.

Total Lectures	**45 Hours**

Text Books	
1.	B.L. Juneja and G.S. Sekhon - "Fundamentals of metal cutting and machine tools", New Age International (p) Ltd., 2015.
2.	M.C. Shaw, "Metal cutting Principles ", Oxford Clarendon Press, 2005.
Reference Books	
1.	Bhattacharya. - "Metal Cutting Theory and Practice ", new central Book Agency pvt. Ltd., Calcutta 2016.
2.	Boothroy.D.G. and Knight. W.A "Fundamentals of Machining and Machine tools", Marcel Dekker, New York, 1989.
3.	Stephenson, D. A., &Agapiou, J. S. Metal cutting theory and practice: CRC Taylor & Francis, 2016.
4.	Rao, P.N. "Manufacturing Technology", Metal Cutting and Machine Tools, Tata McGraw–Hill, New Delhi, 2013.
5.	Trent, E. M. and P. K. Wright, Metal Cutting, 4th edition. Butterworth-Heinemann, 2000
Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr. D. Philip Selvaraj

Course Code	QUALITY CONCEPTS IN DESIGN	L	T	P	C
21ME3010		3	0	0	3

Course Objectives:

To impart knowledge on
1. Basic concepts in total quality management
2. Statistical process control
3. Reliability computation and reliability improvement

Course Outcomes:

The student will be able to
1. Apply the basic tools of quality in product development
2. Analyze the basic tools of quality in improving or redesigning the production process
3. Adopt/adept TQM and SPC tools in product/process industries
4. Conduct experiments and to analyze the significance of proceeds parameters
5. Compute reliability of parallel, series and mixed configurations
6. Improve the reliability of the systems by redundancy

Module: 1	BASIC CONCEPTS	8 Hours

Basic concepts in quality engineering and management, TQM, Cost of quality, quality engineering, concept of quality auditing, customer satisfaction. Kano model and Quality Function Deployment (QFD).

Module: 2	QUALITY LEVEL	8 Hours

Six sigma concept, Six Sigma sustainability, Six Sigma and lean production. Review of Probability and Statistics, Frequency distributions and Histograms, Test of Hypothesis.

Module: 3	STATISTICAL PROCESS CONTROL	8 Hours

DMAIC process for process and design improvement, Acceptance Sampling, Statistical Process Control (SPC), Process Capability, Gage Reproducibility and Repeatability, Quality Function Deployment.

Module: 4	FAILURE ANALYSIS	7 Hours

Failure mode effect analysis, Fault-tree analysis APQP, Embodiment checklist- Advanced methods: systems modeling, mechanical embodiment principles.

Module: 5	DESIGN OF EXPERIMENTS	7 Hours

Quantifying robustness: Signal to Noise Ratio, problem formulation using SNR Procedure for DOE, Fractional, Full and Orthogonal Experiments, Regression model building, Taguchi methods for robust design.

Module: 6	RELIABILITY	8 Hours

Definition, Survival and Failure Rates-Series and parallel and mixed systems-Mean time between failure, Mean time to failure, Availability models-redundancy. Life testing and failure data analysis.

Total Lectures | **45 Hours**

Text Books	
1.	Evans, J R and W M Lindsay, "An Introduction to Six Sigma and Process Improvement", 2nd Edition, Cengage Learning, 2015.

2.	J.M.Juran, “Quality planning and analysis”, McGraw Hill, 5th Edition,1**5** thReprint 2015
Reference Books	
1.	Montgomery, “Design and analysis of Experiments”, Wiley India, 5th Edition 2004
2.	AmitavaMitra, “Fundamentals of quality control and Improvement”, Wiley India, 3rd Edition 2013
3.	M.Mahajan, “Statistical Quality Control”, Dhanpat Rai Sons, 11th Edition 2007
Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by Dr.SabithaJannet

Course Code	**ANALYSIS AND SIMULATION LABORATORY**	**L**	**T**	**P**	**C**
21ME3011		0	0	4	2

Course Objectives:

To impart knowledge on

1. Mechanical engineering problems using advanced analysis package like Ansys
2. Simulation software to construct and execute goal-driven system models.
3. Various simulation and analysis tools to different real time applications.

Course Outcomes:

The student will be able to

1. Demonstrate the use of analysis software for various structural and thermal related problems
2. Apply the suitable commands in solving the problems in analysis software.
3. Compare the various element types, material properties and boundary conditions with the real life problems to get an optimal solution.
4. Charting server models for generic problems.
5. Hypothesizing machine learning model for supply chain management.
6. Building a simple block chain model.

ANALYSIS MODULE USING ANSYS WORKBENCH

1. Force and stress analysis in beams with different support conditions
2. Stress analysis of flat plate (with circular hole) and simple shells
3. Stress analysis of axis- symmetric component
4. Thermal analysis of 2D components and cylindrical shells
5. Modal and harmonic analysis of systems
6. Topology optimization of a structure
7. Transient structural analysis of structures
8. Transient thermal analysis of structures

SIMULATION MODULE USING PYTHON

1. Simulation of single server model using generic examples.
2. Simulation of two server model with failure and repairman.
3. Simple regression model for prediction of an entity in supply chain management.
4. Building up a simple blockchain.

Reference Books	
1.	Lab Manual
Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by: Dr. Ajay Vasanth. X

Course Code	**MECHATRONICS AND ROBOTICS LABORATORY**	**L**	**T**	**P**	**C**
21ME3012		**0**	**0**	**4**	**2**

Course Objectives:

To impart knowledge on

1. Fundamentals of fluid power and Mechatronics systems and primary actuating systems.
2. Programming skills in Programmable logic controllers.
3. Principles of pneumatics and hydraulics and apply them to real life problems.

Course Outcomes:

The student will be able to

1. Apply Boolean algebra for logic design of pneumatic circuits.
2. Apply Boolean algebra for logic design of hydraulic circuits
3. Build logic circuits for industrial applications
4. Build cascade circuits for multiple cylinder applications.

5. Design automation circuits with PLC for industrial problems 6. Write Programme for robot movements	
LIST OF EXPERIMENTS: 1. Boolean logic circuit for Pneumatic operation 2. Material movements/handling using Pneumatic Circuit 3. Electro-Pneumatic Circuit for stamping applications 4. Electro-Pneumatic Circuit Cascade System of sequence A+B+C+A-B-C-. 5. Electro-Hydraulic Circuit using Proximity Sensors for linear and rotary actuator applications 6. PLC Controlled Pneumatic Circuit for Material Handling System 7. Stacking of object using SCORBOT 8. Robot Programming for material transfer application using Mini Robot. 9. Robot programming for object placing and marking applications 10. 10.Assembly and disassembly of PIC controller based Mobile Robot. 11. 11.Robot programming for trajectory planning. 12. 12.Sensor's articulation using programming.	
Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Course Code	**ERGONOMICS IN BIO-MEDICAL INSTRUMENTATION**	**L**	**T**	**P**	**C**
21ME3015		**3**	**0**	**0**	**3**
Course Objectives:					
To impart knowledge on 1. Applied anthropometry and biomechanics of human body system 2. Bio-electrical, bio-magnetic measurements 3. Direct and indirect pressure measurements					
Course Outcomes:					
The student will be able to 1. Apply the principles of anthropometry for designing for special population 2. Determine bio-static and bio-dynamics of human body. 3. Measure bio-electrical and bio-electronic signals 4. Analyze of electrostatics of bio-magnetic signals 5. Evaluate direct muscle force measurements 6. Estimate indirect muscle force measurements					
MODULE:1	**APPLIED ANTHROPOMETRY AND DESIGN FOR SPECIAL POPULATION**	**8 Hours**			
The Human body- Skeletal system, Body planes, Body somatotypes, Anthropometry, Development of anthropometry, Incompatible anthropometric design implications in Indian context, Need for Indian anthropometric data, State-of-the-art anthropometry in India. Anthropometry-Structural (Static) dimensions and functional (Dynamic) dimensions. Special designs for men and women, Sensory abilities, Motor skills, coping with environmental stress- Designing for children, Changes in Somesthetic Sensitivity, Changes in Psychometric Performance-Ergonomic design for the disabled persons, Design for one, Ergonomic-means to enable the disabled, Classification of impairments.					
MODULE:2	**BIOMECHANICS OF HUMAN BODY**	**8 Hours**			
Biomechanics: Human skeletal system-Bone, joints, artificial joints, spinal column, muscles. Biomechanical description of the human body-Links, Joints and Masses, Body kinetics and describing the human motion. Human System and Human System Modelling. Biostatic Mechanics-Statics of the musculoskeletal system, upper extremity and hand, lower extremity and foot. Biodynamic mechanics-human body kinematics, human body kinetics.					
MODULE:3	**BIOELECTRIC AND BIOELECTRONICS MEASUREMENTS**	**8 Hours**			
Bioelectricity and Bioelectronics: Electrobiophysics of nerve cells- Electrical gradients, Membrane model. Electrobiophysics of muscle fibers, Bioelectronics and Electromyogram (EMG), Electrocardiogram (ECG) and Electropneumogram (EPG) Motion measurement of the Body and an Extracted Tissue, Optical methods, Magnetic Methods, Linear and angular velocity measurements, Electromagnetic velocity sensor, Doppler methods, Translational and angular acceleration measurements, Translational accelerometer, Angular accelerometer. Force Measurements-Muscle contraction measurement, Measurements of stresses in the bone, Force plates, Stabilimeters, Instrumented shoe, Foot force distribution measurements.					

MODULE:4	**BIOMAGNETIC MEASUREMENTS**	**7 Hours**
Electromagnetic measurements, Requirement of measurement ratings. Electrode theory-Electrode, electrolyte Interface, Liquid junction potentials, Double layer, Electrode potential. Surface potential electrodes-ECG Electrodes, Electromyogram (EMG) Electrodes. Micro and suction electrodes-Glass micro electrodes, Metal micro electrodes, Suction electrodes, Patch clamping. Bio Magnetism-Bio Magnetic fields, Induction coil measurements, Fluxgate magneto meter, Squid system, Magnetic noise and shielding.		
MODULE:5	**DIRECT PRESSURE MEASUREMENTS**	**7 Hours**
Direct Pressure measurement methods: Catheters and the diaphragm-type pressure sensor, Dynamic Response of Catheter-Sensor system, Catheter-tip pressure sensor, Implantable pressure sensors, Pressure measurements in small vessels, Pressure measurements in collapsible vessels and Interstitial spaces, Different pressure measurement.		
MODULE:6	**INDIRECT PRESSURE MEASUREMENTS**	**7 Hours**
Indirect pressure measurements: Indirect Measurement of Systolic, Diastolic and mean blood pressure, Indirect measurement of instantaneous Arterial pressure, Cuff Design for Indirect Blood Pressure, Detection of Korotkoff Sounds, Mean Blood Pressure Measurements by the Oscillo-metric Method, Blood Pressure Measurements by Doppler, Ultrasound Indirect Measurements of Instantaneous Arterial Pressure.		
	Total Hours	**48 Hours**

Text Books	
1.	Karl Kroemer, Henrike Kroemer and Katrin Kroemer-Elbert, "Ergonomics-How to Design for Ease and Efficiency", Academic Press; 3rd edition, 2018.
2.	Tatsuo Togawa, Toshiyo Tamura, P.Ake Oberg. Biomedical Transducers and Instruments. CRC Press, New York, 2007.
Reference Books	
1	Deb Kumar Chakrabarthi, Indian Anthropometric Dimensions-for Ergonomic Design Practice, (Data book) National Institute of India,1997.
2	Robert B. Northrop: Analysis and application of analog electronic circuits to biomedical instrumentation. Second edition, Biomedical engineering series, CRC Press, Taylor & Francis Group. 2012.
3	R S Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw Hill, 2003.
4	Rangaraj M. Rangayyan. Biomedical Signal Analysis. John Wiley & Sons, 2015.
5	Mark S. Sanders, Ernest J. McCormick, Human Factors in Engineering and Design, McGraw Hill. 1993.

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by: Dr. G.Babu Rao

Course Code	**MICROCONTROLLERS FOR SENSOR CONTROL AND INTERFACES**	**L**	**T**	**P**	**C**
21ME3016		3	0	0	3

Course Objectives: To impart knowledge on

1. ADC and DAC and instrument amplifiers
2. On micro controllers and communication peripherals
3. Interfacing micro controller with various medical sensors

Course Outcomes: The student will be able to

1. Analyze ADC and DAC modules
2. Familiarize the interfacing with instrument amplifiers
3. Know the micro controller I/O port and its peripherals
4. Knowledge on communication modes
5. Knowledge on latest micro controllers
6. Create an embedded system for a particular application

MODULE: 1	**ADC AND DACs**	**8 Hours**
Analog to digital conversion: Basics of ADC, Modes of ADC, ADC in continuous and non-continuous mode, ADC using DMA. ADC trigger by Timer module and external trigger. Basics of Digital to Analog conversion, Generation of Audio waves, Generation of pure sign wave. Generation of constant current and constant voltage for piezo electric sensor.		
MODULE: 2	**INTERFACE WITH INSTRUMENT AMPLIFIERS**	**8 Hours**

Understand instrument amplifiers, Strain gauge interface with whetstone bridge, I2C/SPI interface with pressure sensors and instrument amplifiers. Digital interface sensor and controller development options. block diagram of a sensor electronic interface.		
MODULE -3	**MICROCONTROLLER I/O PORTS AND TIMERPERIPHERALS**	**8 Hours**
Micro controllers: I/O port programming, understand various configuration of port pints, Pull-up and pull-down configurations. Timer Module: Understand timer peripheral, PWM signal generation, white noise generation, Single shot timers and continuous timers, Input capturing mode, Out-put compare modes.		
MODULE -4	**COMMUNICATION INTERFACE**	**7 Hours**
Serial Interface: Basics of UART communication, Understand various modes of UART configuration. UART communication using interrupt and DMA methods. SPI Interface: Basics of SPI communication, Communication modes, Quad SPI. I2C Interface: Basics of I2C communication, Interface with RTC chips. Sensor interfacing and Signal conditioning.		
MODULE -5	**ADVANCED MICROCONTROLLER**	**7 Hours**
PIC Microcontroller: CPU architecture – Timer – Interrupts – I/O port expansion– I2C bus – A/D converter – Instruction set. Typical applications: Stepper motor control –DC motor control – AC power control using any microcontroller. ARM 32-bit micro controllers and its peripherals.		
MODULE -6	**DESIGN OF EMBEDDED SYSTEM**	**7 Hours**
Embedded Design Life cycle, Hardware Interfacing Techniques- Serial Communication, RTC and EEPROM interface, Relay, Stepper and DC motor; Software Development tools and Programming Techniques-IDE-Timer Programming, Serial port programming, Getting Embedded Software into Target System Debug Kernels; Real Time Operating Systems.		
	Total Hours	**45 Hours**

Text Books	
1.	Sarmad Naimi, Muhammad Ali Mazidi and Sepehr Naimi. The STM32F103 Arm Microcontroller and Embedded Systems: Using Assembly and C. Publisher: Microdigitaled. 2020.
2.	Raj Kamal. Embedded Systems: Architecture, Programming and Design. 2008.
Reference Books and Articles	
1	Muhammad Ali Mazidi. The 8051 Microcontroller and Embedded Systems: Using Assembly and C – VTU. Pearson Publications.2011.
2	Firth J. and Errico P., “Low-Power, Low-Voltage IC Choices for ECG System Requirements,” *Analog Dialogue*, Volume 29, Number 3, 1995.
3	Ramesh.S.Gaonkar “Microprocessor Architecture, Programming & Applications With 8085/8080a”, Penram International, 2006.
4	D.V. Hall “Microprocessor and Interfacing Programming and Hardware”, McGraw Hill Publishing Company, 2010.
5	Arnold Berger, ―Embedded System Design: An Introduction to Processes, Tools, and Techniques CMP Books,2001.
6	Myke Predko, Handbook of Microcontrollers (TAB Electronics Technical Library) McGraw-Hill Education TAB; Har/Com edition. 1998.
7	https://www.analog.com/en/analog-dialogue/articles/ecg-front-end-design-simplified.html
8	https://www.st.com/en/microcontrollers-microprocessors/stm32g0-series.html

Recommended by Board of Studies	12.03.2021
Approved by Academic Council	25.09.2021

Prepared by: Dr. G.Babu Rao

DEPARTMENT OF MECHANICAL ENGINEERING

LIST OF NEW COURSES (2020)						
S. No	**Code No.**	**Course Title**	**L**	**T**	**P**	**C**
1	19ME1003	Engineering Mechanics	3	0	0	3
2	19ME1004	Manufacturing Practices Laboratory	0	0	2	1
3	19ME1005	Computer Aided Drafting	0	0	6	3
4	19ME2018	Robotics and Automation	3	0	0	3
5	19ME2019	Actuators for Automation	3	0	0	3
6	19ME2020	Drone Technology	3	0	0	3
7	19ME2021	Manufacturing Technology Laboratory	0	0	2	1
8	19ME2022	Computer Aided Modelling and Assembling Laboratory	0	0	2	1
9	19ME2023	Mechatronics and Additive Manufacturing Laboratory	0	0	2	1
10	19ME2024	Metallurgy and Metrology Laboratory	0	0	2	1
11	19ME2025	Thermodynamics	3	0	0	3
12	19ME2026	Applied Thermodynamics	3	0	0	3
13	19ME3001	Additive Manufacturing and Applications	3	0	0	3
14	19ME3002	Robotics and Automation in Manufacturing	3	0	0	3
15	19ME3003	3D Printing Technology	3	0	0	3
16	19ME3004	Smart Materials and Shape Memory Alloys	3	0	0	3
17	20ME1001	Materials Engineering Laboratory	0	0	2	1
18	20ME1002	Computer Aided Drafting Laboratory	0	0	4	2
19	20ME1003	Soft skills	1	0	0	1
20	20ME1004	Additive Manufacturing Laboratory	0	0	2	1
21	20ME1005	Fluid Power Control and Mechatronics Laboratory	0	0	2	1
22	20ME1006	Professional Ethics	2	0	0	2
23	20ME1007	3D Printing Technology	3	0	0	3
24	20ME1008	Dynamics and Vibration Laboratory	0	0	2	1
25	20ME1009	Engineering Drawing and Graphics	0	0	4	2
26	20ME3001	Additive Manufacturing Technologies	3	0	0	3
27	20ME3002	Intelligent Robotics Systems in Manufacturing	3	0	0	3
28	20ME3003	Internet of Things in Manufacturing	3	0	0	3
29	20ME3004	3D Printing Laboratory	0	0	4	2
30	20ME3005	Advanced Product Life Cycle Management and Automation	3	0	0	3
31	20ME3006	Computer Integrated Manufacturing and FMS	3	0	0	3
32	20ME3007	Automated Inspection Systems	3	0	0	3

19ME1003	**ENGINEERING MECHANICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. To impart knowledge in statics with an emphasis on force equilibrium and free body diagrams.
2. To explore the significance of centroid, centre of gravity and moment of inertia.
3. To teach the principles of the motion of a body and concept of relative velocity and acceleration.

Course Outcome:

Students will be able to

1. Determine the resultant force and moment for a given system of forces.
2. Understand basics of equilibrium of rigid bodies
3. Determine the centroid and second moment of area of simple solids.
4. Apply fundamental concepts of kinematics and kinetics to the analysis of simple / practical problems.

5. Understand basic kinematics concepts – displacement, velocity and acceleration.
6. Determine friction and its effects as per the laws of friction.

Module 1 – Statics of Particle (8 hrs)
Introduction – Units and Dimensions - Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Resolution and components of forces – Resultant of concurrent forces, Equilibrium of a two force and three force body – Forces in space – Equilibrium of a particle in space.

Module 2 – Equilibrium of Rigid Bodies (7 hrs)
Equilibrium of rigid bodies: Free body diagram. Support Reactions – Beams – Types of loads, Moment of a force about a point – Varignon's theorem – Moment of a couple – Resolution of a given force in to force and couple system.

Module 3 – Statics of Rigid Bodies (8 hrs)
Centre of gravity and Centroid of composite plane figure – Moment of inertia – Parallel axis and Perpendicular axis theorem – Moment of inertia of composite planes – Mass moment of inertia of simple solid and composite bodies.

Module 4 – Kinematics of Particles (7 hrs)
Rectilinear motion – Displacements, Velocity and acceleration, their relationship – Relative motion, Curvilinear motion – Tangential and Normal components, velocity and acceleration of a particle – Projectile of body. Newton's second law of motion – D-Alembert's principle – Motion of a lift – Motion on an inclined surface – Motion on connected bodies.

Module 5 – Kinetics of Particles (7 hrs)
Work Energy method – Applications of principle of work and energy – Impulse and momentum method - Motion of connected bodies. Impact of elastic bodies.

Module 6 – Friction (8 hrs)
Frictional force – Laws of sliding friction - Limiting friction – Coefficient of friction and angle of friction – Impending friction – Basic concepts – Problems on body on a rough inclined plane, Ladder friction.

Text Books:
1. N.H Dubey, "Engineering Mechanics – Statics and Dynamics", McGraw-Hill Education (India) Private Limited, 2016.
2. Rajasekaran S, Sankarasubramanian G., "Fundamentals of Engineering Mechanics 3rd Edition", Vikas Publishing House Pvt. Ltd., 2017.

Reference Books:
1. Ferdinand P. Beer and E. Russell Johnston Jr. "Vectors Mechanics of Engineers: Statics and Dynamics", McGraw-Hill International Edition, 2014.
2. Palanichamy M.S., Nagan S., "Engineering Mechanics – Statics and Dynamics 3rd Edition", Tata McGraw-Hill, 2004.
3. Hibbeler R.C., "Engineering Mechanics", Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., 2014.
4. Irving H. Shames, "Engineering Mechanics – Statics and Dynamics 4th Edition", Pearson Education Asia Pvt. Ltd., 2005.
5. N. Kottiswaran, "Engineering Mechanics", Sri Balaji Publications Edition – 2010.

19ME1004	MANUFACTURING PRACTICES LABORATORY	L T P C 0 0 2 1

Course Objective:
1. To impart knowledge in various welding joints.
2. To teach step, tapper and thread cutting operations on engineering lathe.
3. To have working skills on knurling, drilling and reaming operations on turret lathe.

Course Outcome:
Students will be able to
1. Design different welding joints.
2. Cast stepped cone pulley.
3. Perform step and tapper turning operations using lathe.
4. Perform external thread cutting operations using lathe.
5. Make knurling and chamfering turning operations using lathe.

6. Perform drilling and reaming operations using Turret lathe.

List of Experiments:

1. Lap, Butt and T joint using welding process.
2. Casting of stepped cone pulley.
3. Step and tapper turning.
4. External thread cutting.
5. Knurling and chamfering.
6. Drilling and reaming

Reference Books: Lab manual

19ME1005	COMPUTER AIDED DRAFTING	L T P C 0 0 6 3

Course Objectives:

1. To impart knowledge in engineering design and its place in society
2. To teach the visual aspects of engineering design and graphics standards
3. To emphasize the graphics standards to create working drawings and communicate across industries.

Course Outcome:

Students will be able to

1. Understand the engineering design and solid modelling.
2. Visualize the engineering components.
3. Design a system, component, or process to meet desired needs within realistic constraints and sustainability.
4. Communicate effectively with various stake holders of engineering design industry
5. Apply techniques, skills, and modern engineering tools necessary for engineering practice
6. Visualize assembly of system with fewer parts.

Module 1 – User Interface Customization and Drawing Aids (7 hrs)

Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command window, The Status Bar, Different methods of zoom as used in CAD, Select and erase objects. Setting up of units, drawing limits, drawing paper size, scale settings and use of drawing template. Printing and saving PDF files. Drawing aids. Status bar icons and its display; Snap, Grid, Object snap, Ortho settings etc. Object properties (color, line weight etc.) control.

Module 2 – Drawing and Modifying (10 hrs)

Adding and altering objects, moving and duplicating objects, modifying (erase, copy, mirror, offset, trim, extend, rotate and scaling objects, fillet, chamfer, explode etc.) and maneuvering, hatching and sketching. Drawings using lines by various coordinate input entry methods. Applying various command options of drawing circles. Drawing arcs, polylines, ellipses, polygons and use of spline curves. Apply polar and rectangular arrays . Application of arcs to draw simple parts like fan blade, pawl, calipers, gears, spanner etc. Use of text fonts, formatting text and setting title block for drawing template.

Module 3 – Dimensioning Annotations, Layering & Other Functions (10 hrs)

ISO and ANSI standards for coordinate dimensioning and tolerance including GD&T practices; Applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths and line weight through modifying existing lines (extend / lengthen). Working with Blocks; create blocks and insert blocks.

Module 4 – Isometric Drawing and Working in Three Dimension (15 hrs)

Understand isometric planes and axes and their settings. Isometric Drawing of simple solids, Dimensioning in isometric drawing, Apply orthographic to isometric drawing to miscellaneous problems. Create a basic 3D model, apply several 3D viewing options, view and control a model interactively in 3D space. Learn to use the Steering Wheel and View Cube.

Module 5 – Surface and Solid Modeling (10 hrs)
Define surface modeling, create planar surfaces, and create procedural surfaces and NURBS surfaces. Solid Primitives, Boolean Operations, Basic Modeling (apply revolve, extrude, sweep and loft commands), Determine mass properties of sections and solids. Modifying solid models; slicing and shelling. Documenting solid models; creating 2D representation, drawing automatically, indicate sectional views. Visualization and Navigation.

Module 6 – Assembly of 3D Parts in Simple Projects and Create STL File (15 hrs)
Apply 3D modeling to produce simple, medium and complicated parts. Assign simple projects to students group to model and assemble parts of an assembly of five - fifteen parts and document the parts drawing and assembly drawing with sectional views. Create an STL file of a solid model for prototype fabrication. Apply 3D printing of the parts modeled and produce assembly of the parts.

Text Book:

1. Terry T. Wohlers, "Applying AutoCAD 2013", Mc Hraw Hill, 2013.
2. G.Ganesan, "Basic Computer Aided Design and Drafting using AutoCAD 2015", McGraw Hill, 2018.

Reference Book:

1. Sham Tickoo, "AutoCAD 2015 for Engineers and Designers", Dream Tech Press, 2014.

19ME2018	ROBOTICS AND AUTOMATION	L T P C 3 0 0 3

Course Objectives:

1. To impart knowledge in the functional elements of Robotics
2. To explore the dynamics and control of manipulators for different robots.
3. To understand the theory and practices in the field and service of robotics engineering and allied areas using recent technologies.

Course Outcome:
Students will be able to

1. Understand the basic concept of robotics.
2. Know various path planning techniques.
3. Understand the dynamics and control in robotic industries.
4. Use Robots in different applications
5. Apply their knowledge in handling the materials.
6. Identify appropriate AI methods to solve a given problem.

Module 1 – Introduction (8 hrs)
Brief history-Types of Robot–Technology-Robot classifications and specifications- Degrees of freedom-Direct kinematics-Inverse kinematics- SCARA robots- Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance.

Module 2 – Path Planning and Dynamics Control (8 hrs)
Definition-Joint space technique- Parametric descriptions - Straight line and circular paths - Position and orientation planning. Lagrangian mechanics-2DOF Manipulator-Lagrange Euler formulation-Dynamic model – Manipulator control problem-Force control of robotic manipulator.

Module 3 – Field Robots and Humanoids (8 hrs)
Ariel robots- Collision avoidance-Robots for agriculture, mining, exploration, underwater, civilian and military applications, nuclear applications, Space applications. Human activity recognition using vision, touch, sound, Vision, Tactile Sensing, Models of emotion and motivation. Performance, Interaction, Safety and robustness, Applications, Case studies.

Module 4 – Robots for Inspection and Other Applications (7 hrs)
Robotic vision systems, image representation, object recognition and categorization, depth measurement, image data compression, visual inspection, software considerations. Application of Robots in continuous arc welding, Spot welding, underwater and applications.

Module 5 – Material Handling (7 hrs)
Concepts of material handling, principles and considerations in material handling systems design, conventional material handling systems - advanced material handling systems, automated guided vehicle systems, automated storage and retrieval systems(ASRS).
Module 6 – Artificial Intelligence for Robotics (7 hrs)
History, state of the art, Need for AI in Robotics. Thinking and acting humanly, intelligent agents, structure of agents- Problem solving-knowledge and reasoning–knowledge representation – first order logic- Planning-Reasoning-Learning-AI in Robotics.
Text Books:

1. M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej "Industrial Robotics", McGraw-Hill Singapore, 2013.
2. JohnJ.Craig, "Introduction to Robotics Mechanics and Control", 3rd edition, Pearson Education,2009.

Reference Books:

1. Negnevitsky, M, "Artificial Intelligence: A guide to Intelligent Systems", Harlow:Addison-Wesley, 2002.
2. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
3. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, „Introduction to Autonomous Mobile Robots", Bradford Company Scituate, USA, 2004.
4. Richaerd D Klafter, Thomas Achmielewski and Mickael Negin, "Robotic Engineering– An integrated Approach" Prentice HallIndia, New Delhi, 2001.

19ME2019	ACTUATORS FOR AUTOMATION	L	T	P	C
		3	0	0	3

Course Objectives:
1. To impart the knowledge on the various actuators, sensors used in automation.
2. To instruct the concepts of PLC and its significant applications in the industry.
3. To teach the fundamental principles of modular automation and plant economy.

Course Outcome:
Students will be able to
1. Identify and Select suitable automation sensors and actuators for an industrial application.
2. Choose and apply appropriate Pneumatic actuator systems for a specific industrial process.
3. Select and apply appropriate Hydraulic actuator systems for a specific industrial process.
4. Use various PLC functions and develop small PLC programs
5. Classify and select appropriate automated storage and retrieval systems.
6. Apply appropriate modular automation and plant economy techniques.

Module 1 – Introduction (8 hrs)
Automated Manufacturing System, Reasons for Automating, Strategies for automation and process improvement, automation migration strategies, levels of automations, Types of Automations-Pneumatic, Hydraulic, PLC, Piezoelectric Actuators and Sensors.
Module 2 – Pneumatic System Design (7 hrs)
Introduction, pneumatics system components, pneumatics actuators, application of pneumatics system in automation, pneumatics circuit design for automation, limitations of pneumatics system.
Module 3 – Hydraulics System Design (7 hrs)
Introduction, Hydraulic system components, hydraulic actuators, application of hydraulic system in automation, hydraulic circuit design for automation, limitations of hydraulic system.
Module 4 – Programmable Logic Controller and Micro Controller (8 hrs)
Introduction to Programmable logical controller, PLC basics, Basic ladder logic programming, PLC timer function, PLC counter functions. Basics of microcontrollers, Basic components of Microcontrollers, Application of microcontrollers for automations.

Module 5 – Automated Machinery (7 hrs)
Introductions, Automated transfer machine, automated transfer line, auto-storage and retrieval system, automated guided vehicles, automated material handling system, automated inspection system and CMM.
Module 6 – Modular Automation Design and Plant Economy (8 hrs)
Introduction to modular design, modular automations, Case study for modular design: 1. Casting shop design, 2. Press working shop design, 3. Machine shop design. Automation Economy: Plant Economy, Effect of automation on economy, Feasibility and Scope of automation in Indian industries, Break Even point analysis for automation.

Text Books:

1. Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing" Pearson India Education Services Pvt. Ltd., Fourth Edition, 2016.
2. Andrew Parr, "Hydraulics and Pneumatics", Butterworth-Heinemann; 3rd Edition, 2011.

Reference Books:

1. Er. A. K. Gupta and S. K. Arora, Industrial Automation and Robotics, University Science Press Laxmi Publishing Pvt. Ltd 3rd Edition, 2013.
2. Frank Lamb, "Hands on Industrial Automation", McGraw-Hill Profession, 2013.
3. Ilango Sivaraman, Introduction to Hydraulics and Pneumatics, PHI Learning Pvt. Ltd.; 3rd revised edition, 2017.

19ME2020	DRONE TECHNOLOGY	L T P C 3 0 0 3

Course Objectives:
1. To teach an awareness about the basic terminologies models and roles of UAS
2. To impart knowledge on design considerations of UAV systems
3. To instruct aerodynamics, stealth, payload types, communications, control stations, launch and recovery of UAS

Course Outcome:
Students will be able to
1. Understand the design parameters of UAV systems
2. Understand the aerodynamics and selection of power plants of UAV systems
3. Identify stealth and payload types of UAV systems
4. Analyze the principles of communication and control station systems used in UAV's
5. Design launch and recovery systems of UAV's
6. Apply the application of UAS for various applications

Module 1– Introduction to Unmanned Aircraft Systems (8 hrs)
Introduction – history – definitions and terminologies – different types of UAS - different roles performed by unmanned aircrafts – dull roles – dirty roles – dangerous roles – covert roles – research roles – environmentally critical roles – economic reasons.
Module 2 – Design of Unmanned Aircraft Systems (7 hrs)
Conceptual phase – preliminary design – detail design – selection of the system – characteristics of aircrafts types - Equilibrium of rigid bodies: Free body diagram. Support Reactions – Beams – Types of loads, Moment of a force about a point – Varignon's theorem – Moment of a couple – Resolution of a given force in to force and couple system.
Module 3 – Aerodynamics, Airframe Design and Configurations (8 hrs)
Lift induced drag – parasitic drag – rotary wing aerodynamics – scale effects – packaging density – structure and mechanics - airframe configurations – selection of power plants.
Module 4 – Design for Stealth and Payload Types (8 hrs)
Acoustic signature – visual signature – thermal signature – radio/radar signature – non dispensable payloads – dispensable payloads.
Module 5 – Communications, Control Stations, Launch and Recovery Systems (7 hrs)
Communication media – radio communication – midair collision avoidance system – antenna types – control station composition – open system architecture – mini UAV laptop ground control station –

close, medium and long range UAV systems – sea control stations – air control stations – launch and recovery.

Module 6 – Deployment of Unmanned Aircraft Systems (7 hrs)

Naval roles – Army roles – Air Force roles – Civilian roles – Paramilitary roles – Commercial roles – unmanned aircraft systems future.

Text Books:

1. Reg Austin, "Unmanned Aircraft Systems: UAVS Design Development and Deployment", First edition, John Wiley and Sons, 2010.
2. Richard K. Barnhart, Stephen B. Hottman, Dougla M. Marshall, Eric Shappee, "Introduction to Unmanned Aircraft Systems", CRC press, Taylor and Francis, New York, 2012.

Reference Books:

1. Paul. G. Fahlstrom, Thomas. J. Gleason, " Introduction to UAV Systems", UAV Systems, Ins. 2013.
2. Armand. J. Chaput, "Design of UAV Systems", Lockheed Martin Aeronautics company, 2001.

19ME2021	MANUFACTURING TECHNOLOGY LABORATORY	L T P C 0 0 2 1

Course Objective:

1. To explore various special machines.
2. To provide hands on experience on key slotting and gear cutting operations.
3. To instruct the machining operations like surface grinding, tapping and wire-cut EDM.

Course Outcome:

Students will be able to

1. Perform V-block by using Shaping machine.
2. Operate Milling machines for cutting various shapes.
3. Generate a keyway with Slotting Machine.
4. Design spur gear cutting operation using Gear hobbing machine.
5. Perform surface grinding operations.
6. Apply wire-cut EDM for generating profile.

List of Experiments:

1. Machining V- block using shaper
2. Machining rectangular block and letter cutting using milling machine
3. Key way cutting using slotting machine
4. Spur gear cutting using gear hobbing machine
5. Surface grinding and tapping
6. Profile cutting using wire-cut Electric discharge machine

Reference Books: Lab manual

19ME2022	COMPUTER AIDIED MODELLING AND ASSEMBLY LABORATORY	L T P C 0 0 2 1

Course Objective:

1. To impart knowledge on modelling of knuckle, universal joints and couplings.
2. To teach the modelling of screw jack etc.
3. To explore the assembling of knuckle joint, plumber blocks etc.

Course Outcome:

Students will be able to

1. Design the various parts of knuckle or universal joints.
2. Design the various parts of Plumber block or flange coupling.
3. Design the various parts of Screw Jack or Machine Vice.
4. Make assemble various parts of knuckle or universal joints.
5. Perform assembly modelling of Plumber block or flange coupling.
6. Animate the Screw Jack or Machine Vice.

List of Experiments:

1. 3D modeling of parts of Knuckle Joint or Universal Joint
2. 3D modeling of parts of Plumber block or flange coupling
3. 3D modeling of parts of Screw Jack or Machine Vice
4. Assembly of Knuckle Joint or Universal Joint
5. Assembly of Plumber block or flange coupling
6. Assembly of parts and animation of Screw Jack or machine Vice
7. Detailing of any one above assembly with sectional views

Reference Books: Lab manual

19ME2023	MECHATRONICS AND ADDITIVE MANUFACTURING LABORATORY	L	T	P	C
		0	0	2	1

Course Objective:

1. To impart knowledge pneumatic circuit design.
2. To teach the concepts of PLC.
3. To have hands on practice on 3D printing machine

Course Outcome:

Students will be able to

1. Design a pneumatic circuit for material handling.
2. Design a electro-pneumatic circuit for an application.
3. Design a electro-pneumatic circuit for three cylinder sequencing operation.
4. Design a PLC based pneumatic circuit for basic logics.
5. Design a PLC based pneumatic circuit for material handling unit.
6. Design and print the machine component.

List of Experiments:

1. Design of pneumatic circuit for material handling system
2. Design of electro–pneumatic circuit by using relay, limit switch and solenoids.
3. Design of Electro–pneumatic circuit for cascade system of sequence A+B+C+A–B–C–.
4. Design and development of PLC controlled pneumatic logic circuits
5. Simulation of PLC controlled pneumatic circuit for material handling unit
6. Designing and printing of a machine component
7. Designing and printing of a hexagonal nut

Reference Books: Lab manual

19ME2024	METALLURGY AND METROLOGY LABORATORY	L	T	P	C
		0	0	2	1

Course Objective:

1. To teach how to use microscope and profile projector.
2. To impart knowledge on the surface texture.
3. To explore the micro structure of the various materials and composites.

Course Outcome:

Students will be able to

1. Know the use of Tool maker microscope and profile projector.
2. Measure the flatness and angles using Autocollimator.
3. Measure the tapper angle with sine bar and sine center.
4. Identify the type and microstructure of the specimen given.
5. Identify the microstructure of the steel specimen given.
6. Fabricate the metal matrix composites.

List of Experiments:

1. Measurement of thread and gear elements using Tool Maker's Microscope and profile projector
2. Flatness testing and angular measurement using Autocollimator
3. Measurement of tapper angle using sine bar and sine center

4. Identification of Cast Iron specimen (a) Grey Cast Iron(b) Spheroidal Graphite Iron (c) Malleable Cast Iron
5. Identification of Heat Treated steels: (a) Annealed (b) Normalized (c) Hardened (d) Tempered steels and Case Hardened Steel.
6. Fabrication of metal matrix composite materials

Reference Books: Lab manual

19ME2025	THERMODYNAMICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To knowledge on work and heat interactions, and balance of energy between system and its surroundings.
2. To explore various applications of I law and II law to various energy conversion devices.
3. To evaluate the changes in properties of substances in various processes.

Course Outcome:

Students will be able to

1. Understand the basic concepts in thermodynamics and energy balance to systems and control volumes, in situations involving heat and work interactions.
2. Differentiate between high grade and low grade energies.
3. Evaluate changes in thermodynamic properties of pure substances.
4. Apply gas laws to solve problems related to gas mixtures.
5. Create psychrometric chart to perform moist air process calculations
6. Recognize the significance of I law for reacting systems and heating value of fuels.

Module 1 – Basic Concepts in Thermodynamics (5 hrs)

Basic concepts of Thermodynamics - Thermodynamics and Energy - Closed and open systems - Properties of a system - State and equilibrium - Processes and cycles - Forms of energy - Work and heat transfer - Temperature and Zeroth law of thermodynamics.

Module 2 - First Law and Second Law of Thermodynamics (12 hrs)

First Law for Cyclic & Non-cyclic processes; various modes of energy, Internal energy and Enthalpy. Specific heat and constant pressure and volume. First Law for Flow Processes – Steady flow energy equation; Applications of steady flow energy equation to Air compressor, Turbine, Nozzle, Pump and Heat exchangers. **Second law of thermodynamics** - Kelvin-Planck and Clausius statements and its equivalence - Heat engine, heat pump and refrigerator - Thermal efficiency and COP. Reversible process - Carnot cycle; Carnot's Theorem – Entropy - Clausius inequality –Principle of increase of entropy. Availability and irreversibility - Second law efficiency-Quality of Energy

Module 3 – Properties of Pure Substance (8 hrs)

Definition of Pure substance, Thermodynamic properties of pure substances in solid liquid and vapour phases, phase rule P-V, P-T, T-V, T-S, H-S diagrams, P-V-T surfaces, thermodynamic properties of steam. Calculations of work done and heat transfer. Use of steam tables; Saturation tables; superheated tables; Identification of states and determination of properties, Mollier's chart.

Module 4 – Properties of Gas Mixtures (5 hrs)

Ideal Gases and ideal gas mixtures, Properties of ideal and real gases, equation of state, Avagadro's law, Dalton's law of partial pressure, compressibility, and compressibility chart.

Module 5 – Psychrometry (7 hrs)

Properties of dry and wet air, use of psychrometric chart, processes involving heating/cooling and humidification/dehumidification, dew point. Adiabatic mixing, evaporative cooling, problems.

Module 6 – Gas Power Cycles (5 hrs)

Air standard cycles - Otto cycle - Diesel and Dual cycles - Brayton cycle – Thermal Efficiency and mean effective pressure.

Text Books:

1. P.K. Nag, "Engineering Thermodynamics", Tata McGraw-Hill, 2013.
2. Yunus Cengel, "Thermodynamics", Tata McGraw-Hill, 2014.

Reference Books:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen G. J."Fundamentals of Thermodynamics 7th Edition", John Wiley and Sons, 2008.
2. Jones, J. B. and Duggan, R. E., Engineering Thermodynamics, Prentice-Hall of India, 2010.
3. Moran, M. J. and Shapiro, H. N., "Fundamentals of Engineering Thermodynamics, 8th Edition" ,John Wiley and Sons, 2014.
4. J.P. Holman, "Thermodynamics", 4thEdition, McGraw Hill, 2002.
5. T. Roy Choudhury, "Basic Engineering Thermodynamics", Tata McGraw-Hill, 2000.

19ME2026	APPLIED THERMODYNAMICS	L	T	P	C
		3	0	0	3

Prerequisite: Thermodynamics

Course Objectives:

1. To impart knowledge on various practical power cycles and heat pump cycles.
2. To teach the analysis of energy conversion in various thermal devices such as combustors, air coolers, nozzles, diffusers, steam turbines and reciprocating compressors
3. To explore the high speed compressible flow phenomena and refrigeration and air conditioning

Course Outcome:

Students will be able to

1. Estimate the performance of a steam generator.
2. Carry out analysis of vapour power cycles.
3. Conduct analysis of steam nozzles and turbines.
4. Evaluate performance of reciprocating compressors.
5. Apply principles of refrigeration and air conditioning for analysis and performance evaluation.
6. Design turbine and nozzles and compressors.

Module 1 – Steam Generators (8 hrs)

Classification of boilers, boiler terms. Performance of steam generator - evaporative capacity, equivalent evaporation, factor of evaporation, boiler efficiency, heat losses in a boiler plant and heat balance calculations.

Module 2 - Vapour Power Cycles (7 hrs)

Vapor power cycles – Simple Rankine cycle with superheat. Reheat Rankine cycle and Regenerative Rankine cycle – Performance and efficiency calculations.

Module 3 - Steam Nozzles (7 hrs)

Flow of steam through nozzles, general relation for adiabatic flow, effect of friction, critical pressure ratio, supersaturated flow.

Module 4 - Steam Turbines (7 hrs)

Impulse and Reaction principles, compounding, Determination of work done and efficiency using velocity diagrams. Pressure compounding and velocity compounding.

Module 5 - Air Compressors (8 hrs)

Reciprocating compressors, Work input representation on p-v diagram, Effect of clearance and volumetric efficiency. Adiabatic, isothermal and mechanical efficiencies. Staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors.

Module 6 - Refrigeration Cycles (8 hrs)

Vapor compression refrigeration cycle, super heat, sub cooling – Performance calculations - refrigerants and their properties, Working principle and description of vapour absorption systems- Ammonia – Water, Lithium bromide – water systems.

Text Books:

1. P.K. Nag, "Engineering Thermodynamics", Tata McGraw-Hill, 2013.
2. Yunus Cengel, "Thermodynamics", Tata McGraw-Hill, 2014.

Reference Books:

1. J.P. Holman, "Thermodynamics", 4th Edition, McGraw Hill, 2002.
2. T.Roy Choudhury, "Basic Engineering Thermodynamics", Tata McGraw-Hill, 2000.
3. Vanwylen and Sontag, "Classical Thermodynamics", Wiley Eastern, 1999.

4. R.K. Rajput, "A Textbook of Engineering Thermodynamics", Laxmi Publications, 2016.
5. J.P.O Connell and J. M. Haile, "Thermodynamics: Fundamentals for Applications," Cambridge university press, 2005.

19ME3001	ADDITIVE MANUFACTURING AND APPLICATIONS	L T P C 3 0 0 3

Course Objectives:

1. To impart knowledge on the basic concepts and methodologies of various additive manufacturing systems
2. To explore the products using additive manufacturing processes in various sectors of engineering and technology
3. To discover the applications such as rapid tooling, rapid manufacturing and reverse engineering

Course Outcome:

Students will be able to

1. Recognize the need for additive manufacturing in the modern industry
2. Illustrate techniques for processing of CAD models for additive manufacturing
3. Summarize the importance of additive manufacturing in product development cycle
4. Articulate the construction, working principles and process variables of various additive manufacturing technologies
5. Correlate the selection of appropriate additive manufacturing techniques and product development
6. Design additive manufacturing process to solve real time industrial problems

Module 1 – Introduction (8 hrs)

Need - Development of additive manufacturing (AM) systems – AM process chain – Impact of AM on Product Development –Digital prototyping - Virtual prototyping- Rapid Tooling - Benefits-Applications.

Module 2 – Reverse Engineering and CAD Modeling (8 hrs)

Basic concept- Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements – geometric modeling techniques: Wire frame, surface and solid modeling – data formats – Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation.

Module 3 – Liquid Based and Solid Based AM Systems (8 hrs)

Stereo Lithography Apparatus (SLA): Principle, per-build process, part-building, post-build processes, photo polymerization of SLA resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused Deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

Module 4 – Powder Based AM Systems (7 hrs)

Selective Laser Sintering(SLS): Principle, process, Indirect and direct SLS- powder structures, modeling of SLS, materials, post processing, post curing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

Module 5 – Other AM Technologies (7 hrs)

3D Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM): Introduction, basic process, shape decomposition, mold SDM and applications. Selective Laser Melting, Electron Beam melting – Rapid manufacturing.

Module 6 – AM Applications (7 hrs)

Application in Design; Application in Engineering; Application in Analysis and Planning; Application in Manufacturing and Tooling; Aerospace Industry; Automotive Industry; Jewelry Industry; Coin

Industry; Geometric Information Systems application; Arts and Architecture; Medical and Bioengineering Applications.

Text Books:

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", 2nd edition, , World Scientific Publishers, 2003.
2. Andreas Gephardt "Rapid prototyping", Hanser Gardener Publications, 2003.

References Books:

1. Liou W.Liou, Frank W.Liou, "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
2. Ali K. Kamrani, Emad Abouel Nasr, "Rapid Prototyping: Theory and practice", Springer, 2006.
3. Peter D.Hilton, Hilton/Jacobs, Paul F.Jacobs, "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000.

19ME3002	ROBOTICS AND AUTOMATION IN MANUFACTURING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart knowledge on the fundamentals in basic sciences, mathematics and computational platforms for the field robotics and automation applications.
2. To understand mechanism of robotic control and its motion mechanisms
3. To explore the Artificial Intelligence and Allied techniques for Robotic applications.

Course Outcome:

Students will be able to

1. Understand the Motion Control Robot
2. Apply the robot kinematics and inversion Mechanism
3. Analyze path movements of various robots for the variety of applications
4. Diagnose the movement of humanoid robots
5. Solve the risk in artificial intelligence for robotic applications
6. Impart knowledge in networking using sensors for robotic applications

Module 1 – Introduction to Robotic System (8 hrs)

Introduction. Construction of manipulators, advantages and disadvantages of various kinematic structures. Applications, Non servo robots, motion planning. Feedback systems, encoders Kinematics, homogeneous coordinates solution of the inverse kinematic problem, multiple solutions, Jacobian, work envelopes. Trajectory planning. Joint Interpolated Trajectory, Link joints and their Manipulator dynamics and force control.

Module 2 – Sensors for Robotic and Automation Application (8 hrs)

Sensors: Vision, ranging, laser, acoustic, tactile. Developments in sensor technology, sensory control. Programming Language: VAL, RAIL, AML. Mobile robots, walking devices. Robot reasoning.

Module 3 – Robot Programming (8 hrs)

Level of robot programming, Language based programming, task level programming, Robot programming synthesis, robot programming for foundry, press work and heat treatment, welding, machine tools, material handling, warehousing assembly, etc., automatic storage and retrieval system, Robot economics and safety, Robot integration with CAD/CAM/CIM, Collision free motion planning

Module 4 – Industrial Robotics and Material Handling Systems (7 hrs)

Robotic vision systems, image representation, object recognition and categorization, depth measurement, image data compression, visual inspection, software considerations. advanced material handling systems, automated guided vehicle systems, automated storage and retrieval systems(ASRS), bar code technology, radio frequency identification technology.

Module 5 – Wireless Networks for Robotics (7 hrs)

Challenges for Wireless Sensor Networks, Enabling Technologies For Wireless Sensor Networks. Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing. Topology Control, Clustering, Sensor Node Hardware – Berkeley Motes, State-centric programming.

Module 6 – Artificial Intelligence and Expert Systems (7 hrs)
Robotic perception, localization, mapping Ethics and risks of artificial intelligence in robotics. Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.

Text Books:

1. John J Craig: Introduction to Robotics, Mechanics and control, second Edition Addison – Wesley,2012.
2. K.S.Fu, R.C. Gonzalez and C.S.G. Lee, "Robotics Control, Sensing, Vision and Intelligence", Mc Graw Hill, 2010.
3. M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill Singapore, 2013.

Reference Books:

1. Yoram Koren," Robotics for Engineers' Mc Graw-Hill, 2010.
2. Deb, S.R." Robotics Technology and Flexible Automation", Tata Mc Graw-Hill, 2010.
3. Klafter. R.D, Chmielewski.T.A. and Noggin's., "Robot Engineering : An Integrated Approach", Prentice Hall of India Pvt. Ltd.,2010.
4. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 2002.
5. Feng Zhao & Leonidas J. Guibas, "Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.
6. Negnevitsky, M, "Artificial Intelligence: A guide to Intelligent Systems",. Harlow: Addison-Wesley, 2002.

		L	T	P	C
19ME3003	**3D PRINTING TECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objectives:

1. To impart knowledge on various additive manufacturing systems
2. To teach the selection of material for 3D printing
3. To explore various applications of 3D printing

Course Outcome:

Students will be able to

1. Differentiate between additive and conventional manufacturing methods.
2. Know various 3D printing materials.
3. Understand the Ink Jet technology used in the 3D printing.
4. Understand the laser technology used in the 3D printing
5. Correlate the selection of appropriate powder based techniques.
6. Recognize various 3D printing applications in the real time industrial problems

Module 1 – Introduction (8 hrs)
Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing Processes, Applications, Research achievements in printing deposition, Technical challenges in printing, Applications of Printing Processes.

Module 2 – 3D Printing Materials (8 hrs)
Polymers, Metals, Non-Metals, Ceramics; Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties; Support Materials.

Module 3 - Inkjet Technology (8 hrs)
Printer - Working Principle, Positioning System, Print head, Print bed, Frames, Motion control; Print head Considerations – Continuous Inkjet, Thermal Inkjet, Piezoelectric Drop-On-Demand; Material Formulation for

Module 4 - Laser Technology (7 hrs)
Light Sources – Types, Characteristics; Optics – Deflection, Modulation; Material feeding and flow – Liquid, powder; Printing machines – Types, Working Principle, Build Platform, Print bed Movement, Support structures;

Module 5 – Powder Based Systems (7 hrs)
Selective Laser Sintering(SLS): Principle, process, Indirect and direct SLS- powder structures, modeling of SLS, materials, post processing, post curing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

Module 6 – 3D Printing Applications (7 hrs)
Application in Design; Application in Engineering; Application in Analysis and Planning; Application in Manufacturing and Tooling; Aerospace Industry; Automotive Industry; Jewelry Industry; Coin Industry; Geometric Information Systems application; Arts and Architecture; Medical and Bioengineering Applications. Case studies.

Text Books:

1. Chua C.K., Leong K.F., and Lim C.S.,“Rapid prototyping: Principles and applications” , 2nd edition, World Scientific Publishers, 2003.
2. Ian M. Hutchings, Graham D. Martin, “Inkjet Technology for Digital Fabrication”, John Wiley & Sons, 2013.

References Books:

1. Liou W.Liou, Frank W.Liou, “Rapid Prototyping and Engineering applications: A tool box for prototype development” CRC Press, 2007.
2. Ali K. Kamrani, Emad Abouel Nasr, “Rapid Prototyping: Theory and practice”, Springer, 2006.
3. Peter D.Hilton, Hilton/Jacobs, Paul F.Jacobs “Rapid Tooling: Technologies and Industrial Applications”, CRC press, 2001.
4. Gibson D W Rosen, Brent Stucker., “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.
5. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing”, Hanser Publisher, 2011.
6. Khanna Editorial, “3D Printing and Design”, Khanna Publishing House, Delhi, 2010.

19ME3004	SMART MATERIALS AND SHAPE MEMORY ALLOYS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart fundamental knowledge on smart materials
2. To explore possible applications of Shape Memory materials
3. To teach fabrication and usage of smart polymers

Course Outcome:
Students will be able to

1. Understanding of the physical principles underlying the behaviour of smart materials.
2. The basic principles and mechanisms of the stimuli-response for the most important smart materials.
3. Propose improvement on the design, analysis and manufacturing of Smart materials.
4. Command on Shape memory materials fabrication and shape memory effects.
5. Smart polymers usage in space applications
6. Identifying the application issues involved in integrating smart materials to engineering smart structures and products.

Module 1 – Introduction to Smart Materials (8 hrs)
Overview of Smart Materials, Classification of Smart Materials, common smart materials and associated stimulus-response, Application areas of smart systems

Module 2 – Ferroelectric Materials (8 hrs)
Piezoelectric materials- piezoelectric effect, Direct and converse, parameter definitions, Piezoceramics, Piezopolymers, Piezoelectric materials as sensors, Actuators and bimorphs
Module 3 – Shape Memory Materials (8 hrs)
Shape memory alloys (SMAs), Shape memory effect (SME), Martensitic transformation, One way and two-way SME, training of SMAs, binary and ternary alloy systems, Functional properties of SMAs.
Module 4 – Chromogenic Materials (7 hrs)
Thermochromism, Photochromism, Electrochromism, Halochromism, Solvatochromism- principle and design strategies
Module 5 – Smart Polymers (7 hrs)
Thermally responsive polymers, Electro active polymers microgels, Synthesis, Properties and Applications, Protein-based smart polymers, pH-responsive and photo-responsive polymers, Self-assembly, Molecular imprinting using smart polymers, Approaches to molecular imprinting, Drug delivery using smart polymers.
Module 6 – Smart Systems for Space Applications (7 hrs)
Elastic memory composites, Smart corrosion protection coatings, Self-healing materials, Sensors, Actuators, Transducers, MEMS, Deployment devices, Molecular machines
Text Books:

1. Michelle Addington and Daniel L. Schodek, "Smart Materials and Technologies", Elsevier 2005.
2. K.Otsuka, C.M.Wayman(Eds.),"Shape Memory Materials", Cambridge University Press, 2010

Reference Books:

1. M. Schwartz, "New Materials, Processes, and Methods Technology", CRC Press, 2006.
2. P. Ball, "Made to Measure: Materials for the 21st Century", Princeton University Press,2001.
3. I. Galaev, B. Mattiasson (Eds.), "Smart Polymers: Applications in Biotechnology and Biomedicine", 2nd edition, CRC Press, 2008.
4. D.J. Leo, "Engineering Analysis of Smart Material Systems", Wiley 2007.
5. M.V. Gandhi, B. S. Thompson, "Smart Materials and Structures", Chapman & Hall, 2001.

Course code	MATERIALS ENGINEERING LABORATORY	L	T	P	C
20ME1001		0	0	2	1

Course Objective:

Impart knowledge on
1. The microstructural changes in different material.
2. The selection of material for different applications.
3. Determination of mechanical properties like hardness, tensile strength etc.

Course Outcome:

The student will be able to
1. Understand the standards of materials tastings for various applications.
2. Study the microstructure of material to determine the grain size.
3. Determine the density of material by Archimedes' Principle.
4. Measure the hardness and tensile behavior of the material.
5. Analyze the performance parameters for marine applications.
6. Find the tensile strength of material.

List of Experiments

1.	Learning materials testing standards.
2.	Metallographic grinding and polishing of metals/alloys.
3.	Study the microstructure of metals/alloys.
4.	Determination of Density of material.
5.	Testing of material hardness.
6.	Testing of tensile strength of materials.
7.	Determination of corrosion rate of engineering materials.

8.	Testing of impact strength of materials.		
		Total Lectures	**15 Hours**
Recommended by Board of Studies	5th September 2020		
Approved by Academic Council	12th September 2020		

Course code	**COMPUTER AIDED DRAFTING LABORATORY**	**L**	**T**	**P**	**C**
20ME1002		0	0	4	2

Course Objective:

Impart knowledge on

1. The usage of various types of line, arcs, and methods.
2. The application of the theory of projections.
3. The hatching methods, dimensioning, orthographic and isometric views.

Course Outcome:

The student will be able to

1. Draw and Modify lines and circles in CAD software.
2. Create Machine component drawings in CAD software.
3. Build 3D models and create orthographic views in CAD software.
4. Prepare projections and sections of solids.
5. Construct isometric projections of solids.
6. Develop the lateral surfaces of solids.

List of Experiments

1.	2D drawings using Utility, Draw, Modify and Dimensioning commands.		
2.	2D drawings using Coordinate system, Object Snap with Title block.		
3.	Drawing of 2D Nozzle, V-Block, Sprocket wheel using Line and Circle commands.		
4.	Drawing of Pawl, Inside Caliper and Fan Blade using Arc command.		
5.	Drawing of Spur Gear, Flange coupling and CPU cabinet using Polar and Rectangular arrays.		
6.	3D modeling of Hexagonal nut and bolt using Extrusion command.		
7.	Drawing of Projection of points and lines.		
8.	Drawing of Curves: Parabola, Spiral, Involutes.		
9.	Drawing of projections of solids: Prism, Pyramid, Cylinder and Cone.		
10.	Drawing Sectional Views: Prism, Pyramid, Cylinder and Cone.		
11.	Drawing of Isometric view: Prism, Pyramid, Cylinder and Cone.		
12.	Drawing of Development of surface.		
		Total Lectures	**30 Hours**
Recommended by Board of Studies	5th September 2020		
Approved by Academic Council	12th September 2020		

Course code	**SOFT SKILLS**	**L**	**T**	**P**	**C**
20ME1003		1	0	0	1

Course Objective:

To impart knowledge on

1. To help the students in building interpersonal skills.
2. To develop skill to communicate clearly.
3. To enhance team building and time management skills.

Course Outcomes:

The student will be able to

1. Understand the ethical framework in professional life.
2. Know the psychology and philosophy of ethics.
3. Recognize the ethics in scientific and engineering society.
4. Diagnose the code of ethics and ethical standards.
5. Understand the integrity in research.

6. Realize the Enforcement of Code of Ethics.		
Module: 1	**SELF-AWARENESS & SELF-DEVELOPMENT**	**4 Hours**
Self-Awareness: Self-Assessment, Self-Appraisal, SWOT, Goal setting: Personal & career: Self-Assessment, Self-Awareness, Perceptions and Attitudes, Positive Attitude, Values and Belief Systems, Self-Esteem, Self-Appraisal, Personal Goal setting. **Self-Development**: Career Planning, Personal success factors, Handling failure, Depression and Habit, relating SWOT analysis & goal setting, prioritization		
Module: 2	**COMMUNICATION SKILL**	**6 Hours**
Communication: Importance, types, barriers of communication, effective communication. **Speaking Skills**: Public Speaking, Presentation skills, Group discussion: Importance of speaking effectively, speech process, message, audience, speech style, feedback, conversation and oral skills, fluency and self-expression, body language phonetics and spoken English, speaking techniques, word stress, correct stress patterns, voice quality, correct tone, types of tones, positive image projection techniques. **Listening Skills**: Law of nature: you have 2 ears and 1 tongue so listen twice and speak once is the best policy, Empathic listening, and Avoid selective listening. **Group Discussion**: characteristics, Course Title knowledge, oral and leadership skills, team management, strategies and individual contribution and consistency. **Presentation skills**: planning, preparation, organization, delivery. **Written Skills**: Formal & Informal letter writing, Report writing, Resume writing: Sentence structure, sentence coherence, emphasis. Paragraph writing. Letter writing skills: form and structure, style and tone. Inquiry letters, Instruction letters, complaint letters, Routine business letters, Sales Letters etc.		
Module: 3	**CORPORATE / BUSINESS ETIQUETTES**	**2 Hours**
Corporate / Business Etiquettes: Corporate grooming & dressing, Email & telephone etiquettes, etiquettes in social & office setting: Understand the importance of professional behavior at the work place, Understand and Implement etiquettes in workplace, presenting oneself with finesse and making others comfortable in a business setting. Importance of first impression, Grooming, Wardrobe, Body language, Meeting etiquettes (targeted at young professionals who are just entering business environment), Introduction to Ethics in engineering and ethical reasoning, rights and responsibilities.		
Module: 4	**INTERPERSONAL RELATIONSHIP**	**4 Hours**
Team work: Team effectiveness, Group discussion, Decision making: Team Communication. Team, Conflict Resolution, Team Goal Setting, Team Motivation Understanding Team Development, Team Problem Solving, Building the team dynamics. Multicultural team activity. **Group Discussion (GD):** Preparation for a GD, Introduction and definitions of a GD, Purpose of a GD, Types of GD, Strategies in a GD, Conflict management, Do's and Don'ts in GD.		
Module: 5	**LEADERSHIP SKILLS**	**2 Hours**
Leadership: Leaders' role, responsibilities and skill required - Understanding good leadership behaviors, Learning the difference between Leadership and Management, Gaining insight into your Patterns, Beliefs and Rules. **Leadership Qualities**: Defining Qualities and Strengths of leadership, Determining how well you perceive what's going on around you, interpersonal Skills and Communication Skills, Learning about Commitment and How to Move Things Forward, Making Key Decisions, Handling Your and Other People's Stress, Empowering, Motivating and Inspiring Others, Leading by example, effective feedback.		
Module: 6	**OTHER SKILLS**	**2 Hours**
Time management: The Time management matrix, apply the Pareto Principle (80/20 Rule) to time management issues, to priorities using decision matrices, to beat the most common time wasters, how to plan ahead, how to handle interruptions , to maximize your personal effectiveness, how to say "no" to time wasters, develop your own individualized plan of action. **Stress management**: understanding		

the stress & its impact, techniques of handling stress. **Skills**: Problem solving skill, Confidence building Problem solving skill, Confidence building.	
Total Lectures	**15 Hours**

Text Books	
1.	Heckman, J.J. and Kautz, T., "Hard evidence on soft skills. Labour economics", 19(4), pp.451-464, 2012.
2.	Frederick H. Wentz, "Soft Skills Training: A Workbook to Develop Skills for Employment", Create Space Independent Publishing Platform, Large edition, 2012.
Reference Books	
1.	Barun K. Mitra, "Personality Development and Group Discussions", Oxford University Press, 2012.
2.	Priyadarshi Patnaik, "Group Discussions and Interview Skills", Foundation Books, Cambridge University Press, 2012.
3.	Wayne Dyer, "Change Your Thoughts: Change Your Life", Hay House India, 2010.
4.	E. H. McGrath, "Basic Managerial Skills", Eastern Economy Edition, Prentice hall India, 2010.
5.	Julie Morgenstern, "Time management from inside out", Owl Books (NY), 2010.

Recommended by Board of Studies	5th September 2020
Approved by Academic Council	12th September 2020

Course code	ADDITIVE MANUFACTURING LABORATORY	L	T	P	C
20ME1004		0	0	2	1

Course Objective:

Impart knowledge on:

1. The basics of additive manufacturing / rapid prototyping.
2. The generation and working with STL files.
3. Building complex geometries, printing and post-processing techniques.

Course Outcome:

The student will be able to:

1. Demonstrate the working principles of 3D Printing.
2. Design complex / creative models ready for 3D printing.
3. Develop STL file for CAD models with appropriate support structures and Orientation.
4. Build complex engineering assemblies in plastic material with minimum build-time.
5. Evaluate the process parameters of Additive Manufacturing machine to improve the quality of the parts Produced.
6. Model and print multi-component assemblies using Additive Manufacturing processes.

List of Experiments	
1.	Generating & Working on Standard Tessellation Language (STL) files from the CAD Models.
2.	3D Modeling and Printing of a Hexagonal bolt with screw threading.
3.	3D Modeling and Printing of a Helical / Spur Gear.
4.	3D Modeling and Printing of a Turbo Impeller.
5.	3D Modeling and Printing of a Sprockets.
6.	3D Modeling, Printing and Assembly of a knuckle joint.
Total Lectures	**15 Hours**

Recommended by Board of Studies	5th September 2020
Approved by Academic Council	12th September 2020

Course Code	FLUID POWER CONTROL AND MECHATRONICS LABORATORY	L	T	P	C
20ME1005		0	0	2	1

Course Objective:

To impart knowledge on

1. Application of fluid power symbols and Boolean algebra.
2. Designing a suitable pneumatic and electro-pneumatic circuits.
3. Automating a hydraulic circuit for an Industrial application.

Course Outcome:

The student will be able to

1. Recognize the standard symbols and build logical circuits.
2. Illustrate the use of special valves in industrial circuits.
3. Build cascade circuit for a particular application.
4. Build an electro- pneumatic circuit a real-life problem.
5. Construct the hydraulic circuits for an industrial application.
6. Design and develop a PLC controlled pneumatic circuit for industrial application.

List of Experiments

1.	Fluid Power Symbolic representation and basic Pneumatic Logic Circuit.
2.	Application of Special valves in Pneumatic Speed Control Circuits.
3.	Basic Cascade Pneumatic Circuit for Material Handling System.
4.	Electro-Pneumatic Circuit Using for continuous operation of two double acting cylinders in the sequence of $A^+B^+A^-B^-$.
5.	Electro-Hydraulic Circuit for Continuous operation of two double acting cylinders using contact type sensors.
6.	PLC Controlled Pneumatic Circuits.
7.	PLC Controlled Pneumatic Circuit for Material Handling System.

Total Lectures	**15 Hours**
Recommended by Board of Studies	5th September 2020
Approved by Academic Council	12th September 2020

Course Code	PROFESSIONAL ETHICS	L	T	P	C
20ME1006		2	0	0	2

Course Objective:

To impart knowledge on

1. The awareness of Engineering Ethics and Human Values.
2. Moral and Social Values and Loyalty.
3. The rights of others.

Course Outcomes:

The student will be able to

1. Understand the ethical framework in professional life.
2. Know the psychology and philosophy of ethics.
3. Recognize the ethics in scientific and engineering society.
4. Diagnose the code of ethics and ethical standards.
5. Understand the integrity in research.
6. Realize the Enforcement of Code of Ethics.

Module: 1	**ETHICS**	**5 Hours**

Explaining Ethics: Introduction - Morals, values and Ethics - Integrity - Work ethic - Respect for others - The impact of Science and Engineering - The framework of Ethics - Ethics in Professional life - Scientists and Engineers: Definitions - Scientific Disciplines - Engineering Disciplines - Expert Willingness - Professionalism.

Module: 2	PSYCHOLOGY AND PHILOSOPHY OF ETHICS	5 Hours
Ethical responsibilities in research - Ethics in Science and Engineering - A phenomenological theory of ethics - Conflicts of Interest - Education of Scientists and Engineers: The High School experience – The Baccalaureate experience – The Graduate degree experience – Postdoctoral experience – morals and values – Evaluating Scientists and Engineers – Intellectual Property.		
Module: 3	**ETHICS IN SCIENTIFIC AND ENGINEERING SOCIETIES**	**5 Hours**
Scientific societies – Engineering societies – Code of ethics and ethical standards – Promoting research integrity – The effectiveness of society activities – Academic freedom – Code of Ethics and Ethical Standards: Ethics – Code of Ethics – The premise behind code of ethics – Code of ethics and peer reviews.		
Module: 4	**INTEGRITY IN RESEARCH AND PUBLICATION**	**5 Hours**
The nature and conduct of research – Collecting research data – The Controls – Publication and Communication: The Scientific and Engineering literature – The Journals – Data Manipulation for publication – Detection Falsified Data – Peer reviews and their duties – Duties and responsibilities of a journal editor.		
Module: 5	**SAFETY, RESPONSIBILITIES AND RIGHTS**	**6 Hours**
Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination		
Module: 6	**ENFORCEMENT OF CODE OF ETHICS**	**4 Hours**
Following a code of ethics – Enforcing a code of ethics – Reporting misconduct – Examples of unethical behavior.		
	Total Lectures	**30 Hours**

Text Books	
1.	James G. Speight, Russell Foote, "Ethics in Science and Engineering", Wiley, 2011.
2.	Harris Jr, Charles E., Michael S. Pritchard, Michael J. Rabins, Ray James, and Elaine Englehardt, "Engineering ethics: Concepts and cases". Cengage Learning, 2013.
Reference Books	
1.	1. Mike Martin and Roland Schinzinger, "Introduction to Engineering Ethics", McGraw Hill, New York, 2010.
2.	Robert Elliott Allinson, "Saving Human Lives Lessons in Management Ethics", Springer, 2005.
3.	Charles D Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, 2010.
4.	Charles E Harris, Michael S Pritchard and Michael J Rabins, Engineering Ethics – Concepts and Cases, Thompson Learning, 2000.
5.	John R Boatright, Ethics and the Conduct of Business, Pearson Education, 2003.

Recommended by Board of Studies	5th September 2020
Approved by Academic Council	12th September 2020

Course code	3D PRINTING TECHNOLOGY	L	T	P	C
20ME1007		3	0	0	3
Course Objectives:					

Impart knowledge on

1. Understanding the basic concepts of 3D Printing Technology.
2. Exiting 3D Printing Technologies and its working principles.

3. Model a prototype and fabricate it using 3D Printing Techniques.		
Course Outcomes:		
The student will be able to 1. Conceptualize the product development cycle and identify the role of 3D Printing in industries. 2. Illustrate appropriate 3D Printing techniques for developing products. 3. Articulate the working principles of various 3D Printing Technologies. 4. Identify suitable applications for every classification of 3D Printing Technology. 5. Correlate the process variables with the quality of products built using 3D Printing Processes. 6. Design materials for 3D Printing Process to solve real time industrial problems.		
Module: 1	**INTRODUCTION**	**8 Hours**
Market trend, Concurrent engineering fundamentals, Identifying the need for new product development, History of 3D Printing (3D-P) Technology, 3D-P process chain, Impact of 3D-P on Product Development Cycle, Digital prototyping, Digital Manufacturing Vs Virtual prototyping, Rapid Tooling – Benefits and Applications.		
Module: 2	**3D-P FUNDAMENTAL AND CAD DATA PROCESSING**	**8 Hours**
Basic concept, Data Digitization techniques, Model Reconstruction, Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements, Geometric modeling techniques, Data formats, Data interfacing, Part orientation and support generation, Support structure design, CAD model slicing, Tool path generation.		
Module: 3	**LIQUID BASED 3D-P SYSTEMS**	**8 Hours**
Stereo Lithography Apparatus (SLA): Principle, per-build process, part-building, post-build processes, photo polymerization of SLA resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications.		
Module: 4	**SOLID BASED 3D-P SYSTEMS**	**7 Hours**
Fused Deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.		
Module: 5	**POWDER BASED 3D-P SYSTEMS OTHER AM TECHNOLOGIES**	**7 Hours**
Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, modeling of SLS, materials, post processing, post curing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.		
Module: 6	**MODERN 3D-P SYSTEMS AND APPLICATIONS**	**7 Hours**
Three-Dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM): Introduction, basic process, shape decomposition, mold SDM and applications. Selective Laser Melting, Electron Beam melting, Wire Arc Additive Manufacturing – Rapid manufacturing.3D-P Applications: Mechanical, Automobile, Aerospace, Medical, Recreational including toys and sports.		
	Total Lectures	**45 Hours**
Text Books		

1.	Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, 2nd edition, World Scientific Publishers, 2003.
2.	Andreas Gebhardt, “Rapid prototyping”, Hanser Gardener Publications, 2003.
Reference Books	
1.	Liou W.Liou, Frank W.Liou, “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press, 2007.
2.	Ali K. Kamrani, Emad Abouel Nasr, “Rapid Prototyping: Theory and practice”, Springer, 2006.
3.	Peter D.Hilton, Hilton/Jacobs, Paul F.Jacobs, “Rapid Tooling: Technologies and Industrial Applications”, CRC press, 2000.

Recommended by Board of Studies	5th September 2020
Approved by Academic Council	12th September 2020

Course code	**DYNAMICS AND VIBRATION LABORATORY**	**L**	**T**	**P**	**C**
20ME1008		0	0	2	1

Course Objective:

Impart knowledge on

1. Fundamental principles of dynamics for mechanical systems.
2. Sensors, Signal conditioning, digital data acquisition and associated instrumentation for vibration.
3. Vibration measurement techniques.

Course Outcome:

The student will be able to

1. Demonstrate the principle and mechanism used in governor and gyroscope.
2. Recognize the undesirable effects of unbalances resulting from prescribed motions in mechanism.
3. Determine the critical speed of shaft under the given load conditions.
4. Perform balancing of rotating masses.
5. Adapt and evaluate the technique to measure vibration.
6. Understand the behavior of vibration in simple mechanical systems.

List of Experiments

1.	Dynamic analysis of Gyroscope.
2.	Determination of Critical speed for Whirling of shaft.
3.	Dynamic Balancing of rotating masses.
4.	Determination of stability and centrifugal force for Governors.
5.	Longitudinal Vibration for single degree of freedom system.
6.	Torsional vibration for single degree of freedom system.
7.	Transmissibility ratio in vibration table.
8.	Modal testing using FFT Analyzer.
Total Lectures	**15 Hours**

Recommended by Board of Studies	5th September 2020
Approved by Academic Council	12th September 2020

Course Code	**ENGINEERING DRAWING AND GRAPHICS**	**L**	**T**	**P**	**C**
20ME1009		0	0	4	2

Course Objective:

To impart knowledge on

1. Technical standards and procedures for the construction of geometric figures.
2. Communication through the language of technical drawing and sketching.
3. Application of computer software for the preparation of engineering drawing.

Course Outcome:
The student will be able to 1. Understand the conventions and the methods of engineering drawing. 2. Improve their visualization skills and apply it in developing new products. 3. Comprehend the theory of projection. 4. Construct basic and intermediate geometry. 5. Create engineering drawings using CAD software and dimension the parts according to standard practice. 6. Draw the orthographic and isometric views of objects in CAD environment.
List of Experiments

1.	Lettering, Dimensioning and Constructions of geometric figures.
2.	Projection of points in different quadrants.
3.	Conversion of pictorial views into orthographic views.
4.	Projection of lines in first quadrant.
5.	Projection of basic solids like prisms, pyramids, cylinder and cone in simple positions.
6.	Isometric views of basic solids - prisms, pyramids, cylinder and cone.
7.	Drawing aids: snap, grid, limits and Osnap.
8	Application of modifying commands.
9	Methods of drawing lines, circles and arcs.
10	Application of lines, arcs and circles to draw simple geometries.
11	Dimensioning, hatching methods to show different materials, title block and layers.
12	Isometric view of primitive solids and combination of primitive solids.
Total Lectures	**30 Hours**

Reference Books:

1. Leo Dev wins. K., "Engineering Drawing", Pearson India Education, 3rd Edition, 2018.
2. Basant Agrawal, C.M. Agrawal, "Engineering Drawing", Tata McGraw Hill Private Ltd., 2015.
3. Sham Tickoo, "AutoCAD 2015: A Problem-Solving Approach", CADCIM Technologies, 2014.
4. Bhatt N.D., "Elementary Engineering Drawing", 53rd Edition. Chartor Publishing House, Anand, 2014.
5. Venugopal K. "Engineering Graphics", 10th Edn. (Revised), New Age International Publishers, 2015.

Recommended by Board of Studies	5th September 2020
Approved by Academic Council	12th September 2020

Course code	**ADDITIVE MANUFACTURING TECHNOLOGIES**	**L**	**T**	**P**	**C**
20ME3001		3	0	0	3

Course Objectives:

Impart knowledge on:

1. Fundamentals of Additive Manufacturing and its processes.
2. Liquid, Solid and Powder based AM systems and its case studies.
3. Data formats, Pre and Post processing of AM and its applications.

Course Outcomes:

The student will be able to:

1. Describe the significance and importance of Additive manufacturing (AM) for product development and innovation.
2. Demonstrate comprehensive knowledge of the broad range of AM processes, devices, capabilities and materials.
3. Articulate the various trade-offs in selecting advanced/additive manufacturing processes, devices and materials to suit particular product requirements.

4. Design a product and employ suitable AM process for value addition and reproduction of complex parts. 5. Select a RP tool for multi-component object using advanced/additive manufacturing devices and processes. 6. Apply the principles of Rapid tooling and develop a tool for various applications.		
Module: 1	**ADDITIVE MANUFACTURING (AM)**	**8 Hours**
Prototyping fundamentals: Need for time compression in product development, Need for Additive Manufacturing, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Commonly used Terms, Classification of AM process, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies.		
Module: 2	**LIQUID-BASED AND SOLID-BASED AM SYSTEMS**	**8 Hours**
Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Case studies. Polyjet: Process, Principle, working principle. Case studies. Microfabrication. **Solid-based AM Systems**: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Case studies. Multi-Jet Modelling (MJM): Models and specifications, Process, working principle, Case studies.		
Module: 3	**POWDER BASED AM SYSTEMS**	**8 Hours**
Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three-dimensional Printing (3DP): Models and specifications, Process, working principle. Case studies. Laser Engineered Net Shaping (LENS): Models and specifications, Process, working principle, Case studies. Electron Beam Melting (EBM): Models and specifications, Process, working principle, Case studies.		
Module: 4	**RAPID TOOLING**	**7 Hours**
Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification: Indirect Rapid Tooling Methods: Arc Spray Metal Deposition, Investment Casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.		
Module: 5	**AM DATA FORMATS**	**7 Hours**
Reverse engineering for Digital Representation, STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Mesh Refining by Sub division Techniques. AM Software's: Need for AM software. Features of various AM softwares.		
Module: 6	**AM APPLICATIONS**	**7 Hours**
Application – Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules. Web Based Rapid Prototyping Systems.		
	Total Lectures	**45 Hours**
Text Books		
1.	Chua C.K., Leong K.F. and LIM C.S, "Rapid prototyping: Principles and Applications" - World Scientific publications, Third Edition, 2010.	

2.	D.T. Pham and S.S. Dimov, "Rapid Manufacturing", Springer, 2000.
3.	Frank W. Liou, "Rapid Prototyping & Engineering Applications", CRC Press, Taylor & Francis Group, 2011.
Reference Books	
1.	Paul F Jacobs, "Rapid Prototyping and Manufacturing fundamentals of stereo lithography", 1st Edition, Society of Manufacturing Engineers, Dearborn, Michigan, 2012.
2.	Chowdia M.P (ED), "Agile Manufacturing", International Conference on Agile Manufacturing, Bangalore, Feb22–24,1996, Tata Mc Graw Hill Pub Co., Ltd., New Delhi, 2012.
Recommended by Board of Studies	5th September 2020
Approved by Academic Council	12th September 2020

Course Code	INTELLIGENT ROBOTICS SYSTEMS IN MANUFACTURING	L	T	P	C
20ME3002		3	0	0	3

Course Objectives:

Impart knowledge on

1. Apply the fundamentals concepts with computational platforms for the field robotics and automation applications.
3. To understand mechanism of robotic control and its motion mechanisms.
1. 3. Incorporate the Artificial Intelligence and Allied techniques for Robotic applications.

Course Outcomes:

The student will be able to

1. Understand the various motion control of robot.
2. Apply the robot kinematics concepts and inversion Mechanism.
3. Select the path movements of various robots for the variety of applications.
4. Diagnose the movement of robots and its operations.
5. Solve the risk application using artificial intelligence, IOT based algorithms.
6. Impart knowledge in networking of robots using sensors for various applications.

Module: 1	**OVERVIEW OF ROBOTICS FOR MANUFACTURING**	**8 Hours**

Robot types based on industrial application, trends, applications, classification - Anatomy and Architecture of Manipulators – Transformations - Robot Kinematics: Forward and Inverse - Manipulator Jacobian - Force relations - Dynamics: Forward and Inverse – Feedback Control: Position and force - Trajectory planning. Load handling capacity, Robotic material handling, material transfer, machine loading and unloading, CNC machine tool loading, Robot centered cell.

Module: 2	**HUMANOID ROBOTICS FOR MANUFACTURING**	**8 Hours**

Theory of humanoid robots, kinematics and dynamics. Methods for gait generation, including classical control theory, central pattern generators and linear genetic programming. Applications of humanoid robots. Humanoid robots in society - current and future applications, comparison with other types of robots. Hardware construction, including the use of microcontrollers and servo motors in connection with humanoid robots. Simulation in ROS.

Module: 3	**BEHAVIORAL ROBOTICS FOR MANUFACTURING**	**8 Hours**

Introduction to embodied cognitive science and behaviour -based robotics, reactive behaviour -based architectures, perception deliberative systems, hybrid systems.

Module: 4	**ADVANCED PERCEPTION FOR ROBOTICS IN MANUFACTURING**	**7 Hours**

3D reconstruction of objects and scenes from video, camera motion estimation from video, object detection and recognition, and tracking, cloud robotics, Optical flow estimation: motion field and optical flow, calculating optical flow, flow-based motion analysis, robust incremental optical flow.

Object detection and recognition: Global methods-transformation search-based methods, geometric correspondence-based approaches. flexible shape matching, interest point detection and region descriptors, three-dimensional object recognition. Tracking and video analysis.		
Module: 5	**ADVANCED AI FOR INTELLIGENT ROBOTIC MANUFACTURING SYSTEMS**	**7 Hours**
Problem solving: Graph based search, Algorithms for searching, Heuristic search, Robot path planning. Knowledge representation, Semantic networks, Frames, Ontologies, Knowledge based systems. Expert systems. Artificial neural networks: Perceptron, Learning, Associative memories, Self-organized networks, Applications of neural networks in robotics. Fuzzy logic systems, Genetic algorithms: Principles, Working, Design, Applications in robotics case Studies.		
Module: 6	**VIRTUAL REALITY AND APPLICATIONS FOR MANUFACTURING**	**7 Hours**
The three I's of virtual reality, commercial VR technology and the five classic components of a VR system. VR design principles, Input and Output Devices. Modelling: Geometric modelling, kinematics modelling, physical modelling, behaviour modelling, model management. Human Factors: Methodology and terminology, user performance studies, VR health and safety issues. Applications: Medical applications, military applications, robotics applications. VR in Unity 3D. Case Studies.		
	Total Lectures	**45 Hours**

Text Books

1.	Mikell P Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing," Pearson Education, 2015
2.	Goswami Ambarish, Vadakkepat Prahlad, "Humanoid Robotics: A Reference", Springer, 2019

Reference Books

1.	S John J Craig: "Introduction to Robotics: Mechanics and control", Third Edition – Pearson Education,Inc 2014.
2.	Arkin, C. Ronald, "Behaviour -Based Robotics", MIT Press, Cambridge: MA, 1998.
3.	D. Forsyth and J. Ponce, "Computer Vision: A Modern Approach", Prentice-Hall, 2003.
4.	Russell, S.J. and Norvig, P., "Artificial Intelligence – A Modern Approach", Prentice Hall, 2016.
5.	Gregory C. Burdea and Philippe Coiffet, "Virtual Reality Technology", Second Edition, John Wiley and Sons, Inc,2003.

Recommended by Board of Studies	5th September 2020
Approved by Academic Council	12th September 2020

Course code	INTERNET OF THINGS IN MANUFACTURING	L	T	P	C
20ME3003		3	0	0	3

Course Objectives:

Impart knowledge on

1. To make the students understand the requirements of Industrial automation standards
2. To enable the students to get familiarized with the concepts of IoT connecting the mechanical systems
3. To make the students create applications of IoT for mechanical systems

Course Outcomes:

The student will be able to

1. Interpret the Essentials of IoT for Modern Engineers
2. Examine the importance of Smart and Digital Factories
3. Make use of IoT in Manufacturing Process and Applications
4. Model IoT for Cyber-Physical Systems, Virtual Reality and Data Analytics
5. Interpret the IoT Challenges in Mechanical Systems

6. Apply IoT concepts in various applications		
Module: 1	**ESSENTIALS OF IoT FOR MODERN ENGINEERS**	**7 Hours**
The IoT revolution, The smart product mechanical engineer, Consumer IoT, Industrial IoT, Sensor, Analysis, Connectivity, Exchange. Data characteristics, The IoT process, Product components, External sources, Data Visualization, Closed loop design, Performance metrics, statistical data, Future design, Edge/Cloud computing.		
Module: 2	**SMART AND DIGITAL FACTORIES**	**8 Hours**
Big data, Predictive Analytics, Virtualized Processes, Modelling and Simulation, High-performance computing, Robotics, Code Halo Thinking, 3D Printing, Informed Manufacturing, Additive Manufacturing.		
Module: 3	**IoT IN MANUFACTURING PROCESS AND APPLICATIONS**	**8 Hours**
Supply Chain Management, Operating Efficiency, Predictive Maintenance, Inventory Optimization, Intelligent Supply, Maturity Scale for Smart Manufactured Products. Intelligent Product Enhancements, Dynamic Response to Market Demands, Optimized Resource Use, Waste Reduction, Product Safety.		
Module: 4	**IoT MODEL FOR CYBER-PHYSICAL SYSTEMS**	**8 Hours**
Industry 4.0, IoT, smart factories, Cyber Physical production Systems, synchronized planning, COBOTS, Digital Threads, Augmented and Virtual Reality, sensing and control, security, system design, Data analytics		
Module: 5	**IoT CHALLENGES IN MECHANICAL SYSTEMS**	**7 Hours**
Resource Constraints, Appropriate Information Models, Standardization of Device Models, Bridging to the Cloud, Security, AI/Autonomy, Cyber Security. Basics of Block chain.		
Module: 6	**INDUSTRIAL IoT - APPLICATION CASE STUDIES**	**7 Hours**
Robotics Remote Service, Electrical Vehicle Charging, Container Ship Trim Optimization, Condition Monitoring for Industrial Drives, Digital TWINS, monitoring of IC engines based on IoT.		
	Total Lectures	**45 Hours**

Reference Books

1. "Internet of Things", Copyright by Tutorials Point (I) Pvt. Ltd. 2016.
2. Heiko Koziolek, "IoT Challenges for Smart Manufacturing", ABB Corporate Research Germany
3. "The Essentials of IoT for Modern Engineers", Autodesk, Inc., 2016
4. Stephen Ezell "IoT and Smart Manufacturing", Global Innovation Policy Information Technology and Innovation Foundation.
5. "Cyber-Physical Systems and IoT Research Challenges", Gurdip Singh, National Science Foundation
6. "From Mechatronic Components to Industrial Automation Things: An IoT Model for Cyber-Physical Manufacturing Systems", Journal of Software Engineering and Applications

Recommended by Board of Studies	5th September 2020
Approved by Academic Council	12th September 2020

Course code	**3D PRINTING LABORATORY**	**L**	**T**	**P**	**C**
20ME3004		0	0	4	2

Course Objective:

Impart knowledge on:
1. The basics of additive manufacturing/rapid prototyping.

2. The generation, working and analysis of STL files. 3. Building complex geometries, printing and post-processing techniques.	
Course Outcome:	
The student will be able to: 1. Demonstrate the working principles of Additive Manufacturing. 2. Design complex / creative models ready for 3D printing. 3. Develop STL file for CAD models with appropriate support structures and Orientation 4. Build complex engineering assemblies in plastic material with minimum build-time 5. Evaluate the process parameters of AM machine to improve the quality of the parts Produced 6. Model and fabricate working models using AM processes.	
List of Experiments	
1.	Generating and Working with STL files from the CAD Models.
2.	Designing of complex geometries and generating STL files from CAD Data.
3.	Modeling and 3D Printing of Engine components.
4.	Modeling and 3D Printing of navigation components
5.	Modeling and 3D Printing mechanical Joint.
6.	Modeling and 3D Printing of Impeller.
7.	Designing and 3D printing of Intricate shapes for medical applications.
8.	Processing the CAD data in Catalyst and CURA or any slicing software.
9.	Simulation in Catalyst Software for optimizing build-time and material consumption.
10.	3D printing of machine components using 3D Scanning and re-modeling.
11.	Evaluating the quality of the 3D printed part in terms of surface finish and dimensional accuracy.
12.	Evaluating the fabricated part for its suitability for a given application.
Total Lectures	**30 Hours**
Recommended by Board of Studies	5th September 2020
Approved by Academic Council	12th September 2020

Course code	ADVANCED PRODUCT LIFE CYCLE MANAGEMENT AND AUTOMATION	L	T	P	C
20ME3005		3	0	0	3
Course Objectives:					
Impart knowledge on: 1. Fundamentals and principles of Automation. 2. Concepts and various strategies of Product Life Cycle Management. 3. The product design, simulation, product building and product configuration.					
Course Outcomes:					
The student will be able to: 1. Apply the concept of New Product Development and its structuring. 2. Analyze the virtual product development and model analysis. 3. Develop New product development, product structure and supporting systems. 4. Explain various strategies and technologies adapted in industrial automation. 5. Select appropriate evaluation methods used in the automation. 6. Apply modern tools like AI, ANN and Fuzzy logics in the building of automation systems.					
Module: 1	**AUTOMATED MANUFACTURING SYSTEMS**				**8 Hours**
Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations, introduction to automation productivity, Manufacturing Cells, GT and Cellular Manufacturing, FMS, FMS and its Planning and Implementation Overview of Material Handling -Rotary feeders, oscillating force feeder, vibratory feeder, elevator type and Centrifugal type feeders, Principles and Design					

Consideration, Material Transport Systems, Storage Systems. Problems on design of material handling systems.		
Module: 2	**EVALUATION OF AUTOMATIC PRODUCTION**	**8 Hours**
Product manufacturability, orientation devices- active and passive devices, parts orientation and escapement. Pneumatic and hydraulic components and circuits, Boolean algebra, pneumatic sensors and amplifiers, jet destruction devices, logic devices, Schmitz triggering devices, developing pneumatic circuits for automatic die casting machine. Industrial Control Systems, Process Industries Verses Discrete-Manufacturing Industries, Continuous Verses Discrete Control, Computer Process and its Forms. Sensors, Design of Actuators and other Control System Components and simple problems.		
Module: 3	**MODELING AND SIMULATION OF PLANT AUTOMATION**	**8 Hours**
Fundamentals of system Modeling, Building Mathematical Model of a manufacturing Plant, Modern Tools- Artificial neural networks in manufacturing automation, AI in manufacturing, Fuzzy decision and control, robots and application of robots for automation.		
Module: 4	**PRODUCT LIFE CYCLE MANAGEMENT (PLM)**	**7 Hours**
Overview, Need, Benefits, Concept of Product Life Cycle. Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement. Product Data and Product Workflow, Company's PLM vision, The PLM Strategy, Principles for PLM strategy, preparing for the PLM strategy, developing a PLM strategy, Strategy identification and selection, Change Management for PLM.		
Module: 5	**PRODUCT DESIGN, MODELLING AND ANALYSIS TOOLS**	**7 Hours**
Engineering design, organization and decomposition in product design, concurrent engineering, design for X' and design central development model, product recycling, human factors in product design. Modelling and simulation in product, Design for assembly and disassembly - probabilistic design concepts - FMEA - QFD - Taguchi Method for design of experiments -Design for product life cycle. Estimation of Manufacturing costs, Reducing the component costs and assembly costs, Minimize system complexity. Product optimization, Case studies on new product design using brain storming.		
Module: 6	**PRODUCT BUILDING, STRUCTURES AND PDM TECHNOLOGY**	**7 Hours**
Virtual product development tools for components, machines, and manufacturing plants: 3D CAD systems, digital mock-up, model building, model analysis, production (process) planning, and product data technology, Product structures: Variant management, product configuration, material master data, product description data, Data models, Life cycles of individual items, status of items. PDM functions, definition and architectures of PDM systems, product data interchange, portal integration, PDM acquisition and implementation.		
	Total Lectures	**45 Hours**
Text Books		

1	Mikell P Groover, Automation Production Systems and Computer Integrated Manufacturing 4th Edition by Pearson, 2016.
2	A K Gupta, Industrial Automation and Robotics, Third edition, Laxmi Publications Pvt Ltd, 2007.
3	Stark, John., Product Lifecycle Management: Paradigm for 21st Century Product Realization, Springer-Verlag, 2004.
4	Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis, 2006.

Reference Books	
1.	Saaksvuori Antti, Immonen Anselmie, Product Life Cycle Management; Springer-Verlag Berlin Heidelberg publisher, 3rd Edition, 2008.
2.	Michael Grieves, Product Lifecycle Management, Tata McGraw Hill, 2006.
Recommended by Board of Studies	5th September 2020
Approved by Academic Council	12th September 2020

Course code	COMPUTER INTEGRATED MANUFACTURING AND FMS	L	T	P	C
20ME3006		3	0	0	3

Course Objectives:

Impart knowledge on

1. Demonstrate the concept of CIM and FMS to learners
2. Discover the use of computers in CIM and FMS
3. Formulate techniques for CIM and FMS

Course Outcomes:

The student will be able to

1. Assess the use of computers in the area of manufacturing to reduce manual interventions
2. Apply Computer Aided Process Planning (CAPP) and Computer Aided Quality Control (CAQC) principles in manufacturing
3. Evaluate Material Requirement Planning (MRP) and Enterprise Resource Planning (ERP) and their integration towards implementation of Industry 4.0
4. Illustrate Flexible manufacturing systems concepts in production systems
5. Infer FMS control using computers in real time manufacturing environment
6. Analyze the data base for manufacturing systems and integration of data base to shop floor control

Module: 1	GROUP TECHNOLOGY AND FMS	8 Hours

Manufacturing systems, CIM Technology, CIM models, manufacturing cell. Group technology-classification and coding, production flow analysis, machine cell design-simple examples in design. FMS Concepts-Definition of FMS – types– types of flexibility and performance measures, Different FMS layouts, advantages, disadvantages, components of FMS,

Module: 2	COMPUTER AIDED QUALITY CONTROL	8 Hours

Structure model of manufacturing process control & strategies direct digital control supervisory computer control-computer in QC Contact inspection methods non-contact inspection method Computer aided testing - integration of CAQC with CAD/CAM

Module: 3	INTEGRATED MANUFACTURING SYSTEM	8 Hours

Integrated Manufacturing System: Definition - application features – Types of manufacturing systems. Machine tools-materials handling system computer control system – DNC systems manufacturing cell. Artificial Intelligence and Expert system in CIM

Module: 4	DEVELOPMENT AND IMPLEMENTATION OF FMS	7 Hours

Development and implementation of FMS: Planning phases, scheduling – integration – system. configuration – simulation – FMS project development steps. hardware and software development. Installation and implementation. Application and benefits of FMS, Quantitative analysis of FMS-Sizing of FMS problem-Utilization of each workstation in Bottleneck model on a simple problem

Module: 5	CELLULAR MANUFACTURING	7 Hours
Cellular Systems: Group technology – coding schemes – assigning machines to groups – production flow analysis, binary ordering algorithm, single pass heuristic, similarity coefficients, graph partition - assigning parts to machines. Grouping of machines problems using Rank order clustering technique, Hollier Method I and Hollier Method II		
Module: 6	**FMS DATA BASE AND SIMULATION**	**7 Hours**
Manufacturing Data systems - planning FMS data base - Modelling of FMS- analytical – heuristics – queuing - simulation and modelling techniques.		
	Total Lectures	**45 Hours**

Text Books

1.	Groover, M.P., "Automation, Production System and CIM", Pearson, 5th edition 2019.
2.	Nand K. Jha, "Hand-book of Flexible Manufacturing Systems" Academic Press, 2015.

Reference Books

1.	David Bedworth, "Computer Integrated Design and Manufacturing", TMH, New Delhi, 1st Edition 1999
2.	Parish.D.J., "Flexible Manufacturing", Butter worth-Heinemann Ltd,2006.
3.	Raouf, A. and Ben-Daya, M., Editors, "Flexible Manufacturing Systems: recent development", Elsevier Science, 2015.
4.	H K Shivanand , M Benal and V Koti,"Flexible Manufacturing Systems", New Age International Private Limited; First edition ,2006.
5.	Nigel R.Greenwood, " Implementing Flexible Manufacturing Systems", MacMillan Education 2008.

Recommended by Board of Studies	5th September 2020
Approved by Academic Council	12th September 2020

Course Code	AUTOMATED INSPECTION SYSTEMS	L	T	P	C
20ME3007		3	0	0	3

Course Objectives:

Impart knowledge on

1. To impart knowledge on the fundamentals of high precision measurements, laser metrology and Coordinate Measuring Machine (CMM).
2. To facilitate an understanding on functioning and applications of machine vision system for quality control.
3. Machine vision and automated inspection systems.

Course Outcomes:

The student will be able to

1. Understand the various methods of high precision measurements and Ultrasonic techniques.
2. Operate sophisticated measurement and inspection facilities.
3. Asses the methods of laser interferometry, Atomic Force techniques to measure surface topography and interpret the results.
4. Apply suitable programming commands to measure the critical features of a component using CMM.
5. Select suitable Machine Vision system for image acquisition, processing and interpret the results for on-line quality control.
6. Choose the appropriate automated visual inspection method.

Module: 1	UNCERTAINTY IN MEASUREMENTS	8 Hours
Measurement Fundamentals, Uncertainty, Measurement uncertainty according to GUM (Guide to the expression of Uncertainty in Measurement), Type A Evaluation; Repeated measurements,		

concept of Regression. Type B Evaluation, Calculation of combined standard uncertainty using Law of Propagation, Numerical Approach, Handling Correlated components, Expanded Uncertainty, Uncertainty and Resolution, Uncertainty and Conformity.		
Module: 2	**COMPUTER AIDED INSPECTION**	**8 Hours**
High precision measurements – interfacing - software metrology - Automated visual inspection in manufacturing, contact and non - contact type inspection methods, Electrical field techniques, radiation techniques, Ultrasonic sensor for automated inspection - Atomic Force Microscopes (AFM), Talysurf instruments.		
Module: 3	**LASER METROLOGY**	**8 Hours**
Laser Interferometer, Alignment Telescope, laser scanners. On-line and in - process measurements - diameter, surface roughness, Micro holes, surface topography measurements, straightness and flatness measurements, speckle measurements.		
Module: 4	**COORDINATE MEASURING MACHINE**	**7 Hours**
CMM Types, Applications - Non-contact CMM using Electro optical sensors for dimensional metrology - Non-contact sensors for surface finish measurements – Measurements / programming with CNC CMM – Performance evaluations – Measurement integration.		
Module: 5	**MACHINE VISION**	**7 Hours**
Introduction, Image Acquisition and Processing - Imaging geometry - Pixel relationships, Preprocessing, Description, Recognition - Binary and gray level images, image segmentation and labelling, representation and interpretation of colours. Application of Machine Vision in inspection - Measurement of length, diameters, Surface roughness - 3D and dynamic feature extraction. Automated Sorting System- case study. Scanning microscopes: Principles, Applications. Other optical inspection methods -Scanning laser systems, linear allay devices, optical triangulation techniques.		
Module: 6	**AUTOMATED VISUAL INSPECTION**	**7 Hours**
Automated inspection: Automated inspection principles & methods -100% automated inspection, off -line & on -line inspection, distributed inspection & final inspection; Sensor technologies for automated inspection, On-line Quality control: On-line feedback quality control variable characteristics - control with measurement interval, one unit, and multiple units control systems for lot and batch production. Robotic inspection: Robotic testing and inspection - Robot vision system.		
Total Lectures		**45 Hours**

Text Books	
1.	Sabne Soloman, “Sensors and Control systems in Manufacturing”, Mc.Graw Hill Book 2010.
2.	T. Busch and R. Harlow Delmar , “Fundamentals of dimensional Metrology”, 2002.
3.	Nello Zuech,- “Understanding and Applying Machine Vision” - Marcel Dekker, 2nd Edition, 2000.
Reference Books	
1.	Sonka,M., Hlavac,V. and Boyle. R., “Image Processing, Analysis, and Machine Vision”, Cengage Engineering, 2007.
2.	J. Hocken, “Coordinate Measuring Machines and Systems,” 2nd ed., CRC Press, Boca Raton,2012
3.	L. Kirkup, and R. B. Frenkel, “An Introduction to Uncertainty in Measurement Using the GUM”, Cambridge University Press, 2006.
4.	D. Whitehouse, “Surfaces and Their Measurement”, Hermes Penton Science, London, 2002.
3.	Czichos, “The Springer handbook of metrology and Testing”, 2011.

5.	C. Demant, B. Streicher-Abel, and P. Waszkewitz, Industrial Image Processing, Springer-Verlag, Berlin, 2005.

Recommended by Board of Studies	5th September 2020
Approved by Academic Council	12th September 2020

DEPT. OF MECHANICAL ENGINEERING

LIST OF NEW COURSES

S. No.	Course Code	Title of Course	L	T	P	C
1	18ME2040	Computational Fluid Dynamics	3	0	0	3
2	18ME2041	Turbo Machinery	3	0	0	3
3	18ME2042	Design of Heat Exchangers	3	0	0	3
4	18ME2043	Internal Combustion Engines	3	0	0	3
5	18ME2044	Refrigeration and Air Conditioning	3	0	0	3
6	18ME2045	Gas Dynamics and Jet Propulsion	3	0	0	3
7	18ME2046	Solar Thermal Power Engineering	3	0	0	3
8	18ME2047	Power Plant Engineering	3	0	0	3
9	18ME2048	Product Design and Development Strategies	3	0	0	3
10	18ME2049	Composite Materials	3	0	0	3
11	18ME2050	Finite Element Analysis	3	0	0	3
12	18ME2051	Principles of Mechanical Vibrations	3	0	0	3
13	18ME2052	Design for Manufacture and Assembly	3	0	0	3
14	18ME2053	Tribology	3	0	0	3
15	18ME2054	Design of Jigs, Fixtures and Press Tools	3	0	0	3
16	18ME2055	Computer Aided Design	3	0	0	3
17	18ME2056	Micro and Nano Machining	3	0	0	3
18	18ME2057	Welding Technology	3	0	0	3
19	18ME2058	Mechatronic systems	3	0	0	3
20	18ME2059	Metal Cutting Theory and Practice	3	0	0	3
21	18ME2060	Industrial Safety Engineering	3	0	0	3
22	18ME2061	Industrial Engineering	3	0	0	3
23	18ME2062	Modern Vehicle Technology	3	0	0	3
24	18ME2063	Rapid Manufacturing Technologies	3	0	0	3
25	18ME2064	Automation in manufacturing	3	0	0	3
26	18ME2065	Process Planning and Cost Estimation	3	0	0	3
27	18ME2066	Microprocessors in Automation	3	0	0	3
28	18ME2067	Automobile Engineering	3	0	0	3
29	18ME2068	Total Quality Management	3	0	0	3
30	18ME2069	Energy Conservation and Management	3	0	0	3
31	18ME2070	Introduction to Mechatronics	3	0	0	3
32	18ME2071	Robotic Engineering	3	0	0	3
33	18ME2072	Fluid Power Applications	3	0	0	3
34	18ME2073	Modern Manufacturing Techniques	3	0	0	3
35	18ME2074	Renewable Energy Technologies	3	0	0	3
36	18ME2075	Introduction to IC Engines	3	0	0	3
37	18ME2076	Fundamentals of Computer Aided Design	3	0	0	3
38	18ME2077	Fuel Cells Technology	3	0	0	3
39	18ME2078	Experimental Methods in Engineering	3	0	0	3
40	18ME2079	MEMS and Micro System Fabrication	3	0	0	3
41	18ME2080	Introduction to Food Process Engineering and Technology	3	0	0	3
42	18ME2081	Introduction to Modern Energy Technologies	3	0	0	3
43	18ME2082	Introduction to Water Technologies	3	0	0	3
44	18ME2083	Introduction to Health Care Science and Technology	3	0	0	3
45	19ME1001	Industrial Practice - I (Fundamentals of Chassis Design and Fabrication of Go-Kart)	0	0	2	1
46	19ME1002	Industrial Practice - II (Suspension and Steering Dynamics)	0	0	1	0.5

47	19ME2001	Industrial Practice - III (Design and Fabrication of All Terrain Vehicle)	0	0	1	0.5
48	19ME2002	Industrial Practice - IV (Smart Engine, Transmission Technologies and Brake Dynamics)	0	0	1	0.5
49	19ME2003	Industrial Practice - V (Testing and Tuning of Engine and Transmission Systems)	0	0	1	0.5
50	19ME2004	Industrial Practice - VI (Fundamentals of Design for Electric and Hybrid Vehicles)	0	0	1	0.5
51	19ME2005	Industrial Practice - VII (Fabrication Technology for Electric and Hybrid Vehicles)	0	0	1	0.5
52	19ME2006	Thermodynamics	3	0	0	3
53	19ME2007	Applied Thermodynamics	3	0	0	3

18ME2040	COMPUTATIONAL FLUID DYNAMICS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Basic equations that govern the fluid flow, heat transfer and combustion processes.
2. Various discretization methods and solving methodologies to solve complex problems in the field of heat transfer and fluid dynamics.
3. Formulation of explicit and implicit algorithms for solving the Navier Stokes equations.

Course Outcome: After completing the course the student will be able to

1. Formulate the required governing equations for flow and heat transfer problems.
2. Discretize the governing equations of flow and heat transfer problems.
3. Solve the diffusion equations.
4. Solve the diffusion-convection equations.
5. Use appropriate algorithms to solve the discretized equations.
6. Apply turbulence models to accurately predict the variables based on the flow characteristics.

MODULE 1 FORMULATION OF GOVERNING EQUATIONS (8 Lecture Hours)
Basics of Heat Transfer, Fluid flow – Mathematical description of fluid flow and heat transfer – Conservation of mass, momentum, energy and chemical species - Classification of partial differential equations – Initial and Boundary Conditions

MODULE 2 DISCRETISATION TECHNIQUES (8 Lecture Hours) Discretization techniques using finite difference methods – Taylor's Series - Uniform and non-uniform Grids – grid generation, Numerical Errors, Grid Independence study.

MODULE 3 DIFFUSION PROCESSES (8 Lecture Hours)
Steady one-dimensional diffusion, Two and Three dimensional steady state diffusion problems, Discretization of unsteady diffusion problems – Explicit, Implicit and Crank-Nicholson's schemes, Stability of schemes.

MODULE 4 CONVECTION – DIFFUSION PROCESSES (8 Lecture Hours)
One dimensional convection – diffusion problem, Central difference scheme, upwind scheme – Hybrid and power law discretization techniques – QUICK scheme.

MODULE 5FLOW PROCESSES (7 Lecture Hours)
Discretization of incompressible flow equations – Pressure based algorithms, SIMPLE, SIMPLER & PISO algorithms

MODULE 6 TURBULENCE AND ITS MODELING (7 Lecture Hours)
Description of turbulent flow, free turbulent flows, flat plate boundary layer and pipe flow. Algebraic Models, One equation model, $k - \varepsilon$ & $k - \omega$ models standard and high and low Reynolds number models.

Text Books:

1. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational Fluid Mechanics and Heat Transfer", Hemisphere Publishing Corporation, New York, USA, 2012.
2. Versteeg and Malalasekera, N, "An Introduction to computational Fluid Dynamics: The Finite volume Method," Pearson Education, Ltd., 2007.

Reference Books:

1. Subas and V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 2005.
2. Muralidhar, K., and Sundararajan, T, "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.

18ME2041	TURBO MACHINERY	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Basic laws and hydraulic turbines.
2. Working of the hydraulic pumps.
3. Principles of Steam and Gas turbines.

Course Outcome: After completing the course the student will be able to

1. Explain basic concepts of turbo machines and visualize dimensional analysis.
2. Describe the working of Pelton, Francis and Kaplan along their performance parameters.
3. Discuss the operation of centrifugal pumps, centrifugal and axial compressors.
4. Analyze the effect of cavitation in turbines and pumps.
5. Evaluate the performance of steam turbines.
6. Evaluate the performance of gas turbines

MODULE 1 INTRODUCTION (8 Lecture Hours)

Introduction - Classification - Dimensional analysis - Specific speed – Conservation of mass, momentum and energy and equations.

MODULE 2 HYDRAULIC TURBINES (8 Lecture Hours)

Hydraulic turbines; Pelton, Francis, and Kaplan turbines - Turbine efficiencies - Cavitation in turbines.

MODULE 3HYDRAULIC PUMPS (8 Lecture Hours)

Centrifugal pumps; theory, components, and characteristics - Cavitation - Axial flow pumps - Pump system matching.

MODULE 4COMPRESSORS (7 Lecture Hours)

Centrifugal and axial flow compressors; slip, surging and chocking.

MODULE 5 STEAM TURBINES (7 Lecture Hours)

Construction and working principle - impulse and reaction turbines, performance calculations

MODULE 6GAS TURBINES (7 Lecture Hours)

Gas turbine; Brayton cycle and multi-staging - Power and efficiency calculations.

Text Books:

1. Dixon, S.L., Fluid Mechanics and Thermodynamics of Turbo machines, 5thed., Butterworth-Heinemann, 2005.
2. Sayers, A.T., Hydraulic and Compressible Flow Turbo machines, CBLS, 2003.

Reference Books:

1. Ganesan, V., Gas Turbines, 2nd ed., Tata McGraw-Hill, 2003.
2. Lakshminarayana, B., Fluid Dynamics and Heat Transfer of Turbo machinery, Wiley-Interscience, 2006.

18ME2042	DESIGN OF HEAT EXCHANGERS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Thermal and stress analysis on various parts of the heat exchangers.
2. Sizing and rating of the heat exchangers for various applications.
3. Design of evaporative condensers and cooling towers.

Course Outcome: After completing the course the student will be able to

1. Understand the fundamentals of heat exchangers.
2. Analyze the friction and pressure loss in the estimation of stress in heat exchangers.
3. Design of shell and tube heat exchangers.
4. Design of compact and plate heat exchangers.
5. Design condensers and evaporators.

6. Select suitable cooling tower accessories for given application.

MODULE 1 – FUNDAMENTALS OF HEAT EXCHANGERS (8 Lecture Hours)

Temperature distribution and its implications types – shell and tube heat exchangers – regenerators and recuperators – analysis of heat exchangers – LMTD and NTU method.

MODULE 2 – FLOW AND STRESS ANALYSIS (8 Lecture Hours)

Effect of turbulence – friction factor – pressure loss – stress in tubes – header sheets and pressure vessels – thermal stresses, shear stresses - types of failures.

MODULE 3 – DESIGN ASPECTS (8 Lecture Hours)

Heat transfer and pressure loss – flow configuration – effect of baffles – effect of deviations from ideality – design of double pipe - finned tube - shell and tube heat exchangers - simulation of heat exchangers.

MODULE 4 – COMPACT AND PLATE HEAT EXCHANGERS (7 Lecture Hours)

Types – merits and demerits – design of compact heat exchangers, plate heat exchangers, rotory type – performance influencing parameters - limitations.

MODULE 5 – CONDENSERS AND EVAPORATORS (7 Lecture Hours)

Design of surface and evaporative condensers –Design of Shell and Tube, Plate type evaporators.

MODULE 6 – COOLING TOWERS(7 Lecture Hours)

Packings, Spray design, Selection of pumps, Fans and Pipes, Testing and Maintenance, Experimental Methods.

Text Books:

1. Sekulic D.P., Fundamentals of Heat Exchanger Design, John Wiley, 2003 (Check latest edition after)
2. TaborekT.,Hewitt.G.F. and Afgan N., Heat Exchangers, Theory and Practice, McGraw-Hill Book Co.2010.

Reference Books:

1. Arthur P. Frass, “Heat Exchanger Design”, John Wiley & Sons, 2011.
2. Hewitt G.F., Shires G.L. and Bott T.R., Process Heat Transfer, CRC Press, 2005.
3. Nicholas Cheremisioff, “Cooling Tower”, Ann Arbor Science Pub 2006.
4. SadikKakac and Hongtan Liu, Heat Exchangers Selection, Rating and Thermal Design, CRC Press, 2002.
5. Walker, Industrial Heat Exchangers - A Basic Guide, McGraw Hill Book Co., 2000.

		L	T	P	C
18ME2043	**INTERNAL COMBUSTION ENGINES**	**3**	**0**	**0**	**3**

Course Objectives: To impart knowledge on

1. Combustion, fuel supply systems,ignition, lubrication and cooling systems of SI and CI engines.
2. Testing, performance and emissions of IC engines.
3. Alternate fuels and recent developments in IC Engines.

Course Outcome: After completing the course the student will be able to

1. Perform calculations for designing the combustion chambers of IC engines.
2. Estimate the mixture requirements forfuel injection systems
3. Predict the energy requirement for ignition, quantity of lubricating oil and cooling water requirements.
4. Test and analyze performance of SI and CI engines. .
5. Predict concentrations of primary exhaust pollutants and adapt emission control norms.
6. Evaluate alternative fuels for Internal Combustion engines.

MODULE 1 –COMBUSTION IN SI AND CI ENGINES(8 Lecture hours)

Stages of combustion in S.I engine-Effect of engine variables on ignition lag, flame propagation and knock or detonation-S.I engine combustion chamber design. Stages of Combustion in C.I engine-variables affecting delay period-C.I engine combustion chambers- Cold starting of C.I engines.

MODULE 2-FUEL SUPPLY SYSTEMS IN SI AND CI ENGINES(8 Lecture hours)
Mixture requirements – carburetor types Multi point fuel injection system – electronic fuel injection-Diesel Fuel Injection Systems-types and requirements-Common Rail Direct Injection Systems -spray formation, direction-injection timing-super and turbo charging of S.I and C.I engines.
MODULE 3 – IGNITION, LUBRICATION AND COOLING (8 Lecture hours)
Ignition systems-ignition timing. Electronic ignition system- Factors effecting energy requirement of ignition systems–Effect of engine variables on engine friction-properties of lubricating oil- effect of lubrication on engine performance-cooling systems-quantity of water required-radiators.
MODULE 4- TESTING AND PERFORMANCE OF IC ENGINES(7 Lecture hours) Basic measurements- speed, fuel consumption, air consumption, indicated power, brake power, friction power, exhaust smoke, exhaust emission-Performance of S.I and C.I engines. Heat balance.
MODULE 5 – ENGINE EMISSIONS AND CONTROL (7 Lecture hours)
Pollutants from gasoline engine-effect of engine maintenance on emissions- Gasoline engine emission control. Diesel emissions- Methods of controlling Emissions – Catalytic converters, Selective catalytic reduction and particulate traps – current emission norms.
MODULE 6 – DUAL FUEL AND MULTIFUEL ENGINES (7 Lecture hours)
Alcohol, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel – Properties, Suitability, Merits and Demerits – Engine Modifications. Introduction to the future fuels - water and air.

Text Books:
1. Mathur M. L and Sharma. R. P, “Internal Combustion Engines”, Dhanpat Rai publications, 2014.
2. Ganesan V, “Internal Combustion Engines”, Tata McGraw-Hill, 2012.

Reference Books:
1. Ramalingam. K.K., “Internal Combustion Engine Fundamentals”, Scitech Publications, 2011.
2. Colin, Ferguson. R., “Internal Combustion Engines”, John Wiley and Sons, 2015.
3. Heywood J. B, “Internal Combustion Engine Fundamentals”, McGraw Hill Book Co. NY, 2010.

18ME2044	**REFRIGERATION AND AIR-CONDITIONING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives: To impart knowledge on
1. Working principle of refrigeration and air-conditioning cycle
2. Fundamentals of psychrometric processes
3. Applications of refrigeration and air-conditioning equipment.

Course Outcome: After completing the course the student will be able to
1. Understand various refrigeration systems
2. Demonstrate the working of refrigeration equipment.
3. Understand various psychrometric processes
4. Estimate the space cooling load
5. Design the air-conditioning equipments
6. Select suitable refrigeration and air-conditioning systems for various applications.

MODULE 1 –REFRIGERATION AND AIRCONDITIONING SYSTEMS (8 Lecture Hours)
Review of thermodynamic principles – refrigeration. Air refrigeration – Bell–Coleman cycle - Performance calculations - Bootstrap cycle - Aircraft refrigeration system - Vapour compression refrigeration cycle – Use of P-H charts – multistage multiple evaporator systems – COP comparison.
MODULE 2 – REFRIGERATION AND AIRCONDITIONING EQUIPMENT (8 Lecture Hours)
Compressors – working principles of reciprocating and rotary. Condensers – evaporators, types - Refrigerants – properties – selection of refrigerants - Vapour absorption refrigeration system - Ammonia water and Lithium Bromide water systems. Magnetocaloric materials
MODULE 3 – LOW TEMPERATURE REFRIGERATION (8 Lecture Hours)
Cascade Refrigeration system – manufacture of solid carbon dioxide – liquefaction of air, hydrogen, and helium – production of low temperature by adiabatic demagnetization of a paramagnetic salt

MODULE 4 – PSYCHROMETRY AND COMFORT CHART (7 Lecture Hours)
Review of fundamental properties of psychrometric – use of psychrometric charts – psychrometric processes – Grand and room sensible heat factors – by pass factor – requirements of comfort air conditioning – comfort charts –factors governing optimum effective temperature
MODULE 5 – COOLING LOAD ESTMATION (7 Lecture Hours)
Types of load– heat transmission through building - Solar radiation – infiltration – internal heat sources (sensible and latent) – design of space cooling load as per ASHRAE/ ISHRAE standards-outside air and fresh air load – estimation of total load – design of air conditioning cycles, Summer and winter air conditioning systems.
MODULE 6 – APPLICATIONS (7 Lecture Hours)
Applications to refrigeration systems – ice plant – food storage plants – milk –chilling plants – refrigerated cargo ships, central air conditioning systems – applications: car, train, industry, stores, and public buildings

Text Books:

1. S.C.Arora, Domkundwar, Refrigeration and Air Conditioning, Dhanpat Rai and sons, 2009.
2. R.S. Khurmi and J.K Gupta, A Text book of Refrigeration and Air Conditioning, Eurasia publishing house private Ltd, 2015.

Reference Books:

1. Stoecker and Jones, Refrigeration and Air Conditioning, Tata McGraw Hill, New Delhi, 2003
2. Manohar Prasad, Refrigeration and Air Conditioning, Wiley Eastern Ltd, 2009.
3. Jordan and Prister, Refrigeration and Air Conditioning, Prentice Hall of India, New Delhi, 2011
4. J. Dossat, Principles of Refrigeration, Wiley Eastern Ltd, 2012.

		L	T	P	C
18ME2045	**GAS DYNAMICS AND JET PROPULSION**	**3**	**0**	**0**	**3**

Course Objectives: To impart knowledge on
1. Isentropic flow, Fanno and Rayleigh flow
2. Phenomenon of shock waves and its effect on flow.
3. Concepts of Aircraft propulsion and Rocket propulsion.

Course Outcome: After completing the course the student will be able to
1. Understand the basic concepts of gas dynamics.
2. Analyze the effect of variable area on the fluid flow.
3. Analyze the effect of friction and heat transfer on the fluid flow.
4. Determine the effect of shock waves on the fluid flow.
5. Evaluate the performance of aircraft engines.
6. Evaluate the performance of rocket engines.

MODULE 1 – BASIC CONCEPTS OF GAS DYNAMICS (7 Lecture Hours)
Energy equation for flow processes, stagnation state, velocity of sound, critical states, various regions of flow, Mach number, critical Mach number, Mach cone, Crocco number, Effect of Mach number on compressibility.
MODULE 2 – ISENTROPIC FLOWWITH VARIABLE AREA(8 Lecture Hours) Isentropic flow with variable area – T-S diagram and h-s diagrams showing nozzle and diffuser process Mach number variation, area ratio as a function of Mach number, Impulse function, mass flow rate, flow through nozzles, flow through diffusers.
MODULE 3 – FANNO AND RAYLEIGH FLOW (8 Lecture Hours)
Flow in constant area ducts with friction, Fanno curves and Fanno flow equation, variation of flow properties, variation of Mach number with duct length. Flow in constant area ducts with heat transfer, Raleigh line, Raleigh flow equation, variation of flow properties and maximum heat transfer.
MODULE 4 – FLOW WITH SHOCK WAVES (8 Lecture Hours)
Flow with normal shock waves, governing equations, Prandtl-Meyer equation, Mach number downstream of the normal shock, static pressure ratio, temperature ratio, density ratio and stagnation pressure ratio across the shock, entropy change, Flow with oblique shock waves.
MODULE 5 – AIRCRAFT PROPULSION (7 Lecture Hours)

Theory of aircraft propulsion – Thrust equation – Thrust power and propulsive efficiency – Operating principle of ram jet, turbojet, turbofan and turbo prop engines.

MODULE 6 – ROCKET PROPULSION (7 Lecture Hours)

Rocket propulsion – Types of rocket engines, basic theory of equations, thrust equations, effective jet velocity, specific impulse, characteristic velocity, rocket engine performance, solid and liquid propellant rockets – Applications – space flights and space crafts.

Text Books:

1. Yahya, S.M., 'Fundamentals of Compressible flow with aircraft and rocket propulsion', New Age International Publishers, 2010.
2. J. D. Anderson, "Modern Compressible flow", 3 rd Edition, McGraw Hill, 2012.

Reference Books:

1. P. Balachandran, "Fundamentals of compressible fluid dynamics", PHI Learning Private Ltd, 2009.
2. S. Senthil,"Gas Dynamics and Jet Propulsion", A.R.S. Publications, 3rd Edition, 2006.
3. Anderson, D. John Jr., "Introduction to Flights", McGraw Hill, ISE, 2004.

18ME2046	SOLAR THERMAL POWER ENGINEERING	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Solar thermal energy and radiation
2. Liquid flat- plate collector, solar air heaters, concentrating collectors
3. Applications of solar water heating, industrial process heating

Course Outcome: After completing the course the student will be able to

1. Understand commercial energy sources, energy alternatives.
2. Analyze different solar energy option.
3. Apply empirical equations for predicting solar radiation.
4. Evaluate the performance of flat plate collectors, concentrating collectors, solar air heater.
5. Estimate the cost of solar process systems and gain knowledge on storages.
6. The different applications of solar energy.

MODULE 1 – INTRODUCTION (8 Lecture Hours)

Introduction: Man and energy, worlds production, energy sources, India's production and reserves, energy alternatives, basic heat transfer concepts.

MODULE 2 – SOLAR ENERGY (8 Lecture Hours)

Thermal conversion – collection and storage, thermal applications, photo voltaic conversion, wind energy, energy from biomass, ocean thermal energy conversion, observations.

MODULE 3 – SOLAR RADIATION (8 Lecture Hours)

Sun, Solar Spectrum, solar constant and radiation, measuring instruments, sun-earth angles, solar radiation data, empirical equations, solar radiation on tilted surfaces.

MODULE 4 – SOLAR COLLECTORS (7 Lecture Hours)

Introduction, Liquid flat plate collector, concentrating collectors, air heaters, types of heaters, performance analysis, overall cost coefficient, numerical problems.

MODULE 5 – SOLAR ENERGY STORAGE AND ECONOMICS (7 Lecture Hours)

Sensible heat storage, liquid media storage, solid media storage, dual media storage Cost of solar process systems, uncertainties in economic analysis.

MODULE 6 – APPLICATIONS OF SOLAR ENERGY (7 Lecture Hours)

Solar water heating, building heating, cooling, industrial process heat, solar ponds.

Text Books:

1. Suhatme, S.P., 'Solar Energy Principle of Thermal Collection and Storage', Tata Mc Graw Hill publications,2008.
2. Duffie.A.John, Solar engineering of thermal processes. Wileyinterscience publications, 2013.

Reference Books:

1. Mangal, V.S., 'Solar Engineering', Tata McGraw Hill, 2010.

2. Bansal, N.K., ‘Renewable Energy Source and Conversion Technology’, Tata McGraw Hill, 2006.
3. Peter J. Lunde., ‘Solar Thermal Engineering’, John Willey and Sons, New York, 2006.
4. Tiwari.G.N, Solar thermal engineering systems, Narosa publications2010.

18ME2047	POWER PLANT ENGINEERING	L T P C 3 0 0 3

Course objectives: To impart knowledge on
1. Various sources of power generation and engineering analysis of power plants.
2. Economics of power plants and methods of optimum utilization of electrical energy.
3. Environmental effects of power plants.

Course Outcomes: After completing the course the student will be able to
1. Determine the efficiency of a modified Rankine power cycle.
2. Explain the layout, construction and working of steam power plant.
3. Recognize various methods of power generation from nuclear power plant.
4. Analyze the performance of diesel engine cycle and gas turbine cycles.
5. Recognize various methods of power generation from renewable energy sources.
6. Understand the power plant economics and environmental hazards.

MODULE 1 POWER CYCLES (7 Lecture Hours) Simple Rankine cycle, modified Rankine cycle – Reheating – Regeneration, analysis, pressure and temperature limits - Binary vapour cycle and combined cycle.

MODULE 2 STEAM POWER PLANT (8 Lecture Hours)
Various components, layout, Modern high pressure boilers – sub critical and ultra-super critical boilers – Stoker type and Pulverized type combustion systems. Economizer and Air preheater, Ash handling and dust collectors, Draught systems. Feed water treatment. Condensers and cooling towers. Turbine materials.

MODULE 3NUCLEAR POWER PLANT (7 Lecture Hours)
Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors : Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium Uranium reactor (CANDU), Fast Breeder Reactor, Gas Cooled and Liquid Metal Cooled Reactors. Nuclear power plant materials. Safety measures for Nuclear Power plants.

MODULE 4 DIESEL AND GAS TURBINE POWER PLANT (8 Lecture Hours)
Diesel, Dual and Brayton Cycle – Analysis, Diesel Engine power plant: components and layouts, Gas Turbine Power Plant: components and layouts. Open and closed cycle plants – combined gas turbines and steam power plants.

MODULE 5POWER FROM RENEWABLE ENERGY (8 Lecture Hours)
Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems, MHD concepts of energy conversion.

MODULE 6ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS (7 Lecture Hours) Power tariff types, Load distribution parameters, load curve, energy audit. Comparison of site selection criteria, relative merits and demerits, Capital and operating cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.

Text Books:
1. S. C. Arora, and S. Domkundwar, “A course in power plant engineering”,DhanpatRai& Sons, 2005.
2. P. K.Nag, "Power Plant Engineering", Tata McGraw – Hill Publishing Company Ltd., 2008.

References Books:
1. M. M. E. L. Wakil, “Power Plant Technology”, McGraw Hill, 2002.
2. R. K. Rajput, “Power Plant Engineering”, Laxmi Publications (P) Ltd., 2016.

18ME2048	PRODUCT DESIGN AND DEVELOPMENT STRATEGIES	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Basic concepts of product design, product features and its architecture.
2. Applicability of product design and development in industrial applications
3. Key reasons for design or redesign.

Course Outcome: After completing the course the student will be able to

1. Select an appropriate product design and development process.
2. Understand the integration of customer requirements in product design.
3. Select appropriate creative thinking method.
4. Apply suitable approach to various decision making methods.
5. Understand various aspects of design such as product architecture.
6. Develop the methods to minimize the cost.

MODULE 1 – INTRODUCTION TO PRODUCT DESIGN (8 Lecture Hours)

Need for developing products – the importance of engineering design – types of design –the design process – relevance of product lifecycle issues in design –designing to codes and standards- societal considerations in engineering design –generic product development process – various phases of product development-planning for products –establishing markets- market segments- relevance of market research.

MODULE 2 – CUSTOMER NEEDS (8 Lecture Hours)

Identifying customer needs – voice of customer – customer populations- hierarchy of human needs - need gathering methods – affinity diagrams – needs importance - establishing engineering characteristics - competitive benchmarking - quality function deployment - house of quality- product design specification - case studies.

MODULE 3 – CREATIVE THINKING (8 Lecture Hours)

Creative thinking –creativity and problem solving- creative thinking methods- generating design concepts-systematic methods for designing –functional decomposition – physical decomposition – functional representation –morphological methods-TRIZ- axiomatic design.

MODULE 4 – DECISION MAKING (7 Lecture Hours)

Decision making –decision theory –utility theory –decision trees –concept of evaluation methods –Pugh concept selection method- weighted decision matrix –analytic hierarchy process.

MODULE 5 – PRODUCT ARCHITECTURE (7 Lecture Hours)

Introduction to embodiment design –product architecture – types of modular architecture –steps in developing product architecture

MODULE 6 – DESIGN AND COST ANALYSIS (7 Lecture Hours)

Industrial design – human factors design –user friendly design – design for serviceability – design for environment – prototyping and testing – cost evaluation –categories of cost – overhead costs – activity based costing –methods of developing cost estimates – manufacturing cost –value analysis in costing.

Text Books:

1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development ", 4th Edition, Tata McGraw-Hill Education. 2009.
2. George E.Dieter, Linda C.Schmidt, "Engineering Design", McGraw-Hill International Edition, 4th Edition, 2009.

Reference Books:

1. Kevin Otto, Kristin Wood, "Product Design", Indian Reprint, Pearson Education 2015
2. Yousef Haik, T. M. M. Shahin, "Engineering Design Process", 2nd Edition Reprint, Cengage Learning, 2010.
3. David A. Madsen, 'Engineering Drawing and Design', Delmar Thomson Learning Inc. 2002.

18ME2049	COMPOSITE MATERIALS	L T P C 3 0 0 3

Objectives: To impart knowledge on

1. Composite materials and their applications.
2. Fabrication, analysis, and design of composite materials and structures.
3. Prediction of the mechanical response of multi layered materials and structures.

Course Outcomes: After completing the course the student will be able to

1. Evaluate the properties of composites
2. Predict the properties of fiber reinforced composite materials.
3. Design a composite laminate for a given load condition.
4. Know the environmental effects of different composites.
5. Analyze the stresses using laminated plate theories.
6. Compare and contrast various processing techniques for MMCs.

MODULE 1 INTRODUCTION TO COMPOSITES (7 Lecture Hours)

General Characteristics, applications, Fibers- Glass, Carbon, Ceramic and Aramid fibers. Matrices- polymer, Graphite, Ceramic and Metal Matrices. Characteristics of fibers and matrices, Smart Materials- type and Characteristics. Characteristics of fiber-reinforced lamina laminates-inter laminar stresses – Static Mechanical properties- Fatigue and Impact properties.

MODULE 2 ENVIRONMENTAL EFFECTS (7 Lecture Hours)

Environmental Effects - Fracture behavior and Damage Tolerance. Composite Manufacturing processes. Quality Inspection methods.

MODULE 3 CERAMIC MATRIX COMPOSITES(7 Lecture Hours)

Ceramic Matrix Composites: Fundamentals and Properties, Types of Composites. Definition of Engineering Properties, Force Deflection Relationship in a Composite Laminate Powder Processing, Chemical Vapour Infiltration , Lanxide, In-situ Process and Ceramic Matrix Composites: Processing and Post Processing.

MODULE 4 MECHANICS AND PERFORMANCE (7 Lecture Hours)

Stress analysis of laminated Composite beams, plates, shells- vibration and stability. Characterization of composite products – laminate design consideration- bolted and bonded joints design examples- failure mode Predictions.

MODULE 5 POLYMER MATRIX COMPOSITES (8 Lecture Hours)

PMC processes - Hand layup processes – Spray up processes – Compression moulding, Injection moulding, Reinforced reaction injection moulding - Resin transfer moulding – Pultrusion – Filament winding. Fibre reinforced plastics (FRP), natural and Glass fibre reinforced plastics. Introduction to Biocomposites.

MODULE 6 METAL MATRIX COMPOSITES (8 Lecture Hours)

Characteristics of MMC, Various types of Metal matrix composites Alloy vs. MMC, Advantages of MMC, Limitations of MMC, Metal Matrix composite , hybrid composites, laminar composites, smart composites, , Reinforcements – particles – fibres. Effect of reinforcement - Volume fraction – Rule of mixtures. Processing of MMC – Powder metallurgy process - diffusion bonding – stir casting – squeeze casting.

Text Books:

1. Mallick, P.K., "Fiber- Reinforced composites: Materials, Manufacturing and Design"Maneel Dekker inc. 2004.
2. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of fiber composites", John Wiley and Sons, New York, 2011.

Reference Books:

1. Halpin, J. C., "Primer on Composite Materials, Analysis" Techomic Publishing Co., 2009
2. Mallick, P.K. and Newman, S., " Composite Materials Technology: Processes and Properties", Hansen Publisher, Munish, 2012.
3. Williams D, Callister" Material Science and Engineering" John Wiley & sons inc. 2015.
4. Handbook on composites materials ASM handbook on composites

18ME2050	FINITE ELEMENT ANALYSIS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Concepts of mathematical modeling of engineering problems
2. Finite element and the finite element procedure for 1-D, 2-D and 3-D elements.
3. Higher order elements and Iso-parametric element formulation problems.

Course Outcome: After completing the course the student will be able to

1. Outline the various FE techniques used for different applications and problems.
2. Reproduce conservation of energy principle, variational principle and methods of weighted residual for developing finite element models
3. Develop the shape function, strain displacement-relation, stiffness matrix and consistent load vector for structural members.
4. Analyze scalar and vector variable problems for 2-D elements
5. Formulate and construct the shape function for an iso-parametric element.
6. Choose appropriate GDE for the thermal and fluid flow problems and solve them.

MODULE 1 INTRODUCTION TO MATHEMATICAL MODELLING AND FEA (8 Lecture Hours)

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – -Discrete and continuous models – Boundary, Initial and Eigen Value problems–Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Rayleigh Ritz Technique

MODULE 2 ONE DIMENSIONAL PROBLEMS (8 Lecture Hours) FEA Process– Discretization – Element types- One Dimensional Second Order Equations- Linear and Higher order Elements – Boundary Conditions- aspect ratio- Pascal's Triangle- Derivation of Shape functions and Stiffness matrices and force vectors for spar and beam elements- Assembly of Matrices - Solution of structural problems- Global, local and natural coordinate systems

MODULE 3 2-D SCALAR VARIABLE PROBLEMS (8 Lecture Hours)

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems – Quadrilateral elements- Convergence and Continuous criteria- Area Coordinate system

MODULE 4 2-D VECTOR VARIABLE PROBLEMS (7 Lecture Hours)

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements

MODULE 5 HIGHER ORDER ELEMENTS (7 Lecture Hours)

Introduction to Higher Order Elements- Shape Function for Quadratic Element- Shape Function for Cubic Element- Natural Coordinate system- Isoparametric elements- Legrangean elements- Serendipity Element- Numerical integration and application to plane stress problems

MODULE 6 THERMAL AND FLOW ANALYSIS IN FEA (7 Lecture Hours)

Derivation of general differential equation- 1-D Heat transfer- with convection- Problems- Heat transfer in composite materials- formulation of thermal stress problem- Fluid flow- derivation of basic differential equation- Incompressible fluid flow- Problems

Text Books:

1. Reddy. J.N., "An Introduction to the Finite Element Method", 3rd Edition, Tata McGraw-Hill, 2005
2. Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.

Reference Books:

1. Robert D.Cook, e tal, " Concepts and Applications of Finite Element Analysis", John Wiley & Sons, Inc. Singapore, 2007.
2. Bathe. K.J., "Finite Element Procedure", Prentice Hall of India, New Delhi, 2006.

3. Zienkiewicz O. C., Robert Leroy Taylor., "The Finite Element Method Vol. 1 & 2", McGraw Hill Book Company, New York, 2005.
4. Tirupathi, R.Chandrupatla and Ashok, D. Belegundu., "Introduction to Finite Elements in Engineering", Prentice Hall of India Private Limited., New Delhi, 2004.
5. Rajasekaran, S., "Finite Element Methods in Engineering Design", S.Chand& Co Ltd., NewDelhi, 2003.
6. Mukhopadhyay, M., "Matrix, Finite Element Computer and Structural Analysis", Oxford & IBH publishing Co., Pvt. Ltd. New Delhi, 1993.

18ME2051	PRINCIPLES OF MECHANICAL VIBRATIONS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. Formulating mathematical model for vibration problems
2. Analyzing the vibration behavior of mechanical systems subjected to loading
3. Measurement of vibration and the equipments used for collecting response data.

Course Outcomes: After completing the course the student will be able to
1. Classify the systems of vibration and formulate equations of motion for vibratory systems.
2. Solve vibration problems with multiple degrees of freedom.
3. Suggest methods to control vibration
4. Perform vibration tests and acquire data from vibration measuring instruments.
5. Present the theoretical and the experimental principles of mechanical vibrations to gain practical understanding in the field of vibration
6. Recognize unwanted noise in machines and proficient with instrumentation used in noise control tests

MODULE 1 VIBRATION OF SINGLE DEGREE OF FREEDOM SYSTEM (8 Lecture Hours)
Introduction – Equation of motion – Newton’s law, Energy methods – free vibration – forced vibration – damping models – Solutions of problems for one degree of freedom systems for transient and harmonic response – Vibration isolation and transmissibility.

MODULE 2 VIBRATION OF TWO AND MULTI DEGREE FREEDOM SYSTEMS (8 Lecture Hours)
Equations of motion for Two Degree of freedom systems – generalized coordinates – dynamic vibration absorber – semi definite systems – Multi degree of freedom system

MODULE 3 NUMERICAL METHODS TO SOLVE VIBRATION PROBLEMS (8 Lecture Hours)
Numerical methods in vibration problems to calculate natural frequencies – Matrix iteration technique – Stodola’s method, Holzer’smethod.Introduction to smart materials for vibration control.

MODULE 4 ENGINEERING ACOUSTICS (7 Lecture Hours)
Basic physical acoustics – acoustic levels and spectra – decibels, sound power, Sound pressure, power and intensity – Character of noise – Addition of two noise sources – Noise source identification. Noise radiation from vibrating bodies sound – properties of the various sources that create noise – Noise in machines and machine elements.

MODULE 5 EXPERIMENTAL METHODS IN TESTING VIBRATION (7 Lecture Hours)
Vibration instruments – vibration exciters – measuring devices – analysis – vibration Tests – Free, forced environmental vibration tests – Modal and FFT analysis- Spectrum Analyzers and Band pass filter- Filters, Amplifiers, Modulators/Demodulators, ADC/DAC. Energy harvesting methods using vibrations.

MODULE 6 NOISE MEASUREMENT AND STANDARDS (7 Lecture Hours)
Introduction to Acoustic Standards- Acoustic and Noise sensors, instrumentation- measurement and noise control instruments- noise propagation.

Text books:

1. Singiresu S. Rao, “Mechanical Vibrations”, Addison Wesley Longman, 2016.

2. Ambekar A.G., “Mechanical Vibrations and Noise Engineering”, Prentice Hall of India, New Delhi, 2006.

Reference books:

1. Benson H Tongue, “Principles of vibration, 2nd Edition, Oxford University Press, 2002.
2. Thomson W.T., “Theory of Vibration with Applications”, CBS Publishers and Distributers, New Delhi, 2014.
3. Kelly, “Fundamentals of Mechanical Vibrations”, McGraw Hill Publications, 2000.
4. Rao V. Dukkipati, J. Srinivas, “Vibrations Problem Solving Companion”, Narosa Publishers, 2007.
5. KewalPujara. “Vibrations and Noise for Engineers”, DhanpatRai& Co, 4th Edition, 2007.

18ME2052	**DESIGN FOR MANUFACTURING AND ASSEMBLY**	**L T P C** **3 0 0 3**

Course Objectives: To impart knowledge on

1. Various factors influencing the manufacturability of components and the use of tolerances in manufacturing
2. Application of various forging, casting, welding and machining Processes
3. Various assembly methods and design for assembly guidelines

Course Outcome: After completing the course the student will be able to

1. Perform designing of components considering manufacture ability.
2. Apply design concepts for manufacturing, assembly.
3. Design the components suitable for various manufacturing process such casting and welding.
4. Design the components suitable for various manufacturing process such forging and machining.
5. Describe how a product can be designed for the ease of manufacturing and assembly.
6. Apply the principles of design for assembly.

MODULE 1 INTRODUCTION TO DFM (8 Lecture Hours)

Significance of design, Design factors, The basic design - Factors influencing choice of materials and manufacturing; Process capability mean, Median, Variance mode, Standard deviation, Normal distribution; Process capability; Tolerance – symbols and definitions

MODULE 2 FORM DESIGN - CASTING (8 Lecture Hours)

Influence of loading, Materials, Production methods on form design; Casting considerations, Grey iron castings; Steel castings, Aluminum casting requirements and rules for casting; Form design of pressure die castings

MODULE 3 FORM DESIGN - WELDING (8 Lecture Hours)

Welding considerations, welding processes; Requirements and rules for welding; Redesign of components for casting-pattern-mold, Parting Line; Redesign of components for welding; Case studies in form design-simple problems in form design.

MODULE 4 FORM DESIGN - FORGING (7 Lecture Hours)

Forging considerations hammer forging drop forging; Requirements and rules for forging; Choice between casting, forging and welding; Redesign of components for Forging.

MODULE 5 FORM DESIGN - MACHINING (7 Lecture Hours)

Machining considerations Drills, Milling-Keyways Dwells and Dwelling Procedure, Countersunk Head screws; Requirements and rules for Machining considerations and Reduction of machined areas; Redesign of components for Machining; Simplification by separation and Simplification by amalgamation.

MODULE 6 DESIGN FOR ASSEMBLY (7 Lecture Hours)

DFA; Factors Determining assembly methods and processes; Product Design factors independent of methods and processes; Assembly Precedence, Standardization; Design factors dependent on Assembly methods , Introduction-Single Station Assembly; Line Assembly, Hybrid Systems, Manual Assembly Lines, Flexible Assembly Lines; Design factors dependent on Assembly processes, Factors influencing Production rate to Facility Ratio ,Parts Presentation, Manual Assembly.

Text Books:

1. George E. Dieter, "Engineering Design: A Materials and Processing Approach", 3rd ed., 2000 McGraw-Hill
2. Geoffrey Boothroyd, Peter Dewhurst, Winston A Knight, "Product Design for Manufacture and Assembly", CRC Press, Taylor and Francis group, 2010

Reference Books:

1. Chitale.A.K., Gupta.R.C., " Product Design and Manufacturing, Prentice Hall of India, 2007
2. Robert Matousek, "Engineering Design A Systematic Approach", Blackie &sons Ltd.,2007.
3. David.M.Anderson, "Design for Manufacturability and concurrent Engineering", CIM Press, 2004
4. Harry Peck., "Design for Manufacture", Pittman Publications,2017.
5. James G. Bralla, "Hand Book of Product design for Manufacturing", McGraw Hill Co., 1999.

18ME2053	TRIBOLOGY	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Application of basic theories of friction, wear and lubrication.
2. Frictional behavior of commonly encountered sliding interfaces.
3. Various testing methods for tribological properties.

Course Outcomes: After completing the course the student will be able to

1. Apply concepts of friction mechanisms and analyze performance of design components based on relative motion.
2. Identify wear mechanism on macro-scale in metals.
3. Select lubricants based on the applications.
4. Outline the methods to improve surface engineering.
5. Generate performance reports of the lubrications using tribo testing methods.
6. Understand the fundamentals of tribology and associated parameters.

MODULE 1 FRICTION (8 Lecture Hours)

Friction – Adhesion – Ploughing – Energy dissipation mechanisms Friction Characteristics of metals – Friction of non-metals. Friction of lamellar solids – friction of Ceramic materials and polymers – Rolling Friction – Source of Rolling Friction – Stick slip motion – Measurement of Friction.

MODULE 2 WEAR (8 Lecture Hours)

Types of wear – Simple theory of Sliding Wear Mechanism of sliding wear of metals – Abrasive wear – Materials for Adhesive and Abrasive wear situations – Corrosive wear – Surface Fatigue wear situations – Brittle Fracture – wear – Wear of Ceramics and Polymers – Wear Measurements.

MODULE 3 LUBRICANTS, FILM LUBRICATION THEORY AND LUBRICATION TYPES (8 Lecture Hours)

Types and properties of – Hydrodynamic Lubrication – Elasto–hydrodynamic lubrication – Boundary Lubrication – Solid Lubrication– Hydrostatic Lubrication. Fluid film in simple shear – Viscous flow between very close parallel plates – Shear stress variation Reynolds Equation for film Lubrication – High speed unloaded journal bearings – Loaded journal bearings – Reaction torque on the bearings – Virtual Co–efficient of friction.

MODULE 4 SURFACE ENGINEERING (8 Lecture Hours)

Topography of Engineering surfaces – Contact between surfaces – Sources of sliding Surface modifications – Thermo chemical processes – Surface coatings and treatments – Plating and anodizing – Fusion Processes – Vapour Phase processes – Materials for marginally lubricated and dry bearings. Wear and friction resistant materials.

MODULE 5 DYNAMIC TRIBOLOGY (7 Lecture Hours)

Dynamic testing machines and test methods, dry sand–rubber wheel test.

MODULE 6Experimental METHODS (7 Lecture Hours)

Wet sand rubber wheel test, slurry abrasivity test, solid particle erosion test, pin–on–disk wear test, rolling wear test, drum wear test, drill wear test. Four ball tribo test, Lubricants – Testing methods and standards.

Text books:

1. PrasantaSahoo, “Engineering Tribology”, Prentice Hall of India, 2005.
2. Sushil Kumar Srivastava, “Tribology in Industries”, S. Chand Publishers, 2005.

Reference books:

1. Stachowiak G. W. and Batchelor A. W., Engineering Tribology, 3rd Edition (Indian), Butterworth-Heinnmann (Elsevier), 2010.
2. Cameron, "Basic Lubrication Theory", Longman, U.K., 2011.
3. B. Bhushan, “Principles and Application of Tribology”, Wiley, 2013.

18ME2054	DESIGN OF JIGS, FIXTURES AND PRESS TOOLS	L T P C 3 0 0 3

Course objectives: To impart knowledge on

1. Use of standard parts in design
2. Develop proficiency in the development of jigs and fixtures
3. Use design principles to design jigs and fixtures and press tools

Course Outcomes: After completing the course the student will be able to

1. Understand the principles of location, clamping and mechanical actuation.
2. Develop jigs and fixtures for different operations.
3. Adopt standard procedure for the design of jigs, fixtures.
4. Analyze tolerances and specify appropriate tolerances for the design of jigs and fixtures and dies.
5. Design and develop bending, forming and drawing dies.
6. Apply recent developments in tool design.

MODULE 1LOCATING AND CLAMPING PRINCIPLES (**7 Lecture Hours)** Objectives of tool design – Function and advantages of jigs and fixtures- Basic elements- principles of location- Locating methods and devices – Redundant location – Principles of clamping – Mechanical actuation- Standard parts – Drill bushes and jigs buttons – Tolerances and materials used. Tool materials and ceramic tools.

MODULE 2JIGS (8 Lecture Hours)

Design of jigs for given component – Types of jigs – Post, Turnover, Channel, latch, box, angular post jigs.

MODULE 3FIXTURES (7 Lecture Hours)

General principles of milling, lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixture systems – Quick change fixtures.

MODULE 4 PRESS WORKING TOOLS (8 Lecture Hours)

Press working terminologies – operations – Types of presses – press accessories – Computation of press capacity – Strip layout – Material Utilization – Shearing action- Clearances - Press work materials – Center of pressure – Design of various elements of dies – Die Block – Punch holder, Die set, guide plates – Stops – Strippers – Pilots –Selection of standard parts.

MODULE 5 BENDING, FORMING AND DRAWING DIES (7 Lecture Hours)

Difference between bending, forming and drawing – Blank development for above operation – Types of Bending dies – Press capacity – Spring back – knockout –direct and indirect – pressure pads – Ejectors – Variables affecting metal flow in drawing operations – draw die inserts – draw beads – ironing – Design and development of bending, forming and drawing dies.

MODULE 6 ADVANCED PRESS TOOLS (7 Lecture Hours)

Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine blanking dies – recent trends in tool design – computer aided sheet metal forming. Tools for high velocity forming and pressure die casting.

Text Books:

1. Joshi P.H. “ Jigs and Fixtures”, Tata McGraw Hill Publishing Co., Ltd., 2004.
2. Donaldson, Lecain and Goold, “Tool Design”, Tata McGraw Hill, 2012.

Reference Books:

1. K.Venkataraman, “ Design of Jigs and Fixtures & Press Tools”, Tata McGraw Hill, 2005.

2. Hoffman, "Jigs and Fixture Design", Thomson Delmar Learning, Singpore, 2004.
3. Design Data Hand Book, PSG College of Technology, Coimbatore, 2012.
4. V.Balachandran, "Design of Jigs and Fixtures and Press tools", Notion Press, 2015.

18ME2055	COMPUTER AIDED DESIGN	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. Various computer aided design tools for industrial applications.
2. Graphical entities of CAD.
3. Application of computers in manufacturing sectors.

Course Outcome: After completing the course the student will be able to
1. Demonstrate the basic structure and components of CAD.
2. Outline the process of representing graphical entities in a CAD environment.
3. Construct the geometric model using different techniques to represent a product.
4. Illustrate various techniques and devices involved in CAD hardware.
5. Analyze the models for design solutions using FEM.
6. Discuss the various computer aided tools implemented in various industrial applications.

MODULE 1 INTRODUCTION (7 Lecture Hours)
Introduction to CAD, Scope and applications in mechanical engineering, Need for CAD system, use ofcomputer, Computer fundamentals, Computer aided design process, CAD configuration, CAD tools,advantages and limitations in CAD, CAD Standards – IGES, GKS and PDES, CAD/ CAM integration.

MODULE 2 COMPUTER GRAPHICS (8 Lecture Hours)
Computer Graphics Display and Algorithms: Graphics Displays, DDA Algorithm – Bresenham's Algorithm – Coordinate systems – Transformation of geometry – Translation, Rotation, Scaling, Reflection, Homogeneous Transformations – 2D and 3D Transformations – Concatenation – line drawing-Clipping and Hidden line removal algorithms – viewing transformations.

MODULE 3 GEOMETRIC MODELLING (8 Lecture Hours)
Wireframe models and entities – Curve representation – parametric representation of analytic curves – circles and conics – Hermite curve – Bezier curve – B-spline curves – rational curves. Surface Modeling– Surface models and entities – Parametric representation of analytic surfaces – Plane surfaces –Synthetic surfaces – Bicubic Surface and Bezier surface and B-Spline surfaces. Solid Modeling – Models and Entities – Fundamentals of solid modelling – B-Rep, CSG and ASM

MODULE 4 CAD HARDWARE (8 Lecture Hours)
Introduction to hardware specific to CAD, Product cycle, CRT, Random scan technique, raster scan technique, CAD specific I/O devices, DVST, Raster display, Display systems, sequential scanning andinterlaced scan.

MODULE 5 FINITE ELEMENT METHOD (7 Lecture Hours)
Introduction to FEM, Principle of minimum potential energy, steps involved in FEM, discretization, types of nodes and elements, elemental stiffness matrix, elemental strain displacement matrix, types offorce, elemental force matrix, assembly, shape function, introduction to 2 dimensional FEM.

MODULE 6 OPTIMIZATION AND NEW TECHNIQUES OF CAD (7 Lecture Hours)
Introduction to Optimization, Johnson method of optimization, normal specification problem, redundant specification problem, introduction to genetic algorithm. New Techniques: RPT, laser and non- laser process of RPT, STL format to CAD file, Introduction to reverse engineering and related softwares, rapid form.

Text Books:
1. Ibrahim Zeid, "CAD - CAM Theory and Practice", Tata McGraw Hill Publishing Co. Ltd., 2009.
2. Rao. S.S. "The Finite Element Method in Engineering", 2nd Edition, Pergamon Press, Oxford, 2009.

Reference Books:
1. Kunwoo Lee, "Principles of CAD/CAM/CAE Systems", Addison Wesley, 2005.

2. P.N. Rao, “CAD/CAM Principles and Applications", Tata McGraw Hill Publishing Co. Ltd., 2010.
3. Bathe K.J., “Finite Element Procedures”, K.J. Bathe, Watertown, MA, Fourth edition, 2016.

18ME2056	MICRO AND NANO MACHINING	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. Different techniques used in micro and nano manufacturing.
2. Conventional techniques used in micro manufacturing
3. Non-conventional micro-nano manufacturing and finishing approaches

Course Outcome: After completing the course the student will be able to
1. Understand different techniques used in micro and nano manufacturing.
2. Summarize conventional techniques used in micro manufacturing.
3. Explain about non-conventional micro-nano manufacturing and finishing approaches.
4. Demonstrate micro and nano finishing processes.
5. Understand micro and nanofabrication techniques and other processing routes in micro and nano manufacturing.
6. Analyze different techniques used in micro joining and the metrology tools in micro and nano manufacturing

MODULE 1 INTRODUCTION TO PRECISION ENGINEERING (8 Lecture Hours)

Precision engineering, macro milling and micro drilling, Micro-electromechanical systems – merits and applications, Micro phenomenon in Electro-photography – applications

Introduction to Bulk micromachining, Surface micromachining- steps, Micro instrumentation – applications, Micro Mechatronics, Nano finishing – finishing operations. Laser technology in micro manufacturing- Practical Lasers, application of technology fundamentals Introduction to Micro-energy and chemical system (MECS), Space Micro-propulsion, e-Beam Nanolithography – important techniques, Introduction to Nanotechnology Carbon Nano-tubes – properties and structures, Molecular Logic Gates and Nano level Biosensors - applications

MODULE 2 MICROMACHINING (8 Lecture Hours)

Introduction to mechanical micromachining, Micro drilling – process, tools and applications

Micro turning- process, tools and applications, Diamond Micro turning – process, tools and applications. Micro milling and Micro grinding – process, tools and applications. Micro extrusion-process and applications, micro bending with Laser . Nano- Plastic forming and Roller Imprinting

MODULE 3 NON-CONVENTIONAL MICRO-NANO MANUFACTURING (8 Lecture Hours)

Introduction to Non-conventional micro-nano manufacturing. Process, principle and applications – Abrasive Jet Micro Machining, WAJMM . Micro EDM, Micro WEDM, Micro EBM – Process principle, description and applications Micro ECM, Micro LBM - Process principle, description and applications .Focused ion beams - Principle and applications. Laser machining, engraving and hardening.

MODULE 4 MICRO AND NANO FINISHING PROCESSES(7 Lecture Hours)

Introduction. Magneto rheological Finishing (MRF) processes, Magneto rheological abrasive flow finishing processes (MRAFF) – process principle and applications. Force analysis of MRAFF process, Magneto rheological Jet finishing processes. Working principle and polishing performance of MR Jet Machine, Elastic Emission Machining (EEM) – machine description, applications. Ion Beam Machining (IBM) – principle, mechanism of material removal, applications, Chemical Mechanical Polishing (CMP) – Schematic diagram, principle and applications

MODULE 5 MICRO FABRICATION – (7 Lecture Hours)

Introduction to Micro Fabrication: basics, flowchart, basic chip making processes Introduction to Nanofabrication, Nanofabrication using soft lithography – principle, applications – Examples (Field Effect Transistor, Elastic Stamp) Manipulative techniques – process principle, applications

Introduction to Carbon nano materials – CN Tubes– properties and applications CN Tube Transistors – Description only Diamond - Properties and applications CVD Diamond Technology LIGA Processes .

MODULE 6 – LASER MICRO WELDING (7 Lecture Hours)
Laser Micro welding – description and applications, Defects Electron Beam Micro-welding – description and applications Introduction to micro and nano measurement, defining the scale, uncertainty Scanning Electron Microscopy – description, principle Scanning White-light Interferometry – Principle and application Optical Microscopy – description, application Scanning Probe Microscopy, scanning tunneling microscopy- description, application Confocal Microscopy - description, application Introduction to On-Machine Metrology

Text Books:
1. Mark. J. Jackson, Micro and Nano-manufacturing, Springer, 2006.
2. Mark. J. Jackson, Micro-fabrication and Nano-manufacturing - Pulsed water drop micromachining CRC Press 2006.

Reference Books:
1. Nitaigour Premchand Mahalik, Micro-manufacturing and Nanotechnology, 2006.
2. V.K.Jain, Micro-manufacturing Processes, CRC Press, 2012.

18ME2057	**WELDING TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives: To impart knowledge on
1. Conventional fusion welding and solid state welding processes
2. Modern welding techniques based on the power source
3. Design of weld joints, weldability and testing of weldments

Course Outcomes: After completing the course the student will be able to
1. Summarize different welding processes and its applications.
2. Suggest welding processes for ferrous and non-ferrous alloys.
3. Enumerate the various applications, advantages and types of welding processes.
4. Adapt different types of welding process for effective welding of structural components and complex shapes.
5. Design welding joints & test weldments for its quality.
6. Relate the principles of metallurgy during the welding process.

MODULE 1 FUSION WELDING PROCESSES (8 Lecture Hours)
Air Acetylene welding, Oxyacetylene welding, Carbon arc welding, Shielded metal arc welding, Submerged arc welding, Gas Tungsten Arc Welding, Gas Metal Arc Welding, Plasma arc welding and Electro slag welding processes – Fundamental, principles, advantages, limitations and applications. Dissimilar materials welding.

MODULE 2 SOLID STATE WELDING PROCESSES (8 Lecture Hours)
Spot welding, Seam welding, Projection welding, Resistance Butt welding, Flash Butt welding, Percussion welding and High frequency resistance welding processes – Fundamental, principles, advantages, limitations and applications.

MODULE 3 NON-CONVENTIONAL WELDING PROCESSES (8 Lecture Hours)
Cold welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction welding, Forge welding, Roll welding and Hot pressure welding processes, Thermit Welding – Fundamental, principles, advantages, limitations and applications.

MODULE 4 MODERN WELDING PROCESSES (7 Lecture Hours)
Atomic hydrogen welding, Electron beam welding, Laser Beam welding, Friction stir welding, Under Water welding, Welding automation in aerospace, nuclear and surface transport vehicles.

MODULE 5 DESIGN AND TESTING OF WELDMENTS (7 Lecture Hours)
Various weld joint designs – Weldability of Aluminum, Copper, and Stainless steels. Destructive and non–destructive testing of weldments.

MODULE 6 WELDING METALLURGY (7 Lecture Hours)
Physical metallurgy of welding, various zones in weldments, Effect of temperature on metals, Metallurgical defects associated with welding process – causes and remedies.

Text books:

1. R.S Parmer, "Welding Engineering and Technology", 2nd Edition, Khanna Publishers, 2013.
2. R.L Little, "Welding and Welding Technology", Tata McGraw Hill Publishers, 34th Reprint, 2008.

Reference books:

1. M.M. Schwartz, "Metals Joining Manual", McGraw Hill Books, 2003.
2. R.F. Tylecote, "The Solid Phase Welding of Metals", Edward Arnold Publishers Ltd. London, 2003.
3. AWS – Welding Hand Book. "Welding Process" Vol. 2. 2001.
4. S.V Nadkarni. "Modern Arc Welding Technology", 1st Edition, Oxford IBH Publishers, 2005.
5. Christopher Davis. "Laser Welding – Practical Guide", Jaico Publishing House, 2003.
6. A.C. Davis, "The Science and Practice of Welding", Cambridge University Press, Cambridge,2001.

18ME2058	**MECHATRONICS SYSTEM**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives: To impart knowledge on

1. Structure of microprocessors and their applications in mechanical devices
2. Principle of automatic control and real time motion control systems, with the help of electrical drives and actuators
3. Micro-sensors and their applications in various fields

Course Outcome: After completing the course the student will be able to

1. Summarize and recall the overview of mechatronics applications.
2. Demonstrate knowledge of electrical circuits and logic design.
3. Develop and formulate engineering solutions and techniques to solve design problems.
4. Design mechatronic components and systems.
5. Classify and Select various micro-sensors and microprocessors for a specific problem.
6. Develop PLC programs for a given task.

MODULE 1 INTRODUCTION TO MECHATRONICS (8 Lecture Hours)

Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man-Machine Interface.

MODULE 2 SENSORS AND TRANSDUCERS (7 Lecture Hours)

Classification, Development in Transducer technology, Optoelectronics- Shaft encoders, CD Sensors, Vision System.

MODULE 3 DRIVES AND ACTUATORS (8 Lecture Hours)

Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control; Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems.

MODULE 4 SMART MATERIALS (7 Lecture Hours)

Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation.

MODULE 5 MICROMECHATRONIC SYSTEMS (8 Lecture Hours)

Micro sensors, Micro actuators. Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc. Application examples; Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology.

MODULE 6 PROGRAMMABLE LOGIC CONTROLLER (7 Lecture Hours)

Introduction – Architecture – Input / Output Processing – LD Programming with Timers, Counters and Internal relays – Data Handling – Selection of PLC.

Text Books:

1. William Bolton, "Mechatronics: A Multidisciplinary Approach", Pearson Education, 2012.
2. Devdas Shetty & Richard Kolk "Mechatronics System Design", 3rd edition. PWS Publishing, 2009.

Reference Books:

1. R.K.Rajput, “A Textbook of Mechatronics”, S. Chand & Company Private Limited 2014.
2. William Bolton, “Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering”, Prentice Hall, 2015
3. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Penram International Publishing Private Limited, 6th Edition, 2015.
4. NitaigourPremchandMahalik, “Mechatronics Principles, Concepts and Applications”, McGraw Hill Education, 2015.
5. Alciatore David G &Histand Michael B, “Introduction to Mechatronics and Measurement systems”, 4th edition, Tata McGraw Hill, 2006.

18ME2059	**METAL CUTTING THEORY AND PRACTICES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives: To impart knowledge on

1. Fundamentals of chip formation, metal cutting theories and nomenclature of cutting tools.
2. Measurement of cutting force, cutting temperature and application of cutting fluids.
3. Mechanisms of tool wear, Tool life and chatter during machining.

Course Outcome: After completing the course, the student will be able to

1. Understand mechanism and theories of metal cutting and implement it during machining.
2. Select the appropriate cutting tool based on the operation to be done.
3. Understand thermal characteristics and controlling the heat distribution in machining.
4. Analyze tool materials and prolonging the tool life.
5. Measure cutting forces during metal cutting processes.
6. Identify and analyse the tool wear, vibration and chatter.

MODULE 1 METAL CUTTING FUNDAMENTALS (8 Lecture Hours)

Basic mechanism of chip formation-types of chips-Chip Breaker-Orthogonal Vs Oblique cutting- force and velocity relationship and expression for shear plane angle in orthogonal cutting-Energy Consideration in machining-Modern theories in Mechanics of cutting -Review of Merchant and Lee Shaffer Theories.

MODULE 2 TOOL NOMENCLATURE OF CUTTING TOOL (7 Lecture Hours)

Nomenclature of single point tool - Systems of tool Nomenclature and Conversion of rake angles - Nomenclature of multi point tools like drills, milling cutters and broaches.

MODULE 3 THERMAL ASPECTS OF MACHINING (8 Lecture Hours)

Thermodynamics of chip formation - Heat distributions in machining-Effects of various parameters on temperature - Method of temperature measurement in machining - Hot machining - cutting fluids, Surface finish and integrity

MODULE 4 TOOL MATERIALS AND TOOL LIFE (7 Lecture Hours)

Essential requirements of tool materials - Developments in tool materials, ceramic tools-Tool Coating-ISO specifications for inserts and tool holders-Tool life- Taylor’s tool life equation, optimum tool life - Conventional and accelerated tool life tests.

MODULE 5 CUTTING FORCES AND ECONOMICS OF MACHINING (8 Lecture Hours)

Forces in turning, drilling and milling - specific cutting pressure- measurement of cutting forces. Concepts of machinability and machinability index - Economics of machining, Machining Time – Estimation of machining time in different machining operations.

MODULE 6 TOOL WEAR MECHANISMS AND CHATTER IN MACHINING (7 Lecture Hours)

Reasons for failure of cutting tools and forms of wear-mechanisms of wear - chatter in machining - Factors effecting chatter in machining - types of chatters-Mechanism of chatter based on Force Vs Speed graph.

Text Books:

1. B.L. Juneja and G.S. Sekhon - “Fundamentals of metal cutting and machine tools", New Age International (p) Ltd., 2015.
2. M.C. Shaw, “Metal cutting Principles ", Oxford Clarendon Press, 2005

Reference Books:

1. Bhattacharya. - "Metal Cutting Theory and Practice ", new central Book Agency pvt. Ltd., Calcutta 2016.
2. Boothroy.D.G. and Knight. W.A "Fundamentals of Machining and Machine tools", Marcel Dekker, New York, 2001.
3. Stephenson, D. A., &Agapiou, J. S. Metal cutting theory and practice: CRC Taylor & Francis, 2016.

18ME2060	**INDUSTRIAL SAFETY ENGINEERING**	**L T P C** **3 0 0 3**

Course Objectives: To impart knowledge on

1. basic fundamentals of Safety Engineering and Management
2. recognition, investigation, analysis, and control of hazards
3. management's role in safety and assess the importance.

Course Outcome: After completing the course the student will be able to

1. understanding the importance of safety in process industries
2. Understanding the ethical issues that may arise from industrial processes.
3. Communicate the difference between Hazard and Risk.
4. Be able to express Safety in terms of Risk and to recognize unacceptable/inappropriate levels of Risk.
5. Be able to Assess & identify the potential hazards in process industries
6. Appreciation and applying safety procedures in a process industries.

MODULE 1 – SAFETY TRAINING (8 Lecture Hours)

Safety Procedures; Periodic Advice and checking to follow Safety Procedures & Rules; Proper selection and replacement of Handling Equipment; plant layout Personnel Safety and Protective Equipments; Occupational health and safety

MODULE 2 – MACHINE GUARDING (8 Lecture Hours)

Principles of Machine Guarding - Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding of hazards - point of operation protective devices

MODULE 3 – INDUSTRIAL ATMOSPHERIC CONTAMINANTS AND HEALTH HAZARDS (8 Lecture Hours)

Industrial Atmospheric Contaminants – Types. Industrial Health Hazards – Effects Of Pressure, Humidity, Temperature – Radiation, Light, Noise, Electricity – Accidents, Occupational Diseases, Infections.

MODULE 4INDUSTRIAL TOXICOLOGY AND INDUSTRIAL HYGIENE SURVEY (7 Lecture Hours)

Modes of Entry of Toxic Substances Into The Human Body – Long Term And Short Term Effects – Industrial Toxicology. Threshold Limit Values, Kinds Of Exposure Standards, Pollutant Concentrations, Industrial Hygiene Survey – Diagnosis – Remedial Measures

MODULE 5SAFETY AND RISK(7 Lecture Hours)

Effective steps to Implement Safety Procedures; Periodic Advice and checking to follow Safety Procedures & Rules; Proper selection and replacement of Handling Equipment; plant layout Personnel Safety and Protective Equipments; Occupational health and safety

MODULE 6INDUSTRIAL ILLUMINATION AND INDUSTRIAL PLANT SANITATION (7 Lecture Hours)

Industrial Illumination – Glare – Types & Levels Of Illumination. Industrial Plant Sanitation – Housekeeping – Worker Facilities.

Text Books:

1. Accident Prevention Manual, National Safety Council (NSC), Chicago, 1982.
2. Blake R.B., “Industrial Safety” Prentice Hall, Inc., New Jersey, 1973

Reference books:

1. 1 Heinrich H.W. “Industrial Accident Prevention” McGraw-Hill Company, New York, 1980.
2. Occupational safety Manual, BHEL, Trichy, 1988.

3. John V. Grimaldi and Rollin H. Simonds., Safety Management, All India Travelers Book seller, New Delhi, 1989.
4. N.V. Krishnan, Safety in Industry, JaicoPublishery House, 1996.
5. Indian Boiler Acts and Regulations, Government of India.
6. Safety in the use of wood working machines, HMSO, UK 1992.
7. Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.

18ME2061	INDUSTRIAL ENGINEERING	L T P C 3 0 0 3

Course objectives: To impart knowledge on

1. Work study for the improvement of productivity.
2. Planning and management of materials and operations in floor level and plan.
3. Modern Industrial engineering approaches.

Course Outcome: After completing the course the student will be able to

1. Apply work study techniques to improve working condition and productivity.
2. Design an industrial system to optimize various factors of production.
3. Analyze the past data for production planning and control.
4. Identify suitable plant layout to minimize material handling and to improve productivity.
5. Control quality of production using statistical process control and reliability tools.
6. Appraise the human and ergonomics impact on the modern industrial engineering approaches

MODULE 1 - WORK STUDY AND PRODUCTIVITY (8 Lecture Hours)

Introduction to industrial engineering – objectives and functional areas of Industrial engineering Method Study (Motion Study): Definition, objectives, micro motion study, therbligs, operation chart, flow process chart, man machine chart, SIMO chart. Time Study (Work measurement): uses of time study, procedure, standard time, performance rating, allowances, Methods of time study, Number of cycles to be timed. Productivity–Importance, Measurement of productivity, productivity indices, productivity improvement, Productivity bargaining

MODULE 2 - PRODUCTION PLANNING AND CONTROL (8 Lecture Hours)

Types of production – job, batch, mass and continuous production – Introduction to PPC, planning, Routing, scheduling, master schedule and subsidiary schedule, dispatching–functions, Follow up, control boards, idle machine time

MODULE 3 - PLANT LAYOUT (8 Lecture Hours)

Product layout, process layout, cellular manufacturing system, factors influencing layout. Factors governing flow pattern, travel chart, line balancing, work station design, tools and techniques for plant layout, advantages of scientific layout

MODULE 4 - QUALITY AND RELIABILITY ENGINEERING (7 Lecture Hours)

Statistical process control–variable control chart X–R chart – X–S chart – attribute control chart – C,P,U and np charts–process capability analysis – over view of 6 sigma – life testing – reliability – reliability of series parallel and mixed configuration.

MODULE 5 - MODERN MANAGEMENT (7 Lecture Hours)

Business process reengineering–need, steps and process of reengineering .supply chain management (SCM) –objectives and strategies of SCM, Just in Time (JIT) manufacturing, basic elements and benefits of JIT, Kanban system, Implementation of JIT, Human Resource Management.

MODULE 6 – Human factors and ergonomics (7 Lecture Hours)

Cognitive tasks, Physical Tasks - Analysis, design and operation,Human factors Audit, Design for Occupational Health and Safety, Human computer interface.

Text books:

1. MartandTelsang, “Industrial Engineering and Management”, S. Chand, 2014
2. T.R. Banga and Sharma, “Industrial Engineering and Management”, Khanna Publishers, 2010.
3. GavrielSalvendy,"Handbook of Industrial Engineering: Technology and Operations Management", Institute of Industrial Engineers, 3rd Edition, John Wiley & Sons, Inc. 2001.

Reference books:

1. M. Govindarajan and S. Natarajan, "Principles of Management", Prentice Hall of India Pvt. Ltd. New Delhi, 2007
2. George Kanawathi, "Introduction to Work Study", revised Edition, ILO, 2006.
3. S. Chandran, "Organizational Behaviors", Vikas Publishing House Pvt., Ltd, 2014.
4. Panneerselvam, "Production and Operations Management", PHI, 2013

18ME2062	MODERN VEHICLE TECHNOLOGY	L T P C 3 0 0 3

Course objectives: To impart knowledge on

1. Basic principles of engines used for automobiles and different systems.
2. Various transmission and drive line units of automobiles.
3. Importance of sensors and fuel injection systems.

Course Outcomes: After completing the course the student will be able to

1. Identify the importance and functions of vehicle chassis, components of IC Engines and cooling systems.
2. Describe the types of steering and suspension systems.
3. Demonstrate the functions of clutch and braking systems.
4. Recognize and select drives for transmission.
5. Summarize the working principles of sensors and actuators.
6. Express the functions and components of fuel injection and ignition systems.

MODULE 1 INDRODUTION (8 Lecture Hours)

Types of automobiles: Engine location – chassis layout – construction types, engine cylinder arrangements – Piston rings – Cylinder liners – Valves and Actuating mechanisms – Inlet and Exhaust manifolds. Self-driving car. Review of Fuel, Cooling & Lubrication systems.

MODULE 2 STEERING AND SUSPENSION (8 Lecture Hours)

Steering system: Principle of steering – Centre point steering – Steering linkages – Steering geometry and Wheel alignment – Power steering. Suspension system – need, types – independent suspension – coil and leaf springs – suspension systems for multi-axle vehicles.

MODULE 3BRAKES AND WHEEL (8 Lecture Hours)

Brakes: Need, Types – Mechanical, Hydraulic and Pneumatic Brakes – disc and drum types, their relative merits – details of components– Power brake**,** Antiskid brake, Antilock Braking System (ABS) & its operation. Wheels and tyres: Types and places of use – Tyre construction, specification – tyre wear and causes – wheel balancing.

MODULE 4 AUTOMOTIVE CLUTCH (7 Lecture Hours)

Clutches – Need, types – Single and Multiple Disc Clutches, Diaphragm Clutch, Centrifugal Clutch, Overrunning Clutch, Fluid Coupling, Torque Converters. Differential: need and types; Four wheel drive.

MODULE 5 AUTOMOTIVE TRANSMISSION (7 Lecture Hours)

Gear box: Need, types of gear transmission – sliding mesh, constant mesh and synchromesh gearboxes; Gearshift mechanisms; Epicyclic transmission. Universal joint – constant velocity joint – propeller shaft – Hotchkiss drive – Torque tube drive; Front and Rear axles: Types – stub axle.

MODULE 6 SENSORS AND ENGINE ELECTRONICS (7 Lecture Hours)

Types of sensors – vehicle position sensor, sensors for speed, throttle position, exhaust Oxygen Level, Manifold Pressure, Crankshaft Position, Coolant Temperature, Exhaust Temperature, Air-mass flow for engine application. Solenoids, Stepper-Motors, & Relay. Multi point fuel injection (MPFI), Gasoline Direct Injection (GDI); Common Rail Direct Injection (CRDI); Variable Timing Ignition (VTI), On-board Diagnostics; Electronically controlled Automatic Transmission System.

Text Books:

1. Kirpal Singh," Automobile Engineering" vol1 and vol2.Standard Publishers, 2011.
2. Ramalingam K.K., 'Automobile Engineering' SciTech Publications Pvt. Ltd., 2005.

References Books:

1. Robert Bosch, "Automotive Hand Book", SAE 9th Edition, 2014.

2. R.P.Sharma and M.L.Mathur: “A course in Internal Combustion Engines”, D.Rai& sons, 2016.
3. Bechhold, “Understanding Automotive Electronics”, SAE,2000.
4. Newton. K, Steeds.W, Garret.T.K. and Butterworth. ‘Motor Vehicle’, IE, 2003.
5. William B Riddens, “Understanding Automotive Electronics”, 5th Edition, Butterworth & Heinemann Woburn, 2006.

18ME2063	RAPID MANUFACTURING TECHNOLOGIES	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Basics of rapid prototyping/manufacturing technologies and systems and its applications in various fields.
2. Commercial rapid prototyping system models to perform activities such as part building, materials used etc.
3. Mechanical properties and geometric issues relating to specific rapid prototyping applications.

Course Outcome: After completing the course the student will be able to

1. Differentiate between conventional and rapid manufacturing approach.
2. Demonstrate the knowledge of Rapid Manufacturing technologies.
3. Understand the need and place for RP in an integrated manufacturing environment.
4. Get exposed to commercial Rapid Prototyping systems.
5. Possess knowledge on Rapid Prototyping software.
6. Model and manufacture RP components.

MODULE 1 INTRODUCTION (7 Lecture Hours)

Need - Development of RP systems – RP process chain - Impact of Rapid Prototyping on Product Development –Digital prototyping - Virtual prototyping- Rapid Tooling – Benefits Applications.

MODULE 2 REVERSE ENGINEERING AND CAD MODELING (8 Lecture Hours)

Basic concept- Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements – geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation,

MODULE 3 LIQUID BASED RAPID PROTOTYPING SYSTEMS (8 Lecture Hours)

Stereo lithography (SLA): Apparatus: Principle, per-build process, part-building, post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications - Case studies.

MODULE 4 SOLID BASED RAPID PROTOTYPING SYSTEMS (7 Lecture Hours)

Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. laminated object manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

MODULE 5 POWDER BASED RAPID PROTOTYPING SYSTEMS (7 Lecture Hours)

Selective Laser Sintering(SLS): Principle, process, Indirect and direct SLS- powder structures, modeling of SLS, materials, post processing, post curing, surface deviation and accuracy, Applications. Three dimensional printing - types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies.

MODULE 6 RAPID TOOLING (8 Lecture Hours)

Direct tooling methods -Direct tooling using stereo lithography - SLS Rapid Steel – Copper Polyamide Tooling - Direct Metal Laser Sintering - Laminated Tooling - Laser Engineered Net Shaping (LENS) - Controlled Metal Build-up (CMB) – Prometal, Shape deposition manufacturing, Selective Laser melting, Electron beam melting. Indirect Tooling methods - RTV Silicone Rubber Molds – Epoxy tooling - Vacuum Casting – RIM - Wax Injection Molding - Spin Casting - Cast Resin Tooling - Spray Metal Tooling - Sprayed Steel Rapid Solidification Process - Plaster Molds -Electroforming - Cast Aluminum and Zinc Kirksite Tooling - Investment Cast Tooling.

Text Books:

1. C.K. Chua, K.F. Leong., C.S. Lim. “Rapid Prototyping: Principles and Applications”, World Scientific Publishing Co. Pvt. Ltd., 2010.
2. Ian Gibson, David W. Rosen, Brent Stucker. “Additive manufacturing technologies: rapid prototyping to direct digital manufacturing”, Springer, 2010.

Reference Books:

1. Andreas Gebhardt, “Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing”, Hanser Publishers, 2011.
2. Zhiqiang Fan and Frank Liou, “Numerical modeling of the additive manufacturing (AM) processes of titanium alloy”, lnTech, 2012.
3. Kenneth G. Cooper., “Rapid Prototyping Technology: Selection and Application”, Marcel Dekker, Inc., 2007.
4. RafiqueNoorani, “Rapid Prototyping – Principles and Applications”, John Wiley and Sons Inc. New Jersey, 2005.
5. Williams D. Callister “Material Science and Engineering”, John Wiley and Sons. 2013.

18ME2064	AUTOMATION IN MANUFACTURING	L 3	T 0	P 0	C 3

Course Objectives: To impart knowledge on

1. Automation in the of field machine tool based manufacturing
2. Various elements of manufacturing automation, CAD/CAM, sensors, pneumatics, hydraulics and CNC
3. Basics of product design and the role of manufacturing automation

Course Outcomes: After completing the course the student will be able to

1. Relate automation to Industries in general and manufacturing processes in specific.
2. Summarize how automation in industries is implemented using computer aided manufacturing techniques.
3. Enumerate CAD technologies on various applications related to automation.
4. Adapt low cost automation principles and apply them to solve industrial issues pertaining to manufacturing.
5. Analyze design processes and numerically estimate optimized conditions for design and manufacturing.
6. Relate with implementation of robots to solve high end manufacturing problems in industries.

MODULE 1 INTRODUCTION TO AUTOMATION (8 Lecture Hours)

Basic Elements of Automation, Automation functions, Levels of Automation, Industrial Control Systems, Sensors actuators and other components in automation.

MODULE 2 COMPUTER AIDED AUTOMATION (8 Lecture Hours)

Computer Aided Manufacturing, Computer Integrated Manufacturing, Rigid automation: Part handling, Machine tools. Flexible automation: Computer control of Machine Tools and Machining Centers, NC and NC part programming, CNC-Adaptive Control, Automated Material handling, Assembly, Flexible fixtures.

MODULE 3 COMPUTER AIDED DESIGN(8 Lecture Hours)

Fundamentals of CAD - Hardware in CAD-Computer Graphics Software and Data Base, Geometric modeling for downstream applications and analysis methods; Computer Aided Manufacturing: CNC technology, PLC, Micro-controllers, CNC-Adaptive Control.

MODULE 4 LOW COST AUTOMATION (7 Lecture Hours)

Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies.

MODULE 5 INTRODUCTION TO MODELING AND SIMULATION (7 Lecture Hours)

Product design, process route modeling, Optimization techniques, Case studies & industrial applications.

MODULE 6 INDUSTRIAL ROBOTICS (7 Lecture Hours)

Robot anatomy, control systems in robots, end effectors for manufacturing and assembly, sensors in robots, Industrial application.

Text books:

1. Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, prentice Hall,2010.
2. SeropeKalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7th edition, Pearson, 2010.

Reference books:

1. YoramKoren, Computer control of manufacturing system,McGraw-Hill College,1983.
2. Ibrahim Zeid , CAD/CAM : Theory & Practice, 2010.

18ME2065	PROCESS PLANNING AND COST ESTIMATION	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Traditional process planning and methods of computer aided process planning
2. Importance and procedure of costing
3. Elements of costing, budgeting and decision making

Course Outcome: After completing the course the student will be able to

1. Apply traditional process planning and computer aided process planning
2. Estimate the cost of a process and product
3. Assess the elements of cost and ascertain the cost of a product
4. Evaluate the depreciation of a product over the time period/ usage
5. Develop a budget and operate the same in a manufacturing set-up
6. Estimate the manufacturing cost of various manufacturing processes

MODULE 1 PROCESS PLANNING (7 Lecture Hours)

Introduction – Types of production importance of process planning – steps involved in manual experienced Process Planning –need for CAPP – Variant and Generative approaches of CAPP- Future trend of CAPP.

MODULE 2ESTIMATION AND COSTING(7 Lecture Hours)

Estimating – Importance, aims, function of estimating – Constituents of estimation – Estimating procedure – sources of errors – costing – Aims of costing – costing procedure – methods of costing – classification of costs – Advantages of efficient costing – Difference between estimating and costing.

MODULE 3 ELEMENTS OF COSTS(8 Lecture Hours)

Price determination – Elements of costs – Ladder of cost – Material cost Determination of direct material cost – Labour cost – Determination of direct labour cost- over heads – classification of overhead expenses – Depreciation- Methods of depreciation – Allocation of overhead expenses.

MODULE 4 COST ECONOMICS (8 Lecture Hours)

Budget – Essentials of budgeting – Types of Budgets – Budgetary control – Objectives – Benefits – Measures of cost economics – Make or buy decision and Analysis.

MODULE 5 PRODUCT COST ESTIMATION (8 Lecture Hours)

Estimation of Material cost – Estimation of machine shop – Lathe operations – Milling operations – Grinding operations – Planning & shaping operations. Estimation in welding shop – Arc welding – Gas Welding –Flame cutting- Estimation of metal forming – Forging –Forging losses - Estimation in Foundry shop – Moulding – pattern making.

MODULE 6 MACHINING TIME CALCULATION (7 Lecture Hours)

Estimation of Maching Time – Importance of Machine Time Calculation – Calculation of Machining Time for different Lathe operations. Drilling and Boring – Machining Time Calculation for milling, shaping and planning – Machining Time Calculation for grinding.

Text Books:

1. G.B.S.Narang and V.Kumar, "Production and Costing", Khanna Publishers, New Delhi 2000.
2. T.R.Banga and S.C.Sharma, "Estimating and Costing", Khanna Publishers, New Delhi,2000.

Reference Books:

1. M.Adithan and B.S.Pabla, "Estimating and Costing", Konark Publishers Pvt. Ltd., 2001.

2. A.K.Chitale and R.C.Gupta, "Product Design and Manufacturing", Prentice Hall Pvt. Ltd., 2005.

18ME2066	MICROPROCESSOR IN AUTOMATION	L T P C 3 0 0 3

Course objectives: To impart knowledge on
1. Architecture and instruction set of typical 8-bit microprocessor.
2. Assembly Language Programming using macro-assembler.
3. Procedures for input-output techniques and programmable support chips used in microprocessor based systems.

Course Outcomes: Ability to
1. Paraphrase the basics of microprocessor.
2. Articulate on the working of 8-bit microprocessor.
3. Re-enact Assembly Language Programming.
4. Reviewing interrupts in microprocessor.
5. Examine about programmable peripheral interface.
6. Assess programmable interval timer.

MODULE 1 INTRODUCTION OF MICROCOMPUTER SYSTEM (7 Lecture Hours)
CPU, I/O devices, clock, memory, bussed architecture, tristate logic, address bus, data bus and control bus, : Development of semiconductor memory, internal structure and decoding, memory read and write timing diagrams, MROM, ROM,EPROM,EEPROM, DRAM.

MODULE 2 ARCHITECTURE, OPERATION & CONTROL (8 Lecture Hours)
Intel 8085A microprocessor, Pin description and internal architecture. Timing and control MODULE, op-code fetch machine cycle, memory read/write machine cycles, I/O read/write machine cycles, interrupt acknowledge machine cycle, state transition diagram.

MODULE 3 INSTRUCTION SET & ASSEMBLY LANGUAGE PROGRAMMING (9 Lecture Hours) Addressing modes; Data transfer, arithmetic, logical, branch, stack and machine control groups of instruction set, macro RTL and micro RTL flow chart of few typical instructions; Unspecified flags and instructions. Interfacing of memory chips, address allocation technique and decoding; Interfacing of I/O devices, LEDs and toggle-switches as examples, memory mapped and isolated I/O structure;

MODULE 4 INTERRUPTS AND I/O TECHNIQUES (8 Lecture Hours) Interrupt structure of 8085A microprocessor, processing of vectored and non-vectored interrupts, latency time and response time; Handling multiple interrupts. Input / Output techniques: CPU initiated unconditional and conditional I/O transfer, device initiated interrupt I/O transfer.

MODULE 5 PROGRAMMABLE PERIPHERAL INTERFACE (7 Lecture Hours)
Intel 8255, pin configuration, internal structure of a port bit, modes of operation, bit SET/RESET feature, programming. ADC and DAC chips and their interfacing

MODULE 6 PROGRAMMABLE INTERVAL TIMER (6 Lecture Hours)
Intel 8253, pin configuration, internal block diagram of counter and modes of operation, counter read methods, programming, READ-BACK command of Intel 8254**.**

Text books:
1. Hall D.V.," Microprocessor and Interfacing-Programming and Hardware", 2nd Ed., Tata McGraw-Hill Publishing Company Limited, 2008.
2. GaonkarR.S.," Microprocessor Architecture, Programming and Applications", 5th Ed., Penram International, 2007.

Reference books:
1. Stewart J," Microprocessor Systems- Hardware, Software and Programming", Prentice Hall International Edition,1990
2. Short K. L.," Microprocessors and Programmed Logic", 2^{nd} Ed., Pearson Education, 2008.

18ME2067	AUTOMOBILE ENGINEERING	L T P C 3 0 0 3

Course objectives: To impart knowledge on
1. Basic principles of engines used for automobiles and different systems.
2. Importance of sensors and fuel injection systems.

3. Engine exhausts emission control and alternate fuels.

Course Outcomes: After completing the course the student will be able to

1. Understand different types of internal combustion engines.
2. Demonstrate the functions of clutch and gear box systems.
3. Describe the types of steering and suspension systems.
4. Summarize the construction and operating principles of brakes and tyres .
5. Express the functions and components of fuel injection and ignition systems.
6. Analyze the performance and emissions of alternate fuels.

MODULE 1 INDRODUTION (8 Lecture Hours)

Types of automobiles, vehicle construction and layouts, chassis, frame and body, IC engines-components, function and materials, construction types, engine cylinder arrangements – Piston rings – Cylinder liners – Valves and Actuating mechanisms – Inlet and Exhaust manifolds, variable valve timing (VVT).

MODULE 2 AUTOMOTIVE TRANSMISSION SYSTEMS (8 Lecture Hours)

Transmission systems, clutch types & construction, gear boxes- manual and automatic gear shift mechanisms, Over drive, transfer box, flywheel, torque converter, propeller shaft, slip joints, Universal joints, differential and rear axle, Hotchkiss drive and Torque tube drive.

MODULE 3 STEERING AND SUSPENSION SYSTEMS (8 Lecture Hours)

Steering system: Principle of steering – Power steering – Steering linkages – Steering geometry and Types of steering gear box – Power steering. Suspension system – need, types – independent suspension – coil and leaf springs – suspension systems for multi-axle vehicles.

MODULE 4 BRAKES AND WHEEL (7 Lecture Hours)

Brakes: Need, Types – Mechanical, Hydraulic and Pneumatic Brakes – disc and drum types, their relative merits – details of components– Power brake, Antilock Braking System (ABS), electronic brake force distribution (EBD) and traction control. Wheels and tyres: Types and places of use – tyre construction, specification – tyre wear and causes.

MODULE 5 AUTOMOTIVE FUEL INJECTION SYSTEM (7 Lecture Hours)

Engine auxiliary systems, electronic injection for SI and CI engines, unit injector system, rotary distributor type and common rail direct injection system, transistor based coil ignition & capacitive discharge ignition systems, turbo chargers, engine emission control by 3-way catalytic converter system, Emission norms (Euro & BS).

MODULE 6 ALTERNATIVE FUELS (7 Lecture Hours)

Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in Automobiles, water and air as fuels, modifications needed, performance, combustion & emission characteristics of alternative fuels in SI and CI engines, Electric and Hybrid vehicles.

Text Books:

1. Kirpal Singh," Automobile Engineering" vol1 and vol2.Standard Publishers, 2011.
2. S.S. Thipse, "Alternative Fuels", Jaico Publications, 2010.

References Books:

1. S.S. Thipse, "IC Engines", Jaico Publications, 2014
2. R.P.Sharma and M.L.Mathur: "A course in Internal Combustion Engines", D.Rai& sons.2016.
3. Ramalingam K.K., 'Automobile Engineering' SciTech Publications Pvt. Ltd., 2011.
4. Robert Bosch, "Automotive Hand Book", SAE 9th Edition, 2014.
5. Bechhold, "Understanding Automotive Electronics", SAE, 2014.

		L T P C
18ME2068	**TOTAL QUALITY MANAGEMENT**	**3 0 0 3**

Course Objectives: To impart knowledge on

1. Need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
2. TQM Principles and techniques and possible applications of the same in manufacturing and service sectors.
3. Various tools and techniques of TQM.

Course Outcome: After completing the course the student will be able to

1. Apply TQM concepts in a selected enterprise.
2. Apply TQM principles in a selected enterprise.
3. Evaluate the various tools and techniques of TQM.
4. Asses the failures and their effect on the system through FMEA
5. Implement quality circle and Benchmarking in manufacturing and service sectors
6. Apply QMS and EMS in any organization.

MODULE 1 INTRODUCTION (8 Lecture Hours)

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM –-Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.

MODULE 2 TQM PRINCIPLES(8 Lecture Hours)

Leadership-The Deming Philosophy, Quality council, Quality statements and Strategic planning-- Customer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal--Continuous process improvement –Juran Trilogy, PDSA cycle, 5s and Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.

MODULE 3 TQM TOOLS & TECHNIQUES I(8 Lecture Hours)

The seven traditional tools of quality – New management tools – Six-sigma Process Capability– Bench marking – Reasons to bench mark, Bench marking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Bench Marking – FMEA – Intent of FMEA, FMEA Documentation, Stages, Design FMEA and Process FMEA.

MODULE 4 TQM TOOLS & TECHNIQUES II(7 Lecture Hours)

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures-- Cost of Quality – BPR.

MODULE 5 QUALITY MANAGEMENT SYSTEM(7 Lecture Hours)

Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation—Documentation—Internal Audits—Registration.

MODULE 6 ENVIRONMENTAL MANAGEMENT SYSTEM(7 Lecture Hours)

Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001—Benefits of EMS.

Text Books:

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield,MaryB.Sacre,HemantUrdhwareshe and RashmiUrdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", (6th Edition), South-Western (Thomson Learning), 2005.
3. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.

Reference Books:

1. Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
2. Janakiraman,B and Gopal, R.K, "Total Quality Management – Text and Cases", Prentice Hall of India 2016.
3. J.M.Juran, " Quality planning and analysis", McGraw Hill, 5th Edition,15 th Reprint 2015.

18ME2069	ENERGY CONSERVATION AND MANAGEMENT	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Energy conservation
2. Energy auditing
3. Energy management

Course Outcome: After completing the course the student will be able to

1. State the importance of energy conservation
2. Discuss the present status of national energy scenario
3. Apply various energy auditing methods
4. Analyze the energy conservation areas in thermal systems
5. Estimate the energy conservation areas in electrical systems
6. Choose the different financial management methods

MODULE 1 ENERGY CONSERVATION(8 Lecture Hours)

Introduction – energy conservation – importance – energy savings – energy cost – opportunities – energy policy – present energy scenario – conventional and non conventional energy - energy consumption pattern in India and worldwide – energy sector overview - energy measurement

MODULE 2 ENERGY CONSERVATION IN THERMAL AND ELECTRICAL SYSTEMS (8 Lecture Hours)

Boiler and fired systems – steam and condensate systems – cogeneration – waste heat recovery – building envelope – HVAC systems – Electrical energy management – electrical systems - lighting – motors - Energy management control systems – energy systems maintenance

MODULE 3 ENERGY AUDITING (8 Lecture Hours)

Introduction – basic components of an energy audit - Types of energy audit – energy auditing services – specialized audit tools –commercial audits - Residential audit – energy saving opportunities.

MODULE 4 ENERGY CONSERVATION AND AUDITING IN INDUSTRIES

(7 Lecture Hours) Energy conservation and auditing in steel and iron industry – foundry industry – chemical industry – textile industry – thermal power plants – cement industry – ceramic industry.

MODULE 5 ECONOMIC ANALYSIS: (7 Lecture Hours)

Introduction – objective – general characteristics of capital investments – sources of funds – tax considerations – time value of money concepts – projects measures of worth – economic analysis – special problems and applications – economics of energy security and reliability- risk analysis methods.

MODULE 6 ENERGY MANAGEMENT (7 Lecture Hours)

Introduction – principles of energy management – value of energy management - energy management program – organizational structure – energy policy – planning – audit planning – educational planning – strategic planning – reporting – ownership.

Text Books:

1. Wayne C Turner and Steve Doty, Energy Management hand book,6thedition, CRC Press, 2006.
2. Frank Kreith, D Yogi Goswami, Energy management and conservation hand book,CRC Press, 2007.

Reference Books:

1. David H.U., Handbook of Industrial Energy Conservation Van Nostrand Reinhold Company, 2003.
2. Vogt F., Energy Conservation and use of renewable sources of Energy in the Bio-Industries, Pergamon Press, 2011.
3. Albert Thumann, Plant Engineers and Managers Guide to Energy Conservation, Fairmount Press, 2007.
4. Ray D.A., Industrial Energy Conservation, Pergamon Press, 2010.
5. Shinskey E.G., Energy Conservation through Control, Academic Press, 2012.

18ME2070	INTRODUCTION TO MECHATRONICS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. The elements of Mechatronics systems
2. Selection of sensors and actuators
3. Application of mechatronics systems in automation

Course Outcomes: After completing the course the student will be able to

1. Recognize the emerging trends in mechatronics and interpret the principle of sensors.
2. Illustrate the working principles of valves, pneumatic and hydraulic drives.
3. Inference the suitable microprocessor or micro–controller for a real time application.
4. Classify and select an appropriate sensor for a given task.
5. Build a PLC program and a ladder logic program for an industrial application.
6. Identify and use an appropriate drive for an industrial application.

MODULE 1 INTRODUCTION TO MECHATRONICS (8 Lecture Hours)

Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers**:** Static and dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance sensors – Strain gauges – Eddy current sensor – Hall effect sensor – Temperature sensors – Light sensors.

MODULE 2 PNEUMATIC AND HYDRAULIC ACTUATORS (8 Lecture Hours)

DCVS, FCVs, special valves like Servo and Proportional Controls Valves, different types of Pumps and Motors – computation of performance of them.

MODULE 3 8085 MICROPROCESSOR AND 8051 MICROCONTROLLER (8 Lecture Hours)

Introduction – Architecture of 8085 – Pin Configuration – Addressing Modes –Instruction set, Timing diagram of 8085 – Concepts of 8051 microcontroller – Block diagram, selecting a microcontroller.

MODULE 4 SENSORS AND TRANSDUCERS (7 Lecture Hours)

Classification, Development in Transducer technology, Optoelectronics- Shaft encoders, CD Sensors, Vision System.

MODULE 5 PROGRAMMABLE LOGIC CONTROLLERS (7 Lecture Hours)

Architecture, Types of PLCs – Ladder Programming – Latching and internal relays – sequencing – timers and counters, Introduction – Architecture of 8255, Keyboard interfacing, LED display – interfacing, ADC and DAC interface, Temperature Control – Stepper Motor Control – Traffic Control interface.

MODULE 6 ACTUATORS AND MECHATRONIC SYSTEM DESIGN (7 Lecture Hours)

Types of Stepper and Servo motors – Construction – Working Principle – Advantages and Disadvantages. Design process–stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Engine Management system – Automatic car park barrier.

Text Books:

1. W Bolton, “Mechatronics–Electronic Control Systems in Mechanical and Electrical Engineering”, 4th Edition, Pearson Education, 2012.
2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Prentice Hall, 2002.

Reference Books:

1. Er. R. K. Rajput, "A Text Book of Mechatronics", 3rd Edition, Chand & Company – New Delhi, 3rd Edition, 2007.
2. Dan Necsulescu, “Mechatronics”, Pearson Education Asia, 2009.
3. Devadas Shetty, Richard Akolk, “Mechatronics System Design” First reprint 2001.

18ME2071	ROBOTIC ENGINEERING	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Robot types & configurations.
2. Sensors used in industrial robotics.

3. Robot programming skills and Actuating systems

Course Outcome: After completing the course, the student will be able to

1. Identify the robot types and configurations.
2. Evaluate the complete robot and can identify the control system acting on it.
3. Compute the kinematic equations to select an actuator for robot configurations.
4. Categorize the suitable sensor and implement for appropriate robot application.
5. Design the robot Program for an industrial application.
6. Develop the robot for a unique operation.

MODULE 1 BASIC CONCEPTS OF ROBOTICS AND AUTOMATION (8 Lecture Hours)

Basic Concepts such as Definition, three laws, DOF, Misunderstood devices etc., Elements of Robotic Systems i.e. Robot anatomy, Classification, Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device, etc. Automation - Concept, Need, Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations, introduction to automation productivity.

MODULE 2 ROBOT END EFFECTORS AND SENSORS (7 Lecture Hours)

Types of Grippers, Design aspect for gripper, Force analysis for various basic gripper system. Sensors for Robots: - Characteristics of sensing devices, Selections of sensors, Classification and applications of sensors. Types of Sensors, Need for sensors and vision system in the working and control of a robot.

MODULE 3 DRIVES AND CONTROL SYSTEMS (8 Lecture Hours)

Types of Drives, Actuators and its selection while designing a robot system. Types of transmission systems, Control Systems -Types of Controllers, Introduction to closed loop control Technologies in Automation: - Industrial Control Systems, Process Industries Verses Discrete Manufacturing Industries, Continuous Verses Discrete Control, Computer Process and its Forms. Control System Components such as Sensors, Actuators and others.

MODULE 4 KINEMATICS AND DYNAMICS (7 Lecture Hours)

Transformation matrices and their arithmetic, link and joint description, Denavit – Hardenberg parameters, frame assignment to links, direct kinematics, kinematics redundancy, kinematics calibration, inverse kinematics, solvability, algebraic and geometrical methods. Velocities and Static forces in manipulators: -Jacobians, singularities, static forces, Jacobian in force domain. Dynamics: - Introduction to Dynamics, Trajectory generations.

MODULE 5 MACHINE VISION AND PROGRAMMING LANGUAGES (8 Lecture Hours)

Vision System Devices, Image acquisition, Masking, Sampling and quantization, Image Processing Techniques, Noise reduction methods, Edge detection, Segmentation. Robot Programming: - Methods of robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Introduction to various types such as RAIL and VAL II etc, Features of type and development of languages for recent robot systems.

MODULE 6 ARTIFICIAL INTELLIGENCE AND PLANT AUTOMATION (7 Lecture Hours)

Introduction, need for system Modeling, Building Mathematical Model of a manufacturing Plant, Modern Tools- Artificial neural networks in manufacturing automation, AI in manufacturing, Fuzzy decision and control, robots and application of robots for automation. Artificial Intelligence: - Introduction to Artificial Intelligence, AI techniques, Need and application of AI. Other Topics in Robotics: - Socio-Economic aspect of robotisation. Economical aspects for robot design, Safety for robot and associated mass, New Trends & recent updates in robotics.

Text Books:

1. Mikell P. Grooveret. Al., Industrial Robotics: Technology, Programming and Applications, McGraw – Hill International, 1986.
2. Ibrahim Zeid, “CAD/CAM Theory and Practice”, McGraw Hill, 2003

Reference Books:

1. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic Engineering - An Integrated Approach", Prentice Hall India, 2002.
2. Raymond A Higgins “Engineering Materials (Applied Physical Metallurgy) English Language book, society, 2003.

3. John J. Craig, "Introduction to Robotics: Mechanics and Control", by Pearson India, ISBN: 9788131718360, 8131718360. Edition: 3rd Edition, 2008.

18ME2072	FLUID POWER APPLICATIONS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. Applications of hydraulics and pneumatics for automation.
2. Components of hydraulics and pneumatics.
3. Design of hydraulics and pneumatics circuits.

Course Outcome: After completing the course the student will be able to
1. Recognize the symbols used in hydraulics and pneumatics circuits.
2. Identify the components used in hydraulics and pneumatics systems.
3. Design hydraulic circuits for industrial applications.
4. Design pneumatics circuits for machine tool applications.
5. Develop low cost automation circuits for material handling applications.
6. Build multi cylinder hydraulic circuits for automation.

MODULE 1 HYDRAULIC COMPONENTS (9 Lecture Hours)
Introduction to fluid power system-Pascal's Law-Hydraulic fluids-Hydraulic pumps-Gear, Vane and Piston pumps-Pump Performance-Characteristics and Selection-actuators-valves-pressure control-flow control and direction control valves-Hydraulic accessories-Hydraulic Accumulator.

MODULE 2 PNEUMATIC COMPONENTS (9 Lecture Hours)
Introduction to Pneumatics-Compressors-types-Air treatment-FRL MODULE-Air dryer-Control valves-Logic valves-Time delay valve and quick exhaust valve-Pneumatic Sensors–types-characteristics and applications.

MODULE 3 FLUID POWER CIRCUITS (8 Lecture Hours) Circuit Design Methodology-Sequencing circuits-Overlapping signals-Cascade method-KV Map method-Industrial Hydraulic circuits-Double pump circuits-Speed control Circuits-Regenerative circuits-Safety circuits-Synchronizing circuits-Accumulator circuits.

MODULE 4 ELECTRO - PNUEMATICS AND HYDRAULICS (8 Lecture Hours)
Relay, Switches-Solenoid-Solenoid operated valves-Timer-Counter-Servo and proportional control-Microcontroller and PLC based control-Design of electro-pneumatic and hydraulic circuits.

MODULE 5 APPLICATION, MAINTENANCE AND TROUBLE SHOOTING (6 Lecture Hours)
Development of hydraulic / pneumatic circuits applied to machine tools-Presses-Material handling systems-Automotive systems-Packaging industries-Manufacturing automation-Maintenance and trouble shooting of Fluid Power circuits-Safety aspects involved.

MODULE 6 Fluid Logic Control Systems (7 Lecture Hours)
Introduction – Principles of Fluid logic control --- Basic Fluid Devices-- fluidic elements – Fluidic sensors-- MPL control systems- MPL control of Fluid power circuits-- Basic concepts of PLC.

Text Books:
1. Anthony "Esposito, Fluid Power with applications", Prentice Hall international–2008.
2. R. Srinivasan "Hydraulic and Pneumatic Controls" 2 Edition ,Tata McGraw - Hill Education 2008

Reference Books:
1. John Pippenger, Tyler "Hicks, Industrial Hydraulics", McGraw Hill International Edition, 2011.
2. Andrew Parr, "Hydraulics and pneumatics", Jaico Publishing House, 2003.
3. FESTO, "Fundamentals of Pneumatics", Vol I, II, III.
4. Majumdar S.R, "Pneumatic systems-principles and maintenance", Tata McGraw Hill 2000.
5. Werner Deppert, "Kurt Stoll, Pneumatic Application", Vogel verlag–2000.
6. Majumdar.S.R, "Oil Hydraulics", Tata McGraw Hill, 2002

18ME2073	MODERN MANUFACTURING TECHNIQUES	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. Basics of manufacturing processes and the various processing techniques in advanced materials.
2. Different advanced manufacturing processes including machining, forming, welding and foundry.
3. Manufacturing technologies in the competitive environment.

Course Outcome: After completing the course the student will be able to
1. Understand different manufacturing processes and the economic considerations.
2. Understand the theory of metal cutting and the sciences of advanced machining processes.
3. Learn the theories of advanced metal forming.
4. Know about the process of metal casting in detail.
5. Understand the physics of arc welding and theory of advanced welding techniques.
6. Demonstrate an understanding of competitive manufacturing environment.

MODULE 1 INTRODUCTION TO MANUFACTURING (7 Lecture Hours)
Evolution and development of manufacturing, Classification of manufacturing processes, Importance of manufacturing, Economic & technological considerations in manufacturing. Introduction to manufacturing materials. Processing of polymers, ceramics, and composites.

MODULE 2 ADVANCED MACHINING PROCESSES (8 Lecture Hours)
Introduction to basic machining operations and types. Mechanics of orthogonal metal cutting, theory of orthogonal metal cutting. Mechanics of oblique metal cutting. Analysis of machining processes such as USM, AJM, ECM, EDM, LBM, and EBM.

MODULE 3 ADVANCED FORMING PROCESSES (8 Lecture Hours)
Introduction to forming process. Elastic & plastic deformation, yield criteria. Hot working and cold working of metals. Electro-magnetic forming, Explosive forming, Electro-hydraulic forming, Stretch forming, Contour roll forming.

MODULE 4 ADVANCED FOUNDRY PROCESSES (7 Lecture Hours)
Introduction to metal casting processes, Purpose of the gating system, Components of gating system and its functions, Functions, types and applications of the riser, metal mould, continuous, squeeze, vacuum mould, evaporative pattern, and ceramic shell casting.

MODULE 5 ADVANCED WELDING PROCESSES (7 Lecture Hours)
Welding arc initiation, Arc structure, Arc characteristics, Arc stability, Arc blow, Modes of metal transfer, Forces affecting metal transfer. Electron Beam Welding, Laser Beam Welding, Ultrasonic Welding.

MODULE 6 MANUFACTURING IN A COMPETITIVE ENVIRONMENT (8 Lecture Hours)
Automation of manufacturing process - Numerical control - Adaptive control - material handling and movement - Industrial robots - Sensor technology - flexible fixtures - Design for assembly, disassembly and service.

Text Books:

1. Ghosh, Mullick. “Manufacturing Sciences”, Affiliated East-West Press (P) Ltd., 2010.
2. B.L. Juneja. “Fundamentals of Metal Forming Processes”, New Age Publishers; Second edition, 2010.
3. B.L. Juneja. “Fundamentals of Metal Cutting and Machining Tools”, New Age Publishers, 2017.
4. Groover M.P. "Automation, Production Systems and Computer Integrated Manufacturing ", Third Edition, Prentice-Hall, 2007.

Reference Books:

1. AmitabhaBattacharya. “Metal Cutting Theory and Practice”, Central Book Publishers,2012.
2. Shaw M.C. “Metal Cutting Principles”, Oxford University Press, 2012.
3. Kalpakjian, Schmid. “Manufacturing Processes for Engineering Materials”4th edition, Prentice Hall 2003
4. Pandey and Shah. “Modern Machining Process”, Tata McGraw Hill , 2017.

5. Bhattacharaya. “New Technology”, Institution of Engineers (I), 2000.
6. P.R. Beeley. “Foundry Technology”, Buttersworth 2and Edition, 2001.
7. Richard Heine, Carl Loper, Philip Rosenthal. “Principles of Metal Casting”, McGraw Hill, 2004.

18ME2074	RENEWABLE ENERGY TECHNOLOGIES	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. Various renewable energy sources.
2. Power generation techniques of renewable energy systems.
3. The application and environmental aspects of renewable energy systems.

Course Outcome: After completing the course the student will be able to
1. Identify the various renewable energy sources.
2. Summarize the application of solar energy systems.
3. Develop technology to convert waste biomass into useful energy.
4. Evaluate the performance of wind energy systems.
5. Estimate power production from tidal and ocean energy systems.
6. Understand the energy conversion from geothermal and hydrogen sources.

MODULE 1 - NON–CONVENTIONAL ENERGY SOURCES (8 Lecture Hours)
Introduction, non–conventional energy systems, world energy features, non–conventional energy sources and their availability, prospectus of renewable energy sources, advantages and disadvantages of renewable energy sources, history of energy consumption pattern.

MODULE 2 - SOLAR ENERGY SYSTEMS (8 Lecture Hours)
Solar radiation, solar radiation measurements, flat plate collectors, solar air heaters, concentrating collectors, solar water heating, solar space heating, solar refrigeration, solar photo voltaic cells, solar cooking, solar chimney, calculation of collector efficiency, outlet temperature of fluid.

MODULE 3 - BIOMASS ENERGY SYSTEMS (8 Lecture Hours)
Biomass resources, biomass conversion technologies, thermo chemical conversion of biomass – pyrolysis, gasification, direct combustion, liquefaction. Gasifier – classification of biomass gasifiers, gasifier engine systems, application of gasifier. Ethanol production from biomass, biogas plants, calculation of volume of biogas digester, gas holder volume, volume of biogas generated.

MODULE 4 - WIND ENERGY SYSTEMS (7 Lecture Hours)
The power in the wind, forces on the blades and thrust on turbines, wind energy conversion, site selection considerations, basic components of wind energy conversion systems, classification of wind energy conversion systems, wind energy collectors, performance of wind energy machines, application of wind energy, environmental impacts. Determination of power available in the wind.

MODULE 5 – TIDAL ENERGY AND OCEAN THERMAL ENERGY (7 Lecture Hours)
Ocean thermal energy conversion – calculation of power output from turbine. Tidal energy – determination of power available in the tidal energy, types. Wave energy conversion devices, small, mini, micro hydro systems.

MODULE 6-GEOTHERMAL AND HYDROGEN ENERGY(7 Lecture Hours)
Classification of Geothermal areas-calculation of hot water temperature and pressure. Hydrogen energy, fuel cells, magneto hydrodynamic systems.

Text books:
1. G.D Rai, “Non–conventional Energy Sources”, 5th Edition, Khanna Publishers, Delhi, 2011.
2. S.P. Sukhatme, “Solar Energy– Principles of Thermal Collection and Storage”, Tata McGraw Hill Publishing Co.New Delhi, 2008.

Reference books:
1. Desire Le Gouriers, “Wind Power Plants”, Theory and Design, Pregmon Press, 2014.
3. Srivastava, Shukla and Jha, “Technology and Application of Biogas” Jain Brothers, New Delhi, 2000.
4. N.H.Ravindranath, Hall D.O., “Biomass, Energy and Environment”, Reprinted Edition, Oxford University Press, Oxford, 2002.

5. K M Mital., "Non conventional Energy Systems" Wheeler Publishing,2003.

18ME2075	INTRODUCTION TO IC ENGINES	L T P C 3 0 0 3

Course objectives: To impart knowledge on

1. Performance of SI and CI Engines.
2. Understand recent trends in engine technology
3. Engine exhausts emission control and alternate fuels.

Course Outcomes: After completing the course the student will be able to

1. Classify different types of internal combustion engines.
2. Analyze performance of spark ignition and compression ignition engines.
3. Identify recent technology trends in engine.
4. Understand friction reduction and light weighting technologies.
5. Predict concentrations of primary exhaust pollutants
6. Analyze the performance and Emissions of alternate fuels.

MODULE 1 INDRODUTION TO IC ENGINES (8 Lecture Hours)

Basic components and terminology of IC engines, working of four stroke/two stroke - petrol/diesel engine, classification and application of IC engines, Valve timing diagrams, Port timing diagrams. Engine performance and emission parameters.

MODULE 2 SPARK IGNITION ENGINES (8 Lecture Hours)

Mixture requirements of air-fuel ratio, Fuel injection system, Monopoint, Multipoint & Direct injection -Stages of combustion, Normal and Abnormal combustion, Spark Knock, Factors affecting knock, Combustion chambers, New technologies employed in 3 way catalytic convertor, stoichiometric and lean combustion.

MODULE 3 COMPRESSION IGNITION ENGINES (8 Lecture Hours) Diesel Fuel Injection Systems, Stages of combustion, Knocking, Factors affecting knock, Direct and Indirect injection systems, Combustion chambers, Fuel Spray behavior, Spray structure and spray penetration, Air motion, Introduction to Turbo charging, Advanced trends in Diesel oxidation catalyst (DOC), and Diesel particulate filter(DPF).

MODULE 4 POLLUTANT FORMATION AND CONTROL (7 Lecture Hours)

Pollutant, Sources, Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter, Methods of controlling Emissions. Catalytic converters, Latest emission control techniques used in selective Catalytic Reduction and Particulate Traps, Methods of measurement, Emission norms.

MODULE 5 ALTERNATIVE FUELS (7 Lecture Hours)

Bio Diesel, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas, Ethanol and Methanol– Properties, Suitability, Merits and Demerits – Engine Modifications. Latest technology in alternative sources of energy.

MODULE 6 AUTOMOTIVE FUEL INJECTION SYSTEM (7 Lecture Hours)

Air assisted Combustion, Supercharging, Adiabatic combustion, friction reduction, light weighting, composite engine materials, Current trends in multi point fuel injection system, Gasoline Direct Injection Systems, Hybrid Electric, downsizing and de-rating of engines.

Text Books:

1. R.P.Sharma and M.L.Mathur: "A course in Internal Combustion Engines", D.Rai& sons.2016.
2. S. Thipse, "Alternative Fuels", Jaico Publications, 2010.

Reference Books:

1. S.S. Thipse, "IC Engines", Jaico Publications, 2014
2. Ganesan. V., "Internal Combustion Engines", Tata McGraw Hill, New Delhi, 2012
3. John B. Heywood: Internal combustion Engines Fundamentals"", McGraw Hill International Edition, 2011.
4. Rowland S.Benson and N.D.Whitehouse, (2000) Internal combustion Engines, Vol. I and II, Pergamon Press.

5. V.M. Domkundawar: “Internal Combustion Engines”, DhanpatRai& Co., 2008.

18ME2076	FUNDAMENTALS OF COMPUTER AIDED DESIGN	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Various computer aided design tools for industrial applications.
2. Graphical entities of Computer Aided Design.
3. Design solutions using Finite Element Method.

Course Outcome: After completing the course the student will be able to

1. Demonstrate the basic structure and components of CAD.
2. Outline the process of representing graphical entities in a CAD environment.
3. Construct the geometric model using different techniques to represent a product.
4. Understand the mathematical representation of solids.
5. Illustrate various techniques and devices involved in CAD hardware.
6. Analyze the models for design solutions using FEM.

MODULE 1 – INTRODUCTION (7 Lecture Hours)

Introduction to CAD, Scope and applications in mechanical engineering, Need for CAD system, use ofcomputer, Computer fundamentals, Computer aided design process, CAD configuration, CAD tools,advantages and limitations in CAD, CAD Standards – IGES, GKS and PDES, CAD/ CAM integration.

MODULE 2 – COMPUTER GRAPHICS (8 Lecture Hours)

Computer Graphics Display and Algorithms: Graphics Displays, DDA Algorithm – Bresenham’s Algorithm – Coordinate systems – Transformation of geometry – Translation, Rotation, Scaling, Reflection, Homogeneous Transformations – 2D and 3D Transformations – Concatenation – line Drawing-Clipping and Hidden line removal algorithms – viewing transformations.

MODULE 3 – CURVES AND SURFACES (8 Lecture Hours)

Wireframe models and entities – Curve representation – parametric representation of analytic curves – circles and conics – Hermite curve – Bezier curve – B-spline curves – rational curves. Surface Modeling– Surface models and entities – Parametric representation of analytic surfaces – Plane surfaces –Synthetic surfaces – Bicubic Surface and Bezier surface and B-Spline surfaces.

MODULE 4 – MATHEMATICAL REPRESENTATION OF SOLIDS (7 Lecture Hours)

Geometry and Topology, Comparison of wireframe, surface and solid models, Properties of solid model, properties of representation schemes, Concept of Half-spaces, Boolean operations. Schemes: B-rep, CSG, Sweep representation.

MODULE 5 – CAD HARDWARE (7 Lecture Hours)

Introduction to hardware specific to CAD, Product cycle, CRT, Random scan technique, raster scan technique, CAD specific i/o devices, DVST, Raster display, Display systems, sequential scanning and interlaced scan.

MODULE 6 – FINITE ELEMENT METHOD (8 Lecture Hours)

Introduction to FEM, Principle of minimum potential energy, steps involved in FEM, discretization, types of nodes and elements, elemental stiffness matrix, elemental strain displacement matrix, types offorce, elemental force matrix, assembly, shape function, introduction to 2 dimensional FEM.

Text Books:

1. Ibrahim Zeid, “CAD - CAM Theory and Practice”, Tata McGraw Hill Publishing Co. Ltd., 2009.
2. Rao. S.S. “The Finite Element Method in Engineering”, 2nd Edition, Pergamon Press, Oxford, 2009.

Reference Books:

1. Kunwoo Lee, “Principles of CAD/CAM/CAE Systems”, Addison Wesley, 2005.
2. P.N. Rao, “CAD/CAM Principles and Applications", Tata McGraw Hill Publishing Co. Ltd., 2010.
3. Bathe K.J., “Finite Element Procedures”, K.J. Bathe, Watertown, MA, Fourth edition, 2016.

18ME2077	FUEL CELL TECHNOLOGY	L T P C 3 0 0 3

Course objectives: To impart knowledge on
1. Working principle of a typical fuel cell, its types and to elaborate on its thermodynamics and kinetics.
2. Cost effectiveness and eco-friendliness of Fuel Cells.
3. Various fuel cells and it performance based on the requirements in industries.

Course Outcomes: After completing the course the student will be able to
1. Evaluate the performance of fuel cells under different operating conditions.
2. Identify the importance and functions of fuel cell and its types.
3. Demonstrate the functions of fuel cell systems.
4. Understand hybrid fuel cell systems.
5. Describe the working process of gas turbine system.
6. Recognize the recent technology trends in fuel cell.

MODULE 1 INDRODUTION TO FUEL CELL (8 Lecture Hours)
History – principle - working - Advantage and disadvantage -thermodynamics and kinetics of fuel cell process -performance evaluation of fuel cell – comparison on battery Vs fuel cell.

MODULE 2FUELCELL TYPES (8 Lecture Hours)
Construction and operation of Fuel cells - Solid Oxide Fuel Cell (SOFC) -Alkaline Fuel Cell (AFC)- Direct Methanol Fuel Cell (DMFC) -Proton Exchange Membrane Fuel Cell (PEM) - Molten Carbonate Fuel Cell (MCFC)- relative merits and demerits.

MODULE 3 FUEL CELL SYSTEMS (8 Lecture Hours)
Introduction to fuel cell power conditioning systems- Various options- Fuel cell systems fuelled by Natural gas (PEFC, PAFC, MCFC systems) - Coal fuelled fuel cell system- Combined fuel cell and Gas turbine system- Hybrid fuel cell systems-Hybrid electric vehicles.

MODULE 4 FUEL CELL THERMODYNAMICS (7 Lecture Hours)
Heat potential of a Fuel: Enthalpy of Reactions – Work Potential of a Fuel: Gibbs Free energy - Predicting Reversible Voltage of a Fuel Cell under Non-standard state Conditions Fuel Cell Efficiency.

MODULE 5 FUEL PROCESSING AND HYDROGEN STORAGE (7 Lecture Hours)
Processing hydrogen from alcohols- producing hydrogen from hydrocarbons- Hydrogen from other sources- Gas clean up- Hydrogen storage- Methods of Hydrogen storage- Hydrogen as Engine storage.

MODULE 6APPLICATION OF FUEL CELL AND ECONOMICS(7 Lecture Hours)
Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space. Economic and environmental analysis on usage of Hydrogen and Fuel cell. Future trends in fuel cell.

Text Books:

1. Viswanathan.B and AuliceScibion "Fuel Cells: Principles and applications", CRC Press.2008.
2. Noriko HikosakaBehling, "Fuel cells", Elsevier publishers, 2012.

References Books:

1. Barclay F.J., "Fuel Cells", Engines and Hydrogen, Wiley, 2009.
2. Bent Sorensen "Hydrogen and Fuel cells", Academic Press, 2011.
3. Hart A.B. and G.J.Womack, "Fuel Cells: Theory and Application", Prentice Hall, New York Ltd., London 2005.
4. Kordesch K. and G.Simader, "Fuel Cell and Their Applications", Wiley-Vch, Germany 2006.
5. Jeremy Rifkin, "The Hydrogen Economy", Penguin Group, USA 2002.

18ME2078	EXPERIMENTAL METHODS IN ENGINEERING	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. Use of basic concept in engineering experimentation and analysis.
2. Proficiency in handling digital devices in advanced measurement techniques.
3. Error and uncertainty in measurements in thermal and mechanical systems

Course Outcomes: After completing the course the student will be able to

1. Understand the basic concept of engineering experimentation.
2. Analyze various experimental techniques.
3. Understand the use of digital devices in measurements.
4. Apply instruments for advanced measurement techniques and analysis
5. Carry out Error and uncertainty analysis of thermal system and mechanical systems
6. Apply the concept of measurement of displacement, velocity acceleration, force and torque.

MODULE 1EXPERIMENTAL PLANNING (8 Lecture hours)
Planning of experiments, various stages in experimental investigations; preliminary, intermediate and final, steady state and transient techniques, selection of measuring devices based on static, dynamic characteristics and allowable uncertainties, basics of TAGUCHI method for design of experiments.

MODULE 2 INSTRUMENTATION & MEASUREMENTS (8 Lecture hours)
Fundamental elements of a measuring instrument, static and dynamic characteristics, principles of temperature measurement, calibration of thermocouple, RTD, Orifice plate and Pressure gauge, design of temperature measuring instruments, thermo positive elements, thermocouples in series & parallel, pyrometry, steady state and transient methods of measuring heat flux, measurement of thermal radiation and associated parameters, measurement of turbulence, measurement of thermal conductivity of solids, liquids and gases, measurement of thermo-physical properties.

MODULE 3ADVANCEMENT IN MEASUREMENTS (8 Lecture hours)
Data logging and acquisition, use of sensors for error reduction, elements of micro computer interfacing, intelligent instruments and their use, Basics of P, PI, PID controllers, pneumatic and hydraulic controllers, electronic controllers.

MODULE 4 ADVANCED MEASUREMENT TECHNIQUES AND ANALYSIS (7 Lecture hours) Shadowgraph, Schlieren, Interferometer, Laser Doppler Anemometer, Hot wire Anemometer, Telemetry in measurement, Orsat apparatus, Gas Analyzers, Smoke meters, gas chromatography, spectrometry.

MODULE 5UNCERTAINTY IN MEASUREMENTS (7 Lecture hours)
Uncertainty in measurements: Errors in instruments, Analysis of experimental data and determination of overall uncertainties in experimental investigation, uncertainties in measurement of measurable 06 15 parameters like pressure, temperature, flow etc. under various condition.

MODULE 6TRANSDUCERS AND MECHANICAL MEASUREMENT (7 Lecture hours)
Resistive, Capacitive, Inductive and piezoelectric transducers and their signal conditioning. Measurement of displacement, velocity and acceleration (translational and rotational), force, torque, vibration and shock. Measurement of pressure, flow, temperature and liquid level. Measurement of pH, conductivity, viscosity and humidity.

Text Books:

1. Experimental Methods for Engineers – J. P. Holman -7TH Edition, McGraw-Hill, 2017.
2. Mechanical Measurements – Thomas G. Bechwithet. al., 6th Edition, Pearson, 2013.

Reference Books:

1. Instrumentation: Devices and Systems - Raman C. S. et. al., McGraw-Hill, 2001
2. Principles of Measurements and Instrumentation- Morris A.S. - Prentice Hall of India , 2001
3. Experimentation, Validation, and Uncertainty Analysis for Engineers - Huge W. Coleman, W. Glenn Steele - Wiley, 2018.

		L	T	P	C
18ME2079	**MEMS AND MICRO SYSTEM FABRICATION**	**3**	**0**	**0**	**3**

Course Objectives: To impart knowledge on

1. Operation of micro devices, micro systems and their applications.
2. Design the micro devices, micro systems.
3. Various MEMS fabrication processes.

Course Outcome: After completing the course the student will be able to

1. Provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
2. Educate on the rudiments of Micro fabrication techniques.

3. Introduce various sensors and actuators
4. Identify different materials used for MEMS.
5. Choose different applications of MEMS to disciplines beyond Electrical and electronics engineering
6. Choose various applications of MEMS to disciplines beyond Mechanical engineering

MODULE 1 INTRODUCTION (9 Lecture Hours)
Intrinsic Characteristics of MEMS –Energy Domains and Transducers-Sensors and Actuators –Introduction to Micro fabrication -Silicon based MEMS processes –New Materials –Review of Electrical and Mechanical concepts in MEMS –Semiconductor devices –Stress and strain analysis –Flexural beam bending-Torsional deflection.

MODULE 2 SENSORS AND ACTUATORS-I (9 Lecture Hours)
Electrostatic sensors –Parallel plate capacitors –Applications –Interdigitated Finger capacitor –Comb drive devices –Micro Grippers –Micro Motors -Thermal Sensing and Actuation –Thermal expansion –Thermal couples –Thermal resistors –Thermal Bimorph -Applications –Magnetic Actuators –Micromagnetic components –Case studies of MEMS in magnetic actuators-Actuation using Shape Memory Alloys.

MODULE 3 SENSORS AND ACTUATORS-II (9 Lecture Hours)
Piezoresistive sensors –Piezoresistive sensor materials -Stress analysis of mechanical elements –Applications to Inertia, Pressure, Tactile and Flow sensors –Piezoelectric sensors and actuators –piezoelectric effects –piezoelectric materials –Applications to Inertia , Acoustic, Tactile and Flow sensors.

MODULE 4 MICROMACHINING(7 Lecture Hours) Silicon Anisotropic Etching –Anisotrophic Wet Etching –Dry Etching of Silicon –Plasma Etching –Deep Reaction Ion Etching (DRIE)–Isotropic Wet Etching –Gas Phase Etchants –Case studies–97 Basic surface micro machining processes –Structural and Sacrificial Materials –Acceleration of sacrificial Etch –Striction and Antistriction methods –LIGA Process -Assembly of 3D MEMS –Foundry process.

MODULE 5 POLYMER AND OPTICAL MEMS (7 Lecture Hours)
Polymers in MEMS–Polimide -SU-8 -Liquid Crystal Polymer (LCP) –PDMS –PMMA –Parylene –Fluorocarbon -Application to Acceleration, Pressure, Flow and Tactile sensors-Optical MEMS –Lenses and Mirrors –Actuators for Active Optical MEMS.

MODULE 6 MICROSYSTEM FABRICATION PROCESSES (7 Lecture Hours)
Introduction, Phololithography, Ion Implimentation, Diffusion, Oxidation, Chemical Vapour Deposition, Etching.

Text Books:

1. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill,New Delhi, 2002.
2. Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2012.
3. Stephen D Senturia, 'Microsystem Design', Springer Publication, 2000.

Reference Books:

1. James J.Allen, Micro Electro Mechanical System Design, CRC Press Publisher,2005.
2. Chang Liu., Foundations of MEMS, Pearson education india limited,2006.
3. Thomas M.Adams and Richard A.Layton, "Introduction MEMS, Fabrication and Application,"Springer, 2010.
4. M. J. Madou , "Fundamentals of Microfabrication" , 2nd Ed., CRC Press, 2002.
5. Stephen D. Senturia "Microsystem Design",Springer, 2000.
6. The MEMS Handbook, M. Gad-el-Hak, CRC Press, 2010.

18ME2080	INTRODUCTION TO FOOD PROCESS ENGINEERING AND TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Principles of food preservation.
2. Advancement on food processing.
3. Materials and types for food packaging.

Course Outcomes: After completing the course the student will be able to

1. Understand different methods of processing foods.
2. Select suitable packaging material for different food substances.
3. Understand Changes during storage and preservation.
4. Aware the Importance in treating waste products from food industry.
5. Familiarize the methods of food handling and storage.
6. Explain the working principle of food processing equipments.

MODULE 1 – PROCESSING OF FOOD AND ITS IMPORTANCE (8 Lecture Hours)

Source of food - food of plant, animal and microbial origin; different foods and groups of foods as raw materials for processing – cereals, pulses, grains, vegetables and fruits, milk and animal foods, sea weeds, algae, oil seeds and fats, sugars, tea, coffee, cocoa, spices and condiments, additives; need and significance of processing these foods

MODULE 2 – METHODS OF FOOD HANDLING AND STORAGE (8 Lecture Hours)

Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods.

MODULE 3 – LARGE-SCALE FOOD PROCESSING (8 Lecture Hours)

Milling of grains and pulses; edible oil extraction; pasteurization of milk; canning and bottling of foods; drying – traditional and modern methods of drying, dehydration of fruits, vegetables, milk, animal products etc.; preservation by use of acid, sugar and salt; pickling and curing with microorganisms, use of salt, and microbial fermentation; frying, baking, extrusion cooking, snack foods, principles of freezing and chilling, freezing equipment and methods, types of extruder.

MODULE 4 – FOOD PRESERVATION (7 Lecture Hours)

Objectives and techniques of food preservation, principle of canning of food items, thermal process, time calculations for canned foods, spoilage in canned foods, water activity of food and its significance in food preservation, dehydration and drying of food items, low temperature preservation, cold storage, cold chain, freezing, cryogenic freezing, preservation by fermentation, ionization radiation, use of preservative in foods, chemical preservative, bio-preservatives, antibiotics, lactic acid bacteria.

MODULE 5 FOOD PACKAGING (7 Lecture Hours)

Functions of packaging; type of packaging materials; selection of packaging material for different foods; selective properties of packaging film; methods of packaging and packaging equipments, mechanical strength of different packaging materials; printing of packages; barcodes & other marking; interactions between packaging material and foods; environmental and cost consideration in selecting packaging materials.

MODULE 6 FOOD WASTES AND WASTE DISPOSAL (7 Lecture Hours)

Classification and characterization of food industrial wastes from fruit and vegetable processing industry, beverage industry, fish, meat and poultry industry, sugar industry and dairy industry; solid and liquid waste; waste disposal methods – physical, chemical and biological; Economical aspects of waste treatment and disposal.

Texts Books

1. Berk, Zeki “Food Process Engineering and Technology” Academic Press, 2009.
2. Smith, P.G. “Introduction to Food Process Engineering”. Springer, 2004.

References Books

1. Toledo, Romeo T. “Fundamentals of Food Process Engineering”. 3rd Edition, Springer, 2007.
2. Gopala Rao, Chandra “Essentials of Food Process Engineering”. BS Publications, 2006.
3. Ioannis S. Arvanitoyannis. “Waste Management for the Food Industries”. Academic Press, 2008.
4. Khetarpaul, Neelam, “Food Processing and Preservation”, Daya Publications, 2005.
5. Robertson, G.L. “Food Packaging, Principles and Practice”. 2nd Edition. Taylor and Francis, 2006.

18ME2081	INTRODUCTION TO MODERN ENERGY TECHNOLOGIES	L T P C 3 0 0 3

Course objectives: To impart knowledge on

1. New methodologies / technologies for effective utilization of renewable energy sources.
2. Different sources of energy and new energy storage technologies
3. Various power plants and Modern energy applications

Course Outcomes: After this course students will be able to

1. Understand the future energy requirements
2. Recognize the various renewable energy resources available
3. Design an energy conversion systems for maximum conversion efficiency
4. Select a suitable power plants for power generation based on the resource available
5. Select the suitable energy storing methods.
6. Apply the suitable energy conversion technology in real time application

MODULE 1. CURRENT ENERGY SCENARIO (8 Lecture hours)

Overview of global/ India's energy scenario, Current energy requirements, growth in future energy requirements, Review of conventional energy resources, Coal, gas and oil reserves and resources, Tar sands and Oil, Shale, Nuclear energy Option -present day environmental issues – pollution due to conventional power plants-need for modern energy technologies

MODULE 2. RENEWABLE ENERGY RESOURCES (7 Lecture hours)

Energy sources, sun as the source, classification of energy sources of energy, renewable resources; Sources of clean energy - Nuclear fission and fusion, Geothermal energy, Bio energy, Geothermal, Wind, Hydropower, Solar radiation: measurements and prediction. Ocean energy resources

MODULE 3. ENERGY CONVERSION TECHNOLOGIES. (8 Lecture hours)

Solar thermal collectors- Types-flat plate collectors, concentrating collectors, conversion of heat energy in to mechanical energy, solar thermal power generation systems, Solar Photovoltaic: Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication, Thermionic conversion: thermionic effects, analysis of converters, application of heat pipes. Magneto hydrodynamic conversion: gaseous conductors, MHD generators. Batteries and fuel cell, thermoelectric conversion: thermoelectric effects, analysis of thermoelectric generators

MODULE 4. POWER PLANTS (7 Lecture hours)

Layout of Steam power plant , Hydel power plant – Pumped and storage type, Diesel power plant, MHD power plant, Nuclear power Plants-types, Gas turbine Power Plants, Selection of turbines, Geo thermal power plant, OTEC Power plants

MODULE 5. ENERGY STORAGE TECHNOLOGIES. (8 Lecture hours)

Introduction, Need of Energy storage, Different modes of energy storage, Technology Types– Mechanical energy storage: flywheels, compressed air, and pumped hydro; Electrical and Magnetic Energy storage: Batteries, Capacitors, electromagnets, Chemical energy storage. Basics of Sensible heat storage, Stratified storage, Rock bed storage, Thermal storage in buildings, Earthstorage, Aquifers storage. Basics of Latent heat storage, Phase change materials (PCM)

MODULE 6. MODERN ENERGY APPLICATIONS (7 Lecture hours)

Harvesting the energy of vibrations, Hyper loop, hydrogen fueled cars, heat pump water heaters, Chinas hydrogen tram, emissive energy harvester, alternative energy gadgets, alternative electrical heating, compressed air as energy.

Text books:

1. AngristS.W.,Direct Energy Conversion. 4th Ed. Allyn And Bacon, Boston, 1982
2. D. Y. Goswami, Principles of Solar Engineering, CRC Press; 3 edition (February 20, 2015)
3. C. S. Solanki, "Solar Photovoltaics: Fundamental Applications and Technologies, Prentice Hall of India, 2009.

Reference books:

1. Hand book on Batteries and Fuel Cells. Linden, McGraw Hill, 1984.
2. Robert Ristinen, Energy and the Environment, 3rd Edition, John Wiley, 2015.
3. Sc Arora S Domkundwar, Av Domkundwar "A Course in Power Plant Engineering", DhanpatRai , 2014

4. Pendse, Energy Storage Science & Technology , SBS Publishers; UK ed. edition (12 October 2010)
5. Huggins, Robert, Energy Storage, Fundamentals, Materials and Applications, Springer International Publishing, 2016
4. B. Sorensen G. Spazzafumo, Hydrogen and Fuel Cells, Elsevier, 3rd Edition, 2018

18ME2082	INTRODUCTION TO WATER TECHNOLOGIES	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Hydrologic cycle, sedimentation and coagulation.
2. the sources of organic and inorganic solids that pollute wastewater and ion exchange and lime-soda processes,
3. Effective methods used to inactivate viruses

Course Outcome: After completing the course the student will be able to

1. Understand the continuing processes that make up the water or hydrologic cycle.
2. Describe the treatment processes like sedimentation and coagulation.
3. Identify the sources of organic and inorganic solids that pollute wastewater.
4. Describe the ion exchange and lime-soda processes for removing hardness from water
5. Apply effective methods used to inactivate viruses
6. Determine the industrial waste water treatments methods.

MODULE 1 INTRODUCTION - WATER, THE BASIC RESOURCE (7 Lecture Hours)
Precipitation. Surface runoff. Groundwater. Municipal, industrial, and agricultural use. Waste disposal. Upgrading water quality.

MODULE 2 WATER COLLECTION, TREATMENT, AND DISTRIBUTION (8 Lecture Hours) Collecting surface water and ground water – dams, reservoirs and rain harvesting. Transmission of water. Treatment types. Distribution. Primary, secondary and tertiary treatment

MODULE 3 PHYSICAL PROPERTIES OF WATER (8 Lecture Hours)
Color, taste, odor, pH Value and temperature of water. Solids in the water. Turbidity. Suspended matter – Total Dissolved Solids (TDS). Measuring electrical conductivity.

MODULE 4 CHEMICAL PROPERTIES OF WATER (7 Lecture Hours)
Atoms and molecules; Acids, bases, and salts; Ionization; Alkalinity and acidity; Hardness of water; Unwanted chemicals; Dissolved oxygen

MODULE 5 BIOLOGICAL PROPERTIES OF WATER (7 Lecture Hours)
Pathogenicity. Disinfection. Stabilization of organic matter. Biochemical oxygen demand. Bacteria. Viruses. Algae. Protozoa.

MODULE 6 SANITATION AND WASTE WATER TREATMENT (7 Lecture Hours)
Protecting Surface Waterand Groundwater Resources - Sanitation and Wastewater Treatments. Municipal and industrial waste water treatments. Regulations and Laws on sanitation and waste water management.

Text Books:

1. N.F. Gray, “Water Technology. An Introduction for Environmental Scientists and Engineers”. Book • 3rd Edition • 2010.

Reference Books:

1. Jerry A. Nathanson M.S. P.E. and Richard A. Schneider M.S. P.E.,"Basic Environmental Technology: Water Supply, Waste Management and Pollution Control (6th Edition)" Pearson, Jan 17, 2014
2. Mark J. Hammer "Water and Wastewater Technology", Prentice Hall of India; 7th edition (2012).
3. Metcalf & Eddy Inc. an AECOM Company and Takashi Asano "Water Reuse: Issues, Technologies, and Applications", McGraw-Hill Education, Feb 19, 2007
4. Mark J. Hammer Sr. and Mark J. Hammer Jr "Water and Wastewater Technology" Prentice Hall of India, (7th Edition)Jan 15, 2011.

18ME2083	INTRODUCTION TO HEALTH CARE SCIENCE AND TECHNOLOGY	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Health care and technology, workplace safety and safety protocols.
2. First AID practices, CPR procedure and operation of medical instruments.
3. Lab equipments, instruments and bio materials.

Course Outcome: After completing the course the student will be able to

1. Understand various health care systems and policies.
2. Recognize the importance of workplace safety and safety protocols.
3. Practice first aid, CPR and health assessment.
4. Operate important medical instruments
5. Employ lab equipments and instruments for medical health procedures.
6. Appraise the applications of engineering and biomaterials for health care.

MODULE 1 INTRODUCTION TO HEALTH CARE (7 Lecture Hours)

History of health care and health care delivery systems, medical advancements in health care, techniques to prevent the spread of disease, infection control measures, aseptic technique, patient isolation and universal precautions **,** patient safety, ,ethical and legal issues in health care , Health Information Portability and Accountability Act (HIPAA), confidentiality, patient privacy. Awareness on health care insurances.

MODULE 2 WORKPLACE SAFETY AND PERSONAL WELLNESS (7 Lecture Hours)

Occupational Safety and Health Administration (OSHA) standards, body mechanics, fire safety and other patient safety protocols. Safety first, reducing worker injury and disability. Basic medical terminology specific to the area of laboratory, pharmacology, and hospital care.

MODULE 3 FIRST AID, CPR AND HEALTH ASSESSMENT (7 Lecture Hours)

Health assessment **-** different types of temperatures and their averages ranges, an oral temperature. Different pulse points and radial and carotid pulse, measure of respirations and blood pressure. Ratio of weight to height. Emergencies in health care, first aid, cardiopulmonary resuscitation (CPR), CPR Standards, certified and standard first aid.

MODULE 4 INTRODUCTION TO MEDICAL INSTRUMENTS (8 Lecture Hours)

Anesthesia machine, Aspiration/Suction Pump, Autoclave / Sterilizer, Centrifuge, Coagulation analyzer, Computer equipment, CPAP/Humidifier, Defibrillator, Diagnostic Ultrasound with probes, ECG, Electrosurgical Unit, Endoscopy system, Feeding Pump, Fetal Doppler, Hospital Bed – medical and surgical, birthing, Infant Incubator, Infant Warmer, Infusion Pump, Lab Equipment – incubator, shaker, washer

MODULE 5 LAB DEVICES, EQUIPMENTS AND INSTRUMENTS (8 Lecture Hours)

Lab Microscope, Laryngoscope, Nebulizer, Nerve stimulator, Ophthalmic Equipment – slit lamp, surgical scope, Otoscope / Ophthalmoscope, Oxygen Concentrator, Patient Warmer, Portable Glucose Monitor, Pulse Oximeter, Sequential Compression Device, Sphygmomanometer – aneroid and digital Stethoscope, Stretcher, Surgical Microscope, Surgical Table – surgical and delivery, Thermometer, Traction Unit, Ventilator, Vital Sign Monitor, Wheelchair, X-Ray equipment – portable, dental, mammography

MODULE 6 ENGINEERING AND BIO MATERIALS USED FOR HEALTH CARE & MEDICAL APPLICATIONS (8 Lecture Hours)

Introduction to biomaterials, Requirements of Biomaterials, Classifications of Biomaterials, Mechanical properties of Biomaterials, Effects of processing on properties of Biomaterials, Tissue Engineering, Bio compatible materials , Titanium alloys, composite materials, Stainless Implant alloys, Cobalt base Implant alloys and Non Implant alloys. Shape memory alloys and polymers.
FDA Standards.

Text Books:

1. Louise Simmers, Introduction to Health Science Technology, 2nd Edition, 2009
2. David Allan, Karen Lockyer BS RHIT CPC, Medical Language for Modern Health Care 3rd Edition

3. Dakota Mitchell, Lee Haroun, Workbook for Mitchell/Haroun's Introduction to Health Care, 4th Edition, 2017.

Reference Books:

1. George R. Baran, et al, Health care and Biomedical Technology in the 21st Century, 2013.
2. Bruce Colbert, Jeff Ankney, Joe Wilson, John Havrilla, An Integrated Approach to Health Sciences: Anatomy and Physiology, Math, Chemistry and Medical Microbiology, 2nd Edition, 2012
3. Lee Haroun, Susan Royce, Delmar's Teaching Ideas and Classroom Activities for Health Care, 1st Edition, 2004.

		L	T	P	C
19ME1001	**INDUSTRIAL PRACTICE - I (FUNDAMENTALS OF CHASSIS DESIGN AND FABRICATION OF GO-KART)**	**0**	**0**	**2**	**1**

Course Objective: To impart knowledge on

1. Design of a single seater Go -Kart vehicle and Automotive chassis and its applications
2. Steering and brake sub assembly working and application and Development of a single seater Go -Kart vehicle.
3. Powertrain tuning and Test run for optimization

Course Outcomes: After completing the course students will be able to

1. Make selection of frame, steering and braking sub-assemblies for go-kart application
2. Design a space frame and steering wheel for Go -Kart
3. Design of tyres, rims, of steering and rear axle
4. Fabricate a go-kart space frame, rear axle and mount powertrain unit
5. Perform centrifugal clutch assembly, assemble the brake & steering unit on go kart
6. Understand brake bleeding procedure and test run of go kart and its optimization techniques.

MODULE 1 – FRAMES, STEERING, BRAKES & POWERTRAIN (7 Lecture Hours)

Definition of Automotive, automotive applications, Types of frames for different automotive applications, Selection of frame type for go-kart application, steering system types and application. Braking system fundamentals, working of drum & disc brakes, selection procedure, brake force & pressure calculations, types of transmission for go-kart application, working of centrifugal clutch.

MODULE 2 - BASICS OF DESIGNING, GO-KART FRAME DESIGNING (6 Lecture Hours)

CAD introduction and its application, 2-D sketching, 3-D part modeling, design of bottle, design of rim, design of tyre, design of steering wheel.

2-D sketch of frame, Convert to 3-D part, applying weldments, applying fixtures, iteration method of chassis design, confirming the chassis for fabrication session.

MODULE 3 - DESIGN OF REAR AXLE & TORQUE REQUIRED CALCULATIONS, ASSEMBLY OF SUB-COMPONENTS ON FRAME (4 Lecture Hours)

Design of rear axle, bearing & hubs, calculation procedure for torque required calculations.

Assembly of IC engine, assembly of centrifugal clutch, assembly of driver seat, assembly of steering arm and wheel, assembly of brake components, brake bleeding, vehicle testing and optimization.

MODULE 4 - FABRICATION OF FRAME, REAR AXLE FABRICATION (6 Lecture hours)

Cutting of pipes, bending of front impact members, bending of rear engine compartment, bending of cockpit frame, filing of members, welding of members.

Fabricating the rear axle and its mounting - bearing, hubs and wheel assembly

MODULE 5 - STEERING COMPONENTS FABRICATION, POWERTRAIN (14 Lecture Hours)

Fabrication of steering column, fabrication of steering arms and tie rods, fabrication of mechanical linkage of steering unit and assembly of all components.

Fabrication of engine frame, Assembly of engine, assembly of centrifugal clutch and its tuning.

MODULE 6 - ASSEMBLY OF SUB-COMPONENTS ON FRAME, VEHICLE TESTING AND OPTIMIZATION (10 Lecture hours)

Assembly of driver seat, assembly of steering arm and wheel, assembly of brake components, brake bleeding

Vehicle testing and optimization - turning radius measurement, braking distance measurement, test run by students.

Text books:

1. Dr. Kirpal Singh, Automobile engineering Vol 1, Standard Publishers & Distributors, 2013.

19ME1002	INDUSTRIAL PRACTICE - II (SUSPENSION AND STEERING DYNAMICS)	L T P C 0 0 1 0.5

Course objective: To impart knowledge on

1. Design and development of a single seater all-terrain vehicle
2. Automotive suspension design & development
3. Steering and brake dynamics calculations

Course outcomes: After completing the course students will be able to

1. Draw front view swing arm diagram.
2. Draw side view swing arm diagram.
3. Develop bump steer stabilization.
4. Balance turning equation
5. Perform an assembly of suspension and steering system.
6. Analyze BPT stabilization.

MODULE 1 SUSPENSION SYSTEM & BPT (4 Lecture Hours)

Need of suspension system, theory of design for suspension system, four bar mechanism, types of suspension system available in market, selection procedure, BPT design & application.

MODULE 2 FVSA / SVSA ASSEMBLY (6 Lecture Hours)

Camber angle, CCR calculations, FVSA diagram, SVSA diagram

MODULE III SUSPENSION DESIGN ASSEMBLY (4 Lecture Hours)

Assembly of FVSA, SVSA, finalizing the length of UCA, LCA and angle of inclination for ATV application.

MODULE 4 BPT & TURNING EQUATION (6 Lecture hours)

Coordinates from BPT and its stabilization, tuning of steering mechanism via steering / turning equation, concept of drifting - advantages & disadvantages.

MODULE 5 CAD DESIGN OF SUSPENSION SUB-ASSEMBLY (14 Lecture Hours)

design of knuckle joints, design of double wishbone suspension system, design of spring, design of dampers, space frame design and its assembly with wishbone.

MODULE 6 ASSEMBLY OF SUB-COMPONENTS ON FRAME (10 Lecture hours)

Assembly of IC engine, assembly of clutch, assembly of driver seat, assembly of steering arm and wheel, assembly of brake components, brake bleeding, vehicle testing and optimization.

Text books:

1. Thomas D, Gillespie, "Fundamentals of Vehicle Dynamics (R114)", Publisher: Society of Automotive Engineers, Inc., 2014.

19ME2001	INDUSTRIAL PRACTICE - III (DESIGN AND FABRICATION OF ALL TERRAIN VEHICLE)	L T P C 0 0 1 0.5

Course objective: To impart knowledge on

1. Design & development of a single seater all-terrain vehicle
2. Fabrication of suspension sub assembly
3. Steering & braking sub assembly

Course outcomes: After completing the course students will be able to

1. Make a double wishbone suspension system.
2. Fabricate steering arms for ATV application.
3. Fabricate a space frame chassis.
4. Assemble all sub-assemblies on space frame

5. Analyze BPT optimization
6. Conduct test run of ATV.

MODULE 1 SUSPENSION SYSTEM FABRICATION (4 Lecture Hours)
Fabrication of UCA, fabrication of LCA according to CAD design.

MODULE 2 FRAME FABRICATION (6 Lecture Hours) Fabrication of front compartment, fabrication of cockpit & hull area, fabrication of powertrain compartment.

MODULE 3 FIREWALL& BASE PANEL INSTALLATION (4 Lecture Hours)
Installation of firewall & aluminum base panel.

MODULE 4 STEERING ASSEMBLY (6 Lecture hours)
Fabrication of steering arm, fabrication of steering column, fabrication of tie rods, assembly of rack & pinion gears, installation with wheel assembly.

MODULE 5 INSTALLATION OF POWERTRAIN (14 Lecture Hours)
Fabrication of engine mounting frame, fabrication of gearbox mounting frame, installing gearbox in the rear engineer compartment, installing drive shafts to wheel assembly, installing engine, installing clutch & acceleration wire & brake bleeding

MODULE 6 ASSEMBLY OF SUB-COMPONENTS ON FRAME (10 Lecture hours)
Assembly of IC engine, assembly of clutch, assembly of driver seat, assembly of steering arm and wheel, assembly of brake components, vehicle testing and optimization.

Text books:

1. Thomas D, Gillespie, “Fundamentals of Vehicle Dynamics (R114)”, Publisher: Society of Automotive Engineers, Inc., 2014.

19ME2002	INDUSTRIAL PRACTICE - IV (SMART ENGINE, TRANSMISSION TECHNOLOGIES AND BRAKE DYNAMICS)	L	T	P	C
		0	0	1	0.5

Course objective: To impart knowledge on
1. Design and development of a formula III prototype vehicle.
2. Fabrication of suspension sub assembly for formula III prototype vehicle.
3. Steering & braking sub assembly for formula III prototype vehicle.

Course outcomes: After completing the course students will be able to
1. Perform balancing of g-g diagrams
2. Design friction circle
3. Perform balancing of BPT via coordinates of FBF and RBF.
4. Design of bodyworks
5. Perform stress analysis and FEA of frame
6. Analyze stress and FEA of suspension components

MODULE 1 FVSA& SVSA DIAGRAM FOR FORMULA 3 PROTOTYPE (4 Lecture Hours)
Drawing of FVSA, SVSA and its assembly procedure.

MODULE 2 G-G DIAGRAM, FRICTION CIRCLE & ITS APPLICATION (6 Lecture Hours)
Fundamentals of G-G diagram, Friction circle application and drawing

MODULE 3 OPTIMIZATION OF SUSPENSION DRAWING (4 Lecture Hours)
Group Discussion and optimization of suspension drawing with respect to bump steer calculations

MODULE 4 DESIGN OF SUSPENSION SUB ASSEMBLY (6 Lecture hours)
Design of suspension sub assembly components - knuckle joint, hub, wishbones, tie rod ends, studs.

MODULE 5 DESIGN OF FRAME & ASSEMBLY (14 Lecture Hours)
Design of space frame chassis for formula 3 prototype vehicle, suspension compartment design and assembly, disc brakes & caliper design and assembly. FEA analysis procedure, FEA of frame and suspension components

MODULE 6 BODYWORKS DESIGN (10 Lecture hours)
Design of spoilers, design of front nose, design of side ports, design of front wing, diffuser design and its application, flow simulation procedure.

Text books:

1. Millikan & Millikan , “Race Car Vehicle Dynamics (R146),” Publisher: Society Of Automotive Engineers Inc, ISBN: 9781560915263, 1560915269, Edition: 1994.

19ME2003	INDUSTRIAL PRACTICE - V (TESTING AND TUNING OF ENGINE AND TRANSMISSION SYSTEMS)	L	T	P	C
		0	0	1	0.5

Course objective: To impart knowledge on

1. Design and development of a formula 3 prototype vehicle.
2. Fabrication of suspension sub assembly
3. Steering and braking sub assembly

Course outcomes: After completing the course students will be able to

1. Fabricate a double wishbone suspension system.
2. Fabricate steering arms for Formula 3 vehicle application.
3. Fabricate a space frame chassis.
4. Assemble all sub-assemblies on space frame
5. Perform bodyworks mounting
6. Perform the test run of Formula III prototype vehicle.

MODULE 1 SUSPENSION SYSTEM FABRICATION (4 Lecture Hours)

Fabrication of upper control arm (UCA) and Lower control arm (LCA) as per CAD design.

MODULE 2 FRAME FABRICATION (6 Lecture Hours)

Fabrication of front compartment, fabrication of cockpit & hull area, fabrication of powertrain compartment.

MODULE III FIREWALL & BASE PANEL INSTALLATION (4 Lecture Hours)

Installation of firewall & aluminum base panel.

MODULE 4 STEERING ASSEMBLY (6 Lecture hours)

Fabrication of steering arm, fabrication of steering column, fabrication of tie rods, assembly of rack & pinion gears, installation with wheel assembly.

MODULE 5 INSTALLATION OF POWERTRAIN (14 Lecture Hours)

Fabrication of engine mounting frame, fabrication of gearbox mounting frame, installing gearbox in the rear engineer compartment, installing drive shafts to wheel assembly, installing engine, installing clutch & acceleration wire & brake bleeding

MODULE 6 ASSEMBLY OF SUB-COMPONENTS ON FRAME (10 Lecture hours)

Assembly of IC engine, assembly of clutch, assembly of driver seat, assembly of steering arm and wheel, assembly of brake components, assembly of body kits, vehicle testing and optimization.

Text books:

1. Millikan &Millikan , “Race Car Vehicle Dynamics (R146),” Publisher: Society Of Automotive Engineers Inc, ISBN: 9781560915263, 1560915269, Edition: 1994.

19ME2004	INDUSTRIAL PRACTICE - VI (FUNDAMENTALS OF DESIGN FOR ELECTRIC AND HYBRID VEHICLES)	L	T	P	C
		0	0	1	0.5

Course objective: To impart knowledge on

1. Design and development of electric and hybrid vehicle
2. Battery technology and its applications
3. Motor, controllers and final drive design.

Course outcomes: After completing the course students will be able to

1. Design Electric and Hybrid vehicle architecture.
2. Design battery pack with Battery Management System (BMS).
3. Design and code Controller as per the powertrain.
4. Assemble complete powertrain with final drive.
5. Assemble battery pack with cooling system.
6. Assemble motor and controller heat management system.

MODULE 1 INTRODUCTION TO EMOTOR AND CONTROLLER ELECTRIC MOBILITY (E-MOBILITY) (4 Lecture Hours)
Definition of E. Mobility, E mobility application, Introduction to electric powertrain, Types of Electric powertrain and its application, Introduction to Hybrid powertrain, Types of Hybrid Powertrain and its application.
MODULE 2 E MOBILITY APPLICATION, INTRO.(6 Lecture Hours)
Powertrain fundamentals, working of Electric Powertrain, selection procedure, Torque & Power calculations, types of Final drive transmission, Controller Architecture, sensors and its usage.
MODULE 3 N FUNDAMENTALS, WORKING OF ELECTRIC (5 Lecture Hours)
Working of Hybrid Powertrain, selection procedure, types of Hybrid Transmission, Controller Architecture, sensors and its usage, IC engine and motor coupling procedure, coupling design and its analysis.
MODULE 4 D POWERTRAIN, SELECTION OF POWER PACK (6 Lecture hours)
Introduction to Electric power pack, working of electric power pack, power pack capacity calculation, selection of battery cells, battery cells layout, Introduction to battery management system, Design of battery management system, virtual system check.
MODULE 5 VEHICLE PLATFORM AND HEAT MANAGEMENT SYSTEM (14 Lecture Hours) Introduction to vehicle platform, type of e vehicle platform, Design of vehicle platform, design of electric vehicle sub assembly, design of frame, compatible suspension, braking and steering design with user interface.
MODULE 6 ION TO VEHICLE PLATFORM, T-VEHICLE (10 Lecture hours)
Assembly of motor, controller clutch, power pack, steering arm and wheel, brake components. Perform Vehicle wiring and circuit check.

Text books:
1. M. AbulMasrur& Chris Mi, “Hybrid Electric Vehicle,” Wiley Publishers, 2011.

19ME2005	**INDUSTRIAL PRACTICE - VII (FABRICATION TECHNOLOGY FOR ELECTRIC AND HYBRID VEHICLES)**	**L**	**T**	**P**	**C**
		0	**0**	**1**	**0.5**

Course objective: To impart knowledge on
1. Fabrication of electric and hybrid vehicle.
2. Battery pack with Battery Management System (BMS).
3. Motor, controllers and final drive installation.

Course outcomes: After completing the course students will be able to
1. Fabricate an Electric and Hybrid vehicle architecture.
2. Fabricate battery pack with BMS.
3. Install and code Controller as per the powertrain.
4. Assemble complete powertrain with final drive.
5. Assemble battery pack with vehicle heat management system.
6. Perform vehicle testing and powertrain optimization.

MODULE 1 STEERING AND POWERTRAIN OPTIMIZATION. ENGAMENT SYSTEM.RM. (6 Lecture Hours)
Fabrication of front suspension unit, front bulkhead, rear suspension box, types of pillars - A pillar, B pillar, C pillar, rear bulkhead and occupant restraint system.
MODULE 2 B PILLAR, C PILLAR, REAR BULKHEAD (6 Lecture Hours)
Motor assembly and platform fabrication, controller unit platform fabrication, wiring harness fabrication with data collecting sensors.
MODULE 3 ASSEMBLY AND PLATFORM FABRICATION, CONTROLLER UNIT PLATFORM (6 Lecture Hours)
Assembling of controller subcomponents, preparing controller code on system, burning controller code on unit, final controller check and installation of heat sink.
MODULE 4 SUBCOMPONENTS, PREPARING PACK (6 Lecture hours)
Fabrication of cell platform, assembling cells in different design layout, connecting cells terminal, fabrication of battery management system, virtual system check.

MODULE 5 VEHICLE SUBSYSTEM ASSEMBLY ON PLATFORM (14 Lecture Hours)
Assembly of vehicle platform with electric power train, power train controller assembly and power pack assembly, assembly of suspension, braking and steering, installing user interface system.
MODULE 6 ASSEMBLY OF SUSPENSION, BRAKING AND STEERING (4 Lecture hours)
Dry vehicle circuit check, vehicle testing, and error fixing and performance optimization.

Text books:

1. M. Abul Masrur& Chris MI, "Hybrid Electric Vehicle," Wiley Publishers, 2011.

19ME2006	THERMODYNAMICS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. To learn about work and heat interactions, and balance of energy between system and its surroundings.
2. To learn about application of I law and II law to various energy conversion devices.
3. To evaluate the changes in properties of substances in various processes.

Course Outcome: After completing the course the student will be able to

1. Understand the basic concepts in thermodynamics and energy balance to systems and control volumes, in situations involving heat and work interactions.
2. Differentiate between high grade and low grade energies.
3. Evaluate changes in thermodynamic properties of pure substances.
4. Apply gas laws to solve problems related to gas mixtures.
5. Apply psychrometric chart to perform moist air process calculations
6. Recognize the significance of I law for reacting systems and heating value of fuels.

MODULE 1 – FUNDAMENTALS AND FIRST LAW OF THERMODYNAMICS (9 Lecture Hours)
Fundamentals - System and Control volume; Property, State and Process; Work - Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work. Temperature, Definition of thermal equilibrium and Zeroth law. First Law for Cyclic & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy. First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; First law applications for system and control volume.
MODULE 2 – SECOND LAW OF THERMODYNAMICS AND ENTROPY (9 Lecture Hours)
Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Carnot cycle; Absolute temperature scale. Clausius inequality; Definition of entropy S; Demonstration that entropy S is a property; Evaluation of S for solids, liquids, ideal gases. Principle of increase of entropy; Illustration of processes in T-s coordinates. Irreversibility and Availability, Exergy balance equation and Exergy analysis.
MODULE 3 – PROPERTIES OF PURE SUBSTANCE (7 Lecture Hours)
Definition of Pure substance, Thermodynamic properties of pure substances in solid liquid and vapour phases, phase rule P-V, P-T, T-V, T-S, H-S diagrams, P-V-T surfaces, thermodynamic properties of steam. Calculations of work done and heat transfer in non-flow and flow processes. Use of steam tables; Saturation tables; Superheated tables; Identification of states and determination of properties, Mollier's chart.
MODULE 4 – PROPERTIES OF GAS MIXTURES (7 Lecture Hours)
Ideal Gases and ideal gas mixtures, Properties of ideal and real gases, equation of state, Avagadro's law, Dalton's law of partial pressure, compressibility, and compressibility chart.
MODULE 5 - PSYCHROMETRY (7 Lecture Hours)
Properties of dry and wet air, use of psychrometric chart, processes involving heating/cooling and humidification/dehumidification, dew point. Adiabatic mixing, evaporative cooling, problems.

MODULE 6 - COMBUSTION FUNDAMENTALS (6 Lecture Hours)
Introduction to solid, liquid and gaseous fuels– Stoichiometry. A/F ratio. Energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion. Combustion efficiency.

Text Books:
1. P.K. Nag, "Engineering Thermodynamics", Tata McGraw-Hill, 2013
2. Yunus Cengel, "Thermodynamics", Tata McGraw-Hill, 2014

Reference Books:
1. Sonntag, R. E, Borgnakke, C. and Van Wylen G. J."Fundamentals of Thermodynamics 7th Edition", John Wiley and Sons, 2008.
2. Jones, J. B. and Duggan, R. E., Engineering Thermodynamics, Prentice-Hall of India, 1996.
3. Moran, M. J. and Shapiro, H. N., "Fundamentals of Engineering Thermodynamics, 8th Edition" ,John Wiley and Sons, 2014.
4. J.P. Holman, "Thermodynamics", 4thEdition, McGraw Hill, 2002
5. T. Roy Choudhury, "Basic Engineering Thermodynamics", Tata McGraw-Hill, 2000.

19ME2007	APPLIED THERMODYNAMICS	L	T	P	C
		3	0	0	3

Prerequisite: Thermodynamics
Course Objectives: To impart knowledge on
1. Various practical power cycles and heat pump cycles.
2. Analysis of energy conversion in various thermal devices such as combustors, air coolers, nozzles, diffusers, steam turbines and reciprocating compressors
3. High speed compressible flow phenomena and refrigeration and air conditioning

Course Outcome: After completing the course the student will be able to
1. Estimate the performance of a steam generator.
2. Carry out analysis of various gas and vapour power cycles.
3. Conduct analysis of steam nozzles and turbines.
4. Evaluate performance of reciprocating compressors.
5. Apply principles of refrigeration and air conditioning for analysis and performance evaluation.
6. Analyze compressible flow phenomena

MODULE 1 – STEAM GENERATORS (8 Lecture Hours) Classification of boilers, boiler terms. Performance of steam generator - evaporative capacity, equivalent evaporation, factor of evaporation, boiler efficiency, heat losses in a boiler plant and heat balance calculations.
MODULE 2 - VAPOUR AND AIR-STANDARD CYCLES (8 Lecture Hours) Vapor power cycles - Rankine cycle with superheat, reheat and regeneration, Gas power cycles, Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle, effect of reheat, regeneration and intercooling.
MODULE 3 - STEAM NOZZLES AND TURBINES (7 Lecture Hours) Flow of steam through nozzles, effect of friction, critical pressure ratio, supersaturated flow. Impulse and Reaction principles, compounding, Determination of work done and efficiency using velocity diagrams.
MODULE 4 - AIR COMPRESSORS (8 Lecture Hours) Reciprocating compressors, Work input representation on p-v diagram, Effect of clearance and volumetric efficiency. Adiabatic, isothermal and mechanical efficiencies. Staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors.
MODULE 5 - REFRIGERATION AND AIRCONDITIONING (7 Lecture Hours) Vapor compression refrigeration cycle, super heat, sub cooling – Performance calculations - refrigerants and their properties, Working principle and description of vapour absorption systems- Ammonia –Water, Lithium bromide – water systems.
MODULE 6 - COMPRESSIBLE FLOWS (7 Lecture Hours) Basics of compressible flow. Stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables for isentropic flow and normal shock flow.

Text Books:
1. P.K. Nag, "Engineering Thermodynamics", Tata McGraw-Hill, 2013.
2. YunusCengel, "Thermodynamics", Tata McGraw-Hill, 2014.

Reference Books:

1. J.P. Holman, "Thermodynamics", 4^{th} Edition, McGraw Hill, 2002.
2. T. Roy Choudhury, "Basic Engineering Thermodynamics", Tata McGraw-Hill, 2000.
3. Vanwylen and Sontag, "Classical Thermodynamics", Wiley Eastern, 1999.
4. R.K. Rajput, "A Textbook of Engineering Thermodynamics", Laxmi Publications, 2016.
5. J. P. O'Connell and J. M. Haile, "Thermodynamics: Fundamentals for Applications," Cambridge university press, 2005.

MECHANICAL ENGINEERING

LIST OF COURSES

Sl. No	Course Code	Name of the Course	Credits
1	17ME4001	Applied Thermal Engineering and Experimental Methods	3:1:0
2	18ME2001	Thermodynamics, Refrigeration and Air Conditioning	3:0:0
3	18ME2002	Refrigeration and Air Conditioning Lab	0:0:1
4	18ME2003	Theory of Machines	2:1:0
5	18ME2004	Machine Design	3:0:0
6	18ME2005	Machine Drawing Lab for Agriculture	0:0:1
7	18ME2006	Heat and Mass Transfer in Food Processing	2:0:0
8	18ME2007	Heat Transfer Lab for Agriculture	0:0:1
9	18ME2008	CAD Applications Lab	0:0:2

S. No	Code No.	Name of the Course	Hours per week			Credits
			L	T	P	
1	18ME1001	Engineering Drawing	0	0	4	2
2	18ME1002	Engineering Graphics (AutoCAD)	0	0	2	1
3	18ME1003	Engineering Mechanics	3	1	0	4
4	18ME1004	Workshop / Manufacturing Practices Laboratory	0	0	2	1
5	18ME1005	Basic Mechanical Engineering	3	0	0	3
6	18ME1006	Workshop Practice	0	0	2	1
7	18ME1007	Computer Aided Engineering Drawing	0	0	4	2
8	18ME2009	Fluid Mechanics Laboratory	0	0	2	1
9	18ME2010	Heat and Mass Transfer	3	0	0	3
10	18ME2011	Heat Transfer Laboratory	0	0	4	2
11	18ME2012	Strength of Materials	3	0	0	3
12	18ME2013	Strength of Materials Laboratory	0	0	2	1
13	18ME2014	Solid Mechanics	3	0	0	3
14	18ME2015	Kinematics and Theory of Machines	3	1	0	4
15	18ME2016	Design of Machine Elements	3	0	0	3
16	18ME2017	Design of Transmission Systems	3	0	0	3
17	18ME2018	Dynamics Laboratory	0	0	2	1
18	18ME2019	Machine Drawing Laboratory	0	0	2	1
19	18ME2020	Manufacturing Processes	3	0	0	3
20	18ME2021	Manufacturing Laboratory-I	0	0	4	2
21	18ME2022	Manufacturing Technology	3	0	0	3
22	18ME2023	Manufacturing Laboratory -II	0	0	2	1
23	18ME2024	Computer Aided Manufacturing Laboratory	0	0	2	1
24	18ME2025	Materials Engineering	3	0	0	3
25	18ME2026	Basic Automobile Engineering	3	0	0	3
26	18ME2027	Fundamentals of Thermal Sciences and Fluid Mechanics	3	0	0	3
27	18ME2028	Hydraulics and Pneumatics	3	0	0	3
28	18ME2029	Hydraulics and Pneumatics Laboratory	0	0	2	1

29	18ME2030	Mechanics and Engineering Design Lab	0	0	2	1
30	18ME2031	Kinematics and Dynamics of Machinery	3	0	0	3
31	18ME2032	Mechanics of Solids	3	0	0	3
32	18ME2033	Engineering Design Laboratory (CAE)	0	0	4	2
33	18ME2034	Operations Research	3	0	0	3
34	18ME2035	Technical Aptitude	0	0	1	1
35	18ME2036	Thermodynamics	3	0	0	3
36	18ME2037	Applied Thermodynamics	3	0	0	3
37	18ME2038	Thermal Engineering Laboratory	0	0	2	1
38	18ME2039	Fluid Mechanics and Fluid Machines	3	1	0	4
76	18MR2001	Metrology and Measurement Systems	3	0	0	3
77	18MR2002	Fluid Power Control and Automation Lab	0	0	2	1
78	18MR2003	Design of Mechatronic System	3	0	0	3
79	18MR2004	Metallurgy Laboratory	0	0	2	1
80	18MR2005	CAD/CAM Laboratory	0	0	2	1
81	18ME3001	Thermodynamics and Combustion	3	0	0	3
82	18ME3002	Advanced Fluid Dynamics	3	0	0	3
83	18ME3003	Advanced Heat Transfer	3	0	0	3
84	18ME3004	Design of Thermal Power Equipment	3	0	0	3
85	18ME3005	Refrigeration System Design	3	0	0	3
86	18ME3006	Computer Aided Design Laboratory	0	0	4	2
87	18ME3007	Analysis and Simulation Lab	0	0	4	2
88	18ME3008	Advanced Heat Transfer Laboratory	0	0	4	2
89	18ME 3009	Advanced Computational Fluid Dynamics Laboratory	0	0	4	2
90	18ME3010	Advanced Manufacturing Processes	3	0	0	3
91	18ME3011	Advanced Metal Cutting Theory	3	0	0	3
92	18ME3012	Design for Manufacturing and Assembly	3	0	0	3
93	18ME3013	Engineering Materials and Applications	3	0	0	3
94	18ME3014	Advanced Metrology and Measurement Systems	3	0	0	3
95	18ME3015	Advanced Computer Aided Manufacturing Lab	0	0	4	2
96	18ME3016	Mechatronics and Robotics Laboratory	0	0	4	2
97	18ME3017	Advanced Stress Analysis	3	0	0	3
98	18ME3018	Finite Element Methods in Engineering	3	0	0	3
99	18ME3019	Advanced Vibrations and Acoustics	3	0	0	3
100	18ME3020	Computer Aided Design	3	0	0	3
101	18ME3021	Vibration Laboratory	0	0	4	2
102	18ME3022	Multi body Dynamics Lab (ADAMS)	0	0	4	2
103	18ME3023	Nuclear Power Engineering	3	0	0	3
104	18ME3024	Energy Conservation and Management.	3	0	0	3
105	18ME3025	Solar Energy Utilization	3	0	0	3
106	18ME3026	Air Conditioning System Design	3	0	0	3
107	18ME 3027	Gas Turbines	3	0	0	3

108	18ME 3028	Advanced Instrumentation in Thermal Engineering	3	0	0	3
109	18ME 3029	Biomass Energy	3	0	0	3
110	18ME 3030	Design and Analysis of Heat Exchangers	3	0	0	3
111	18ME 3031	Two Phase Flow and Heat Transfer	3	0	0	3
112	18ME 3032	Computational Fluid Dynamics	3	0	0	3
113	18ME 3033	Advanced IC Engines	3	0	0	3
114	18ME 3034	Advanced Turbo machinery	3	0	0	3
115	18ME 3035	Design of Solar and Wind System	3	0	0	3
116	18ME3036	Quality Concepts in Design	3	0	0	3
117	18ME3037	Manufacturing System and Simulation	3	0	0	3
118	18ME3038	Flexible Manufacturing System	3	0	0	3
119	18ME3039	Computer Integrated Manufacturing systems	3	0	0	3
120	18ME3040	Computer Applications in Design	3	0	0	3
121	18ME3041	Design of Fluid Power Systems	3	0	0	3
122	18ME3042	Total Quality Management	3	0	0	3
123	18ME3043	Industrial Automation and Mechatronics	3	0	0	3
124	18ME3044	Control of CNC Machine tools	3	0	0	3
125	18ME3045	Engineering Product Design and Development Strategies	3	0	0	3
126	18ME3046	Advanced Tool Design	3	0	0	3
127	18ME3047	Industrial Robotics	3	0	0	3
128	18ME3048	Advanced Machine Design	3	0	0	3
129	18ME3049	Advanced Strength of Materials	3	0	0	3
130	18ME3050	Engineering Fracture Mechanics	3	0	0	3
131	18ME3051	Advanced Mechanism Design	3	0	0	3
132	18ME3052	Tribology in Design	3	0	0	3
133	18ME3053	Rotor Dynamics	3	0	0	3
134	18ME3054	Optimization Techniques	3	0	0	3
135	18ME3055	Condition Based Monitoring	3	0	0	3
136	18ME3056	Multi-body Dynamics	3	0	0	3
137	18ME 3057	Research Methodology and IPR	2	0	0	2
138	18ME 3058	Business Analytics	3	0	0	3
139	18ME 3059	Industrial Safety	3	0	0	3
140	18ME 3060	Operations Research	3	0	0	3
141	18ME 3061	Cost Management of Engineering Projects	3	0	0	3
142	18ME 3062	Composite Materials	3	0	0	3
143	18ME 3063	Waste to Energy	3	0	0	3
144	18ME3064	Disaster Management	2	0	0	0
145	18ME3065	Constitution of India	2	0	0	0
146	18ME3066	Pedagogy Studies	2	0	0	0

17ME4001 APPLIED THERMAL ENGINEERING AND EXPERIMENTAL METHODS

Credits: 3:1:0

Course Objectives:
To impart Knowledge on
- Fundamentals of heat transfer, exergy analysis and optimization techniques for various energy systems.
- Measurement of thermo physical properties of fluids.
- Design and modelling of experiments.

Course Outcomes:
Ability to:
- Design various experimental systems based on the conservation laws of physics.
- Relate the knowledge in analyzing the heat transfer systems to the fundamental heat transfer laws.
- Identify high performance heat transfer fluids for thermal systems.
- Apply the knowledge of measurement techniques in the modern energy systems.
- Conduct the experiments and record data for further analysis.
- Demonstrate knowledge of various modelling techniques for optimization of experimental results.

UNIT I THERMAL SYSTEM DESIGN. First law and Second law analysis – principle of increase of entropy – Exergy analysis of thermal systems – heat pipes, heat exchanger, thermoelectric cooler.
UNIT II FLUID FLOW AND HEAT TRANSFER. Forced convection – Mass, Momentum and Energy equations – thermal boundary layer – Laminar and Turbulent flow through mini & micro channels.
UNIT III ADVANCED HEAT TRANSFER FLUIDS. Nanofluid preparation and characterization – Micro level mechanisms in nanofluid flow. Measurement of Thermo physical properties.
UNIT IV EXPERIMENTAL METHODS. Pressure, temperature and flow measurements – Velocity. Methods of development of correlations – Uncertainty analysis in experiments. Data acquisition and processing. Regression analysis and curve fitting
UNIT V DESIGN OF EXPERIMENTS. Modeling of thermal equipment - system simulation (successive substitution - Newton - Raphson method) - optimization - linear programming, geometric programming- Examples applied to heat transfer problems and energy systems.

Text books:
1. Frank P Incropera & David P De witt, "Fundamentals of Heat & Mass Transfer", 5th Edition, John Wiley& Sons, 2007.
2. Holman, J.P, "Experimental methods for engineers", 7th Edition, McGraw Hill Education, 2017.

Reference Books:
1. K V Wong, Thermodynamics for Engineers, First Indian Edition, 2010, CRC Press.
2. Kalyanamoy Deb. "Optimization for Engineering Design algorithms and Examples", Prentice Hall of India Pvt. Ltd. 2013.
3. Sarit K Das, SUS Choi, Nanofluid: Science and Technology, Wiley-Inderscience, 2008.

18ME2001 THERMODYNAMICS, REFRIGERATION AND AIR CONDITIONING
(Use of standard thermodynamic charts and tables are permitted)

Credits: 3:0:0

Course Objectives:
To impart knowledge on
- The laws of thermodynamics and their applications on thermal systems.
- The working principle and applications of refrigeration and air conditioning systems.
- Psychrometric processes and cycles of air conditioning systems.

Course Outcomes:
Ability to

- Apply the basic concepts of thermodynamics to different thermal systems.
- Perform energy balance and exergy analysis for thermal systems.
- Evaluate the performance of refrigeration cycles
- Analyse psychrometric processes and cycles of air conditioning systems.
- Estimate the energy requirements of cooling and heating equipment for simple air conditioning applications.
- Analyse the performance of air conditioning systems.

Course Description
Basics of thermodynamics: Thermodynamic System and Control Volume, Thermodynamic Properties, Processes and Cycles, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics, work transfer, heat transfer, specific heat and latent heat, first law of thermodynamics, First Law for a Closed System Undergoing a Cycle, Different Forms of Stored Energy, enthalpy, Steady Flow Process, Otto, diesel and dual cycles. **Entropy and properties of steam:** Second law of thermodynamics, cyclic heat engine, refrigerator and heat pump, reversibility and irreversibility, Carnot cycle, Carnot theorem, entropy principle, The Inequality of Clausius, first and second law combined, third law of thermodynamics, available energy, properties of steam. **Refrigeration cycles:** Refrigerants, refrigeration equipments, vapour compression refrigeration cycle, absorption refrigeration cycle, heat pump system, air refrigeration cycle, Liquefaction of Gases, production of solid ice. **Psychrometric and air conditioning systems:** Properties of atmospheric air, Psychrometric Chart, Psychrometric Processes, air conditioning equipments, comfort air conditioning, summer and winter air conditioning, cooling load estimation, air distribution and ducts. **Applications of refrigeration and air conditioning:** Domestic refrigerator and freezer, water coolers, ice manufacture, refrigerated trucks, cooling of milk, cold storages, room air conditioner, application of air conditioning in industry.

Text Books:

1. P K Nag, "Engineering thermodynamics", Tata McGraw-Hill, 2013.
2. Arora C P, "Refrigeration and Air conditioning", Tata McGraw-Hill, New Delhi, 2013.

Reference Books:

1. R S Khurmi and J K Gupta, "A text book of Refrigeration and air conditioning", S Chand and company Ltd, 2013.
2. R K Rajput, "A text book of engineering thermodynamics", Laxmi publications, 2016.
3. Yunus A Cengel, Michael A Boles, "Thermodynamics, An engineering approach", fifth edition, Tata McGraw-Hill, 2014.
4. Manohar Prasad, "Refrigeration and Air conditioning", Wiley Eastern Ltd, 2011.

18ME2002 REFRIGERATION AND AIR CONDITIONING LAB

Credits: 0:0:1

Course Objectives:
To impart knowledge on

- Refrigeration and air conditioning cycles.
- Refrigeration and air conditioning equipment.
- Working principle of heat pump.

Course Outcomes:
Ability to

- List the components and functions of a household domestic refrigerator.
- Describe the working principle of a water cooler.
- Compare the construction and working principle of window and split air conditioners.
- Analyse the performance of a refrigerator.
- Evaluate the performance of a heat pump.
- Determine the performance of an air conditioner.

List of Experiments

1. Performance test on Refrigeration cycle.
2. Performance test on Heat pump.
3. Performance test on Air Conditioning Cycle.
4. Determination of bypass and capacity factors in air conditioning test rig.
5. Experiments on psychrometric properties of air
6. On-site study of chilling or ice making and cold storage plants.

Reference Books:

1. Arora C P, "Refrigeration and Air conditioning", Tata McGraw-Hill, New Delhi, 2013.
2. R S Khurmi and J K Gupta, "A text book of Refrigeration and air conditioning", S Chand and company Ltd, 2013.
3. Manohar Prasad, "Refrigeration and Air conditioning", Wiley Eastern Ltd., 2011.

18ME2003 THEORY OF MACHINES

Credits: 2:1:0

Course Objectives:

To impart knowledge on

- Fundamentals of mechanisms and principles involved in velocity and acceleration at any point in a link of a mechanism.
- Concepts of toothed gearing and kinematics of gear trains.
- The effects of friction in motion transmission and in machine components and balancing of rotating masses

Course Outcomes:

Ability to

- Illustrate fundamentals of different mechanisms.
- Analyse position, velocity and acceleration of links in mechanisms.
- Understand gear nomenclature and analysis of gear trains
- Design transmission elements considering frictional aspects
- Determine governing speed of various governors
- Balance rotating masses on same and different planes.

Course Description

Fundamentals of mechanisms and kinematics of simple mechanisms: Elements, links, pairs, kinematics chain and mechanisms. Classification of parts and mechanisms. Lower and higher pairs. Four bar chain, slider crank chain and their inversions. Determination of velocity and acceleration graphical (relative velocity and acceleration) method. **Gear and Gear Trains:** Types of Gears. Law of toothed gearing, velocity of sliding between two teeth in mesh. Involute and cycloidal profile for gear teeth. Spur gear, nomenclature. Introduction to helical, spiral, bevel and worm gear. Simple, compound, reverted and Epicyclic trains. Determining velocity ratio by tabular method. **Flywheel, Belt and Chain Drives, Bearings:** Turning moment diagrams, coefficient of fluctuation of speed and energy, weight of flywheel, flywheel applications. Belt drives, belt materials, length of belt, power transmitted, velocity ratio, belt size for flat and V belts. Chain drives. Types of friction, laws of dry friction. Friction of pivots and collars. Single disc, multiple disc, and cone clutches. Rolling friction, anti-friction bearings. **Governors:** Types of governors. Constructional details and analysis of Watt, Porter and Proell governors. Effect of friction. Sensitiveness, stability, hunting, isochronism. **Balancing:** Static and dynamic balancing. Balancing of rotating masses in one and different planes.

Text Books:

1. Rattan.S.S, "Theory of Machines" , Tata McGraw Hill, 2012

Reference Books:

1. Ambekar A.G., "Mechanism and Machine Theory", Prentice Hall of India, New Delhi, 2007.

2. Shigley , Pennock,G, Uicker J.J. “Theory of Machines and Mechanisms”, Oxford University Press, 2015.
3. Thomas Bevan, “Theory of Machines”, CBS Pub., 2001.
4. Ghosh A. and Mallick A.K., “Theory of Mechanisms and Machines”, affiliated East-West Press Pvt. Ltd., New Delhi, 3rd Edition, Paper back, 2011.
5. R.S. Khurmi. “Theory of Machines” Khanna Publishers, Delhi, 2006.

18ME2004 MACHINE DESIGN

(Use of approved Data books are permitted)

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Stress analysis, theories of failure and material science in the design of machine components .
- Design of common machine elements such as shafts, fasteners, springs, belts and bearings.
- Solving simple, open-ended design problems involving cost, drawings and structural analysis.

Course Outcomes:

Ability to

- Apply basic stress and strain analysis techniques.
- Describe the design process, material selection and calculation of stresses and stress concentrations.
- Make use of standard theories of failure and analyse fatigue to develop safety factors for machine elements.
- Develop solid, hollow shafts and couplings.
- Examine cotter and knuckle joints and design helical and leaf springs.
- Design belt drives, screws and bearings.

Course Description

Introduction: The design process - Machine Design, Phase/steps in Machine design process - Engineering Materials and their Mechanical properties - Types of loads and stresses - Direct, Bending and torsional stress equations - Impact and shock loading - Factor of safety - theories of failure. **Stress concentration and fatigue**: Stress concentration: Definition, Reason for occurrence, Methods to reduce Stress concentration factor - Design for Variable Loading: Types of variable/Cyclic loads, Fatigue Failure, Endurance Limit and Strength, S-N Diagram (Simple problems). **Shafts and couplings**: Design of solid and hollow shaft under torsion and combined bending and torsion - Design of Keys and keyways - Design of muff, sleeve and rigid flange couplings. **Joints and springs**: Design of cotter and knuckle joints - Design of welded joints subjected to static loads - Design of helical and leaf springs under constant loads and varying loads. **Belts, screws and bearings**: Belt drives - Ratio of tensions - Design of flat and V-belts. Design of screw motion mechanisms like screw jack, lead screw. Design of sliding contact and rolling contact type bearings.

Text Books:

1. T. V. Sundararajamoorthy, "Machine Design", 9th Edition, Anuradha Publications, 2013.
2. S. Md. Jalaludeen, “Machine Design”, Anuradha Publications, Chennai 2011.

Reference Books:

1. T.J.Prabhu, "Fundamentals of Machine Design", Paperback, 2015.
2. V. B. Bhandari , “Design of Machine Elements”, 4th Edition, Tata McGraw-Hill, 2016.
3. Jain R K, “ Machine Design”, Khanna Publishers, New Delhi, 2013.
4. Joseph Shigley, Charles, Richard Budynas and Keith Nisbett, “Mechanical Engineering Design”, 8th Edition, Tata McGraw–Hill, 2015.
5. Bernard Hamrock, “Fundamentals of Machine Elements”, McGrawHill, 2014.

Hand book:

Design data book for engineers, PSG College of Technology, Coimbatore, Kalaikathir Achagam, 2012.

18ME2005 MACHINE DRAWING LAB FOR AGRICULTURE

Credits: 0:0:1

Course objectives:

To impart knowledge on

- The basic concepts of design of agricultural machineries.
- Detailed design and drawing of various components of agricultural machineries.
- Part drawing and assembly drawing.

Course Outcomes:

Ability to

- Identify the angles of projection and dimensioning methods.
- Select suitable standards for fasteners.
- Categorize different forms of screw threads.
- Distinguish between the square, hexagonal nuts and bolts.
- Compare various couplings and joints.
- Construct part drawing from assembled drawing.

List of experiments

1. First and third angle projection, different methods of dimensioning and Sectional drawing of simple machine parts.
2. Forms of screw threads and drawing of BSW, Square and Metric threads.
3. Drawing of square headed and hexagonal headed nuts and bolts & drawing of different types of keys.
4. Drawing of coupling (Sleeve / Flange).
5. Drawing of joints (Cotter / Knuckle).
6. Assembly drawing of simple agricultural equipment.

Reference Books:

1. Narayana K L and Kannaiah P., “Machine Drawing”, SciTech Publications (India) Pvt. Ltd., Chennai, 2010.
2. Anilkumar.K.N.,“Engineering Graphics”, Adhyuthnarayan Publishers, Kottayam, 2005.
3. Bhatt. N. D and Panchal.V. M.,“Machine Drawing”, Charotar Publishing House Pvt. Ltd., Anand, 2013.

18ME2006 HEAT AND MASS TRANSFER IN FOOD PROCESSING

Credits: 2:0:0

Course Objectives:

To impart knowledge on

- Fundamentals and principles of heat and mass transfer.
- Design of heat exchangers.
- Determination of heat transfer coefficient of different modes of heat transfer.

Course Outcomes:

Ability to

- Solve heat transfer problems by applying the principles of conduction, convection, radiation and mass diffusion.
- Design heat transfer systems with extended surfaces.
- Analyse heat exchanger performance.
- Develop empirical correlations to determine the heat transfer coefficient.
- Predict flow patterns in boiling and condensation processes.
- Estimate the diffusion and mass transfer coefficient for gasses and liquids.

Course Description

Basic heat transfer processes. Theory of heat conduction, Fourier’s law, concept of electrical analogy and its application for thermal circuits, heat transfer through composite walls and insulated pipelines; One-dimensional steady state heat conduction with heat generation: Heat flow through slab, hollow sphere and cylinder with linear heat transfer, uniform/non-uniform heat generation. Extended surfaces.

Effectiveness and efficiency of the fins; unsteady state heat conduction. **Convection:** Forced and free convection, dimensional analysis in convective heat transfer; Dimensionless numbers. **Radiation** emissivity, absorptivity, transmissivity, radiation through black and grey surfaces, determination of shape factors; **Condensation and boiling**: Film- and drop-wise condensation. **Heat Exchangers:** fouling factors, jacketed kettles, LMTD, classification of heat exchangers, heat exchanger design and application of different types of heat exchangers in dairy and food industry. **Mass transfer:** Fick's law of diffusion, steady state diffusion of gases and liquids through solids, equimolal diffusion, isothermal evaporation of water into air, mass transfer coefficient, application in dairy and food industry.

Text Books:

1. R. C. Sachdeva, "Heat and Mass Transfer", Wiley Eastern, 2017.
2. J.P. Holman, "Heat Transfer", SI Metric 10^{th} Edition, McGraw Hill, ISE, 2011.

Reference Books:

1. P.K. Nag, "Heat Transfer", Tata McGraw Hill, New Delhi, 2011.
2. P.S. Ghoshdastidar, "Heat Transfer", Oxford, 2012.
3. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 2010.
4. C.P. Kothandaraman, "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 2012.
5. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 2011.

18ME2007 HEAT TRANSFER LAB FOR AGRICULTURE

Credit: 0:0:1

Course Objectives:

To impart knowledge on

- Heat transfer characteristics of various heat transfer apparatus.
- Design calculations of different modes of heat transfer.
- Heat transfer coefficients in thermal systems.

Course Outcomes:

Ability to

- Calculate and compare the thermal conductivity of different materials.
- Predict the convective heat transfer coefficient by free convection.
- Determine forced convective heat transfer coefficient using pin–fin.
- Analyze the performance parameters of parallel flow heat exchanger.
- Evaluate the performance parameters of counter flow heat exchanger.
- Estimate the emissivity of grey and black surfaces by radiation.

List of Experiments

1. Determination of thermal conductivity of lagged pipe.
2. Determination of thermal conductivity of composite wall.
3. Determination of free convection using a vertical cylindrical rod.
4. Determination of heat transfer coefficient using a fin–pin by forced convection.
5. Determination of heat transfer coefficient using a parallel and counter flow heat exchangers.
6. Determination of emissivity of the given test surface.

Reference Books:

1. R. C. Sachdeva, "Heat and Mass Transfer", Wiley Eastern, 2017.
2. J.P. Holman, "Heat Transfer", SI Metric 10^{th} Edition, McGraw Hill, ISE, 2011.
3. P.K. Nag, "Heat Transfer", Tata McGraw Hill, New Delhi, 2011.
4. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 2010.
5. C.P. Kothandaraman, "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 2012.

18ME2008 CAD APPLICATIONS LAB

Credits: 0:0:2

Course Objectives:

To impart knowledge on

- Simple modelling software.
- Drawing commands using AutoCAD.
- Sectional views, 2D and 3D drawings using AutoCAD.

Course Outcomes:

Ability to

- Make use of basic drawing aids and modifying tools in AutoCAD.
- Construct and dimension lines and arcs using different methods.
- Create 2D drawings using various tool bars.
- Prepare sectional drawings for machine parts.
- Develop isometric drawing of primitive solids.
- Produce 3D drawings using various tool bars.

List of Experiments

1. Drawing Aids: Snap, Grid, Limits, Osnap tool bars.
2. Modifying Commands: Trim, Extend, Offset, mirror, copy, chamfer, fillet, array, rotate.
3. Application of Line, Arc and Circle commands.
4. Dimensioning, hatching and Layers.
5. 2-D drawing of machine parts- Foot step bearing.
6. 2-D Sectional drawing of machine parts- Knuckle joint and stuffing box.
7. Isometric Drawings of primitive solids and combination of primitive solids.
8. Drawing of hexagonal nut, bolt and other machine parts.
9. Practice on 3-D Commands: Extrusion and loft.
10. Practice on 3-D Commands: Sweep and press pull.
11. Practice on 3-D Commands: revolving and joining.
12. Demonstration on CNC Machine.

Reference Books:

1. Sham Tickoo, "AutoCAD 2017 for Engineers & Designers", 23rd edition, Dreamtech Press, 2016.
2. Zeid Ibrahim, “Mastering CAD/ CAM with Engineering”, McGraw- Hill Education Pvt. Ltd., New Delhi, 2011.

18ME1001	ENGINEERING DRAWING	L	T	P	C
		0	0	4	2

Course Objectives: To impart knowledge on

1. Modern engineering tools necessary for engineering drawing
2. Drafting, analysis and to understand the operational functions.
3. Interpretation of technical graphics assemblies of machine components.

Course Outcome: After completing the course the student will be able to

1. Understand the engineering design and solid modelling.
2. Visualize the engineering components.
3. Perform basic geometrical constructions and multiple views of objects.
4. Develop orthographic projection of lines and plane surfaces.
5. Prepare projections and sections of simple solids
6. Prepare isometric and perspective projections of simple solids

LIST OF EXPERIMENTS

CONCEPTS AND CONVENTIONS (Not for Examination)

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

PLANE CURVES : Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves.
SCALES : Scales: Construction of Diagonal and Vernier scales.
ORTHOGRAPHIC PROJECTIONS: Orthographic projections – principles, Principal planes-First angle projection-projection of points.
FREE HAND SKETCHING: Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Free hand sketching of multiple views from pictorial views of objects.
PROJECTION OF POINTS; Projections of points located in four different quadrants
PROJECTION OF LINES; Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces
PROJECTION OF PLANE SURFACES: Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method
PROJECTION OF SOLIDS; Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method and auxiliary plane method.
SECTION OF SOLIDS: Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section.
DEVELOPMENT OF SURFACES; Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Development of lateral surfaces of solids with cut-outs and holes.
ISOMETRIC PROJECTIONS: Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones - combination of two solid objects in simple vertical positions and miscellaneous problems.
PERSPECTIVE PROJECTIONS; Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method

Text Book:

1. Leo Dev Wins. K, Engineering Drawing, 3rd Edition Pearson Publications, 2017.
2. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.

Reference Book:

1. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
2. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.
3. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.
4. Rathnam K., "A First Course in Engineering Drawing", Springer Singapore, 2018.
5. George Sydenham Clarke, "Practical Geometry and Engineering Drawing", Nabu Press 2012.

18ME1002	**ENGINEERING GRAPHICS (AUTOCAD)**	**L T P C** **0 0 2 1**

Co requisite: Engineering Drawing

Course Objectives: To impart knowledge on
1. To learn engineering design and its place in society
2. To get exposure to the visual aspects of engineering design and graphics standards
3. To apply graphics standards to create working drawings and communicate across industries.

Course Outcome: After completing the course the student will be able to
1. Design a system, component, or process to meet desired needs within realistic constraints and sustainability.

2. Communicate effectively with various stake holders of engineering design industry
3. Apply techniques, skills, and modern engineering tools necessary for engineering practice
4. Extract mass, moment of inertia and center of gravity from 2D and 3D model data
5. Optimize material required in fabrication of parts.
6. Visualize assembly of system with fewer parts.

MODULE I – USER INTERFACE (5 Lecture hours)

Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command window, The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.

MODULE II – CUSTOMIZATION, DRAWING AIDS, PAGE SETUP AND PRINTING (5 Lecture hours)

Setting up of units, drawing limits, drawing paper size, scale settings and use of drawing template. Draw to PDF files the printer, Snap to objects manually and automatically using object snap settings; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles; Printing and saving drawings.

MODULE III – DRAWING AND MODIFYING (5 Lecture hours)

Drawing polylines, ellipses, polygons and use of spline curves. Adding and altering objects, moving and dublicating objects, modifying and maneuvering, hatching and sketching. Polar and rectangular arrays. Application of arcs to draw simple parts. Use of text fonts, formatting text and setting title box for drawing template.

MODULE IV – DIMENSIONING ANNOTATIONS, LAYERING & OTHER FUNCTIONS (5 Lecture hours)

ISO and ANSI standards for coordinate dimensioning and tolerance; Orthographic constraints, applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths and weight through modifying existing lines (extend/lengthen).

MODULE V – ISOMETRIC, ORTHOGRAPHIC AND 2D TO 3D (5 Lecture hours)

Orthographic projection techniques; drawing isometric drawing from orthographic drawing and vice versa. Creating regions, converting polylines to single entity and 2D to 3D of simple objects. Modeling of simple parts and assemblies. Modifying solids using Boolean operations. Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface. Application of isometric, multi view, auxiliary, and section views. Spatial visualization exercises. Solid, surface, and wireframe models.

MODULE VI – DEMONSTRATION OF A SIMPLE TEAM DESIGN PROJECT (5 Lecture hours)

Use of Block commands to model repetitive objects in civil, mechanical, electrical and electronics and computer science industries and apply in a design project. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying color coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling.

Text Book:

1. G.Ganesan, “Basic Computer Aided Design and Drafting using AutoCAD 2015”, McGraw Hill, 2018.
2. Sham Tickoo, “AutoCAD 2015 for Engineers and Designers”, Dream Tech Press, 2014.

Reference Books:

1. Elliot Gidis, “Up and Running with AutoCAD 2015”, 2D and 3D Drawing and Modeling. Academic Press, 2014
2. Gary R. Bertoline and Eric n. Wiebe, “Fundamentals of Graphics Communication”, McGraw Hill, 2002.
3. Sham Tickoo, “AutoCAD 2015 for Engineers and Designers”, Dream Tech Press, 2014
4. Terry T. Wohlers, “Applying AutoCAD”, McGrawHill, 2013

5. Antonio Ramirez., Jana Schmidt., Douglas Smith, "Technical Drawing 101 with AutoCAD 2016 5th Edition, 2016.

18ME1003	ENGINEERING MECHANICS	L T P C 3 1 0 4

Course Objectives: To impart knowledge on

1. Statics with an emphasis on force equilibrium and free body diagrams.
2. Significance of centroid, centre of gravity and moment of inertia.
3. Principles to study the motion of a body and concept of relative velocity and acceleration.

Course Outcome: After completing the course the student will be able to

1. Determine the resultant force and moment for a given system of forces.
2. Determine the centroid and second moment of area of simple solids.
3. Apply fundamental concepts of kinematics and kinetics to the analysis of simple / practical problems.
4. Understand basic kinematics concepts – displacement, velocity and acceleration.
5. Understand basic dynamic concepts – force, momentum, work and energy.
6. Determine friction and its effects as per the laws of friction.

MODULE I – STATICS OF PARTICLE (8 Lecture Hours)

Introduction – Units and Dimensions - Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Resolution and components of forces – Resultant of concurrent forces, Equilibrium of a two force and three force body – Forces in space – Equilibrium of a particle in space – Equilibrium of rigid bodies: Free body diagram. Support Reactions – Beams – Types of loads, Analysis of roof trusses by method of joints and method of sections. Moment of a force about a point – Varignon's theorem – Moment of a couple – Resolution of a given force in to force and couple system.

MODULE II – STATICS OF RIGID BODIES (8 Lecture Hours)

Centre of gravity and Centroid of composite plane figure – Moment of inertia – Parallel axis and Perpendicular axis theorem – Moment of inertia of composite planes – Mass moment of inertia of simple solid and composite bodies.

MODULE III – KINEMATICS OF PARTICLES (8 Lecture Hours)

Rectilinear motion – Displacements, Velocity and acceleration, their relationship – Relative motion, Curvilinear motion – Tangential and Normal components, velocity and acceleration of a particle – Projectile of body. Newton's second law of motion – D-Alembert's principle – Motion of a lift – Motion on an inclined surface – Motion on connected bodies.

MODULE IV – KINETICS OF PARTICLES (7 Lecture Hours)

Work Energy method – Applications of principle of work and energy – Impulse and momentum method - Motion of connected bodies. Impact of elastic bodies.

MODULE V – DYNAMICS OF RIGID BODIES (7 Lecture Hours)

Translation and Rotation about a fixed axis – Equations defining the rotation of a rigid body about a fixed axis – General plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

MODULE VI – FRICTION (7 Lecture Hours)

Frictional force – Laws of sliding friction - Limiting friction – Coefficient of friction and angle of friction – Impending friction – Basic concepts – Problems on body on a rough inclined plane, Ladder friction, Wedge friction.

Text Books:

1. N.H Dubey, "Engineering Mechanics – Statics and Dynamics", McGraw-Hill Education (India) Private Limited, 2016.
2. Rajasekaran S, Sankarasubramanian G., "Fundamentals of Engineering Mechanics 3rd Edition", Vikas Publishing House Pvt. Ltd., 2017

Reference Books

1. Ferdinand P. Beer and E. Russell Johnston Jr. "Vectors Mechanics of Engineers: Statics and Dynamics", McGraw-Hill International Edition, 2014.

2. Palanichamy M.S., Nagan S., "Engineering Mechanics – Statics and Dynamics 3rd Edition", Tata McGraw-Hill, 2004
3. Hibbeler R.C., "Engineering Mechanics", Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., 2014
4. Irving H. Shames, "Engineering Mechanics – Statics and Dynamics 4th Edition", Pearson Education Asia Pvt. Ltd., 2005.
5. N. Kottiswaran, "Engineering Mechanics", Sri Balaji Publications Edition – 2010

18ME1004	WORKSHOP/ MANUFACTURING PRACTICE LABORATORY	L T P C 0 0 2 1

Co requisite: Manufacturing Technology

Course Objectives: To impart knowledge on
1. Fitting joints, carpentry joints and plumbing practices.
2. Process planning and procedures to develop models in foundry and smithy laboratories.
3. Sequence of operations adopted in welding and sheet metal laboratories to fabricate various Joints and models.

Course Outcome: After completing the course the student will be able to
1. Apply carpentry and fitting joints, to fabricate useful products.
2. Prepare green sand moulds for different patterns.
3. Make machine elements using forging technique.
4. Use welding equipment's to join the structures.
5. Design and fabricate the various objects in sheet metal using hand tools.
6. Apply manufacturing process for typical engineering components.

LIST OF EXPERIMENTS
1. Making of middle lap joint in carpentry.
2. Making of V joint in Fitting.
3. Assembly of pipes, valves and other fittings in Plumbing.
4. Preparation of green sand mould for stepped cone pulley with core preparation.
5. Making of butt joint by arc welding process.
6. Preparation of J bends from square rod by smithy forging operation.
7. Making of Rectangular tray by sheet metal fabrication.

18ME1005	BASIC MECHANICAL ENGINEERING	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. IC Engines, External Combustion Engines, Boilers.
2. Power plants, metal forming, metal joining, machining process
3. The application of CAD, CAM, MEMS and CIM.

Course Outcome: After completing the course the student will be able to
1. Describe the working principle of Engines and Turbines.
2. Classify Boilers and identify different types of engines.
3. Distinguish conventional and non- conventional power plants.
4. Examine various types of engineering materials.
5. Select different types of metal forming and joining processes.
6. Analyze metal machining processes.

MODULE I – ENGINES, BOILERS AND REFRIGERATION (8 Lecture Hours)

Working of Petrol and Diesel Engine – Difference between two stroke and four stroke engines. Principles of fire tube and water tube boilers – Cochran boiler – Babcock & Wilcox boiler, Working principle of Impulse turbine reaction turbine, Refrigeration and air conditioning- working principle of refrigeration and air conditioning.

MODULE II – POWER PLANTS (8 Lecture Hours)

Conventional power plants: Hydro, Thermal, Nuclear power plants – Diesel and Gas Turbine power plants. Non-conventional power plants: Solar, wind and tidal power plants – Geothermal power plant – Ocean Thermal Energy conversion power plant.

MODULE III – ENGINEERING MATERIALS (8 Lecture Hours)

Engineering materials: classification of materials –properties of metals – Alloy steels – Nonferrous metals and alloys. Introduction to plastics and composites.

MODULE IV – INTRODUCTION TO MANUFACTURING PROCESSES (7 Lecture Hours)

Introduction: Metal casting process: patterns –molding processes – melting of cast iron. Metal forming process: Introduction – Forging – Rolling – Extrusion – Drawing operations. Metal joining Process: Introduction - welding – arc welding - gas welding.

MODULE V – INTRODUCTION TO MACHINE TOOLS (7 Lecture Hours)

Lathe – Drilling machine – Milling machine – Shaping Machine – Grinding Machine - Introduction to NC and CNC machines.

MODULE VI – INTRODUCTION TO CAD/CAM, MEMS AND CIM (7 Lecture Hours)

Introduction - Computer Aided Design – Computer Aided Manufacturing – Computer Integrated Manufacturing – Micro Electro Mechanical Systems (MEMS).

Text Books:

1. Praveen Kumar, R Raja, " Basic Mechanical Engineering", Pearson Education 2018.
2. G. Shunmagam, S. Ravindran, "Basic Mechanical Engineering", Tata McGraw Hill, 2011.

Reference Books:

1. I.E. Paul Degarmo, J.T. Black, Ronald A. Kosher, "Material and Processes in Manufacturing", 8th Edition, John Wiley and Sons. 2003.
2. S.R.J. Shantha Kumar, "Basic Mechanical Engineering", HiTech Publications, 2001.
3. Williams D. Callister "Material Science and Engineering", John Wiley and Sons. 2013.
4. C.M. Agrawal, Basant Agrawal, "Basic Mechanical Engineering", Wiley, 2008.
5. Gaurav Shukla, "Handbook Series of Machanical Engineering", Arihant, 2013.

18ME1006	WORKSHOP PRACTICE	L	T	P	C
		0	0	2	1

Course Objectives: To impart knowledge on

1. Fitting joints, carpentry joints and plumbing practices.
2. Process planning and procedures to develop models in foundry and smithy laboratories.
3. Sequence of operations adopted in welding and sheet metal laboratories to fabricate various Joints and models.

Course Outcome: After completing the course the student will be able to

1. Apply carpentry and fitting joints, to fabricate useful products.
2. Prepare green sand moulds for different patterns.
3. Make machine elements using forging technique.
4. Use welding equipment's to join the structures.
5. Design and fabricate the various objects in sheet metal using hand tools.
6. Apply manufacturing process for typical engineering components.

LIST OF EXPERIMENTS

1. Making of middle lap joint in carpentry.
2. Assembly of pipes, valves and other fittings in Plumbing.
3. Preparation of green sand mould for stepped cone pulley with core preparation.
4. Making of butt joint by arc welding process.
5. Making of circular and rectangular rings for RCC using bar bending.
6. Making of Rectangular tray by sheet metal fabrication.

Text Books:

1. Bava, R Raja, "Workshop Practice", Tata McGraw 2018.

18ME1007	COMPUTER AIDED ENGINEERING DRAWING	L 0	T 0	P 4	C 2

Course Objectives: To impart knowledge on

1. To learn engineering design and its place in society
2. To get exposure to the visual aspects of engineering design and graphics standards
3. To apply graphics standards to create working drawings and communicate across industries.

Course Outcome: After completing the course the student will be able to

1. Understand the engineering design and solid modelling.
2. Visualize the engineering components.
3. Design a system, component, or process to meet desired needs within realistic constraints and sustainability.
4. Communicate effectively with various stake holders of engineering design industry
5. Apply techniques, skills, and modern engineering tools necessary for engineering practice
6. Visualize assembly of system with fewer parts.

USER INTERFACE AND CUSTOMIZATION (5 Lecture hours)

Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command window, The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.

Setting up of units, drawing limits, drawing paper size, scale settings and use of drawing template. Draw to PDF files the printer, Snap to objects manually and automatically using object snap settings;

DRAWING AIDS, PAGE SETUP AND PRINTING (5 Lecture hours)

Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles; Printing and saving drawings.

DRAWING AND MODIFYING (5 Lecture hours)

Drawing polylines, ellipses, polygons and use of spline curves. Adding and altering objects, moving and dublicating objects, modifying and maneuvering, hatching and sketching. Polar and rectangular arrays. Application of arcs to draw simple parts. Use of text fonts, formatting text and setting title box for drawing template.

DIMENSIONING ANNOTATIONS, LAYERING & OTHER FUNCTIONS 5 Lecture hours)

ISO and ANSI standards for coordinate dimensioning and tolerance; Orthographic constraints, applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths and line weight through modifying existing lines (extend / lengthen).

ORTHOGRAPHIC PROJECTIONS: (5 Lecture hours)

Orthographic projections – principles, Principal planes - First angle projection, Conversion of isometric view into orthographic views.

PROJECTION OF POINTS: (5 Lecture hours)

Projections of points located in four different quadrants.

PROJECTION OF LINES: (5 Lecture hours)

Projection of straight lines (only First angle projections) parallel to both planes, inclined to one plane and parallel to the other, inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces.

PROJECTION OF PLANE SURFACES: (5 Lecture hours)

Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

PROJECTION OF SOLIDS: (5 Lecture hours)

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

SECTION OF SOLIDS: (5 Lecture hours)

Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section.

DEVELOPMENT OF SURFACES: **(5 Lecture hours)**
Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Development of lateral surfaces of solids with cut-outs.
ISOMETRIC PROJECTIONS: **(5 Lecture hours)**
Principles of isometric projection – isometric scale –Isometric views of simple solids and truncated solids - Prisms, pyramids, cylinders, cones - combination of two solid objects in simple vertical positions and miscellaneous problems.

Text Book:

1. Leo Dev Wins. K, "Engineering Drawing", 3rd Edition, Pearson Publications, 2017.
2. G.Ganesan, "Basic Computer Aided Design and Drafting using AutoCAD 2015", McGraw Hill, 2018.
3. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.

Reference Book:

1. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.
2. C M Agrawal, Basant Agrawal, Engineering Graphics, C M Agrawal, Basant Agrawal, McGraw Hill Education, 2017.
3. Rathnam K., "A First Course in Engineering Drawing", Springer Singapore, 2018.
4. George Sydenham Clarke, "Practical Geometry and Engineering Drawing", Nabu Press 2012.
5. Sham Tickoo, "AutoCAD 2015 for Engineers and Designers", Dream Tech Press, 2014.

18ME2009	FLUID MECHANICS LABORATORY	L	T	P	C
		0	0	2	1

Co requisite: Fluid Mechanics and Machines

Course Objectives: To impart knowledge on
1. The calibration of flow measurement devices and calculation of losses due to friction and pipe fittings.
2. The working principles of Pumps.
3. The working of different types of hydraulic turbines.

Course Outcomes: After completing the course the student will be able to
1. Determine friction factor.
2. Calibrate venture meter.
3. Calibrate orifice meter.
4. Conduct flow measurements in pipes.
5. Determine minor losses in pipes.
6. Conduct load test on pelton wheels.

LIST OF EXPERIMENTS
1. Determination of Darcy's friction factor.
2. Calibration of venturi meter.
3. Calibration of orifice meter.
4. Determination of minor losses in pipes.
5. Performance of single stage centrifugal pump.
6. Load test on Pelton wheel.
7. Performance of Turbine- Kaplan, Francis, pumps-gear/centrifugal/reciprocating pumps

18ME2010	HEAT AND MASS TRANSFER	L	T	P	C
		3	0	0	3

Pre requisite: Thermodynamics

Course Objectives: To impart knowledge on
1. To build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation.

2. To understand governing equations and solution procedures for the three modes, along with solution of practical problems using empirical correlations.
3. To provide knowledge on boiling and condensation heat transfer, analysis, design of heat exchangers and mass transfer.

Course Outcome: After completing the course the student will be able to

1. Formulate and analyze a heat transfer problem involving any of the three modes of heat transfer.
2. Obtain exact solutions for the temperature variation using analytical methods where possible or employ approximate methods or empirical correlations to evaluate the rate of heat transfer.
3. Evaluate radiation heat transfer between black, gray surfaces and the surroundings.
4. Design devices such as heat exchangers and also estimate the insulation needed to reduce heat losses where necessary.
5. Apply boiling and condensation correlations to two phase flow processes.
6. Apply mass transfer correlations to process–based problems.

MODULE I –CONDUCTION (8 Lecture Hours)

Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number, heat transfer through pin fins- Two dimensional conduction solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction heat transfer by the use of Heissler charts.

MODULE II –CONVECTION (8 Lecture Hours)

Heat convection, basic equations, boundary layers- Forced convection, external and internal flows- Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow- Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.

MODULE III –RADIATION (8 Lecture Hours)

Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann'slaw, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method.

MODULE IV – HEAT EXCHANGER (7 Lecture Hours)

Types of heat exchangers, overall heat transfer coefficient, fouling, Analysis and design of heat exchangers using both LMTD and ε- NTU methods.

MODULE V – BOILING AND CONDENSATION (7 Lecture Hours)

Boiling and condensation heat transfer, pool boiling curve, types of condensation, correlations and simple problems.

MODULE VI – MASS TRANSFER (7 Lecture Hours)

Introduction mass transfer, Fick's law of diffusion, equimolar counter diffusion, Convective mass transfer coefficient, non-dimensional number in mass transfer, evaporation process in the atmosphere. Similarity between heat and mass transfer

Text Books:

1. J.P.Holman, Heat Transfer, Eighth Edition, McGraw Hill, 2011
2. Yunus A Cengel, Heat Transfer : A Practical Approach, McGraw Hill, 2010

Reference Books:

1. A. Bejan, Heat Transfer John Wiley, 1993
2. F.P.Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley,Sixth Edition, 2007
3. Massoud Kaviany, Principles of Heat Transfer, John Wiley, 2002
4. P.K. Nag, "Heat Transfer", Tata McGraw Hill, New Delhi, 2011.
5. R. C. Sachdeva, 'Heat and Mass Transfer', Wiley Eastern, 2017.

18ME2011	HEAT TRANSFER LABORATORY	L T P C 0 0 4 2

Co requisite: Heat and Mass Transfer

Course Objectives: To impart knowledge on

1. The heat transfer characteristics of various heat transfer apparatus
2. The design calculations of different modes of heat transfer
3. Conducting the heat transfer experiments and practically learn how to find heat transfer coefficients

Course Outcome: After completing the course the student will be able to

1. Calculate and compare the thermal conductivity of different materials.
2. Predict the convective heat transfer coefficient by free convection.
3. Analyze the performance of forced convective heat transfer coefficient through pin –fin.
4. Evaluate the performance of radiation through black and gray bodies.
5. Analyze the performance parameters of parallel flow heat exchanger.
6. Analyze the performance parameters of counter flow heat exchanger.

LIST OF EXPERIMENTS

1. Measurement of thermal conductivity through a composite wall.
2. Measurement of thermal conductivity in a lagged pipe.
3. Determination of thermal conductivity in a guarded plate.
4. Measurement of heat transfer coefficient in a vertical cylindrical rod by free convection.
5. Measurement of heat transfer coefficient in a flat plate by natural convection.
6. Determination of heat transfer coefficient in a fin–pin by free convection.
7. Determination of heat transfer coefficient in a fin–pin by forced convection.
8. Measurement of heat transfer coefficient in a forced convection apparatus.
9. Determination of emissivity of the given test surface.
10. Determination of Stefan–Boltzmann constant in radiation heat transfer.
11. Determination of heat transfer coefficient in a parallel flow heat exchangers.
12. Determination of heat transfer coefficient in a counter flow heat exchangers.

18ME2012	STRENGTH OF MATERIALS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Nature of stresses developed in simple geometries
2. Elastic deformation occurring in various simple geometries for different types of loading.
3. Stresses action on shafts, springs and cylinders

Course Outcome: After completing the course the student will be able to

1. Recognize various types loads applied on machine components
2. Understand the nature of internal stresses that will develop within the components
3. Analyse the stresses acting simple geometry of structures.
4. Evaluate the strains and deformation due to the elastic stresses developed.
5. Compute inertia, slopes and deflection in beams
6. Determine the torsional stresses of shaft and hoop stresses in cylinders

MODULE I – SIMPLE STRESSES (8 Lecture Hours)

Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses- elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle.

MODULE II – BEAMS (8 Lecture Hours)

Beams and types of transverse loading on beams - shear force and bending moment diagrams.
Types of beam supports - cantilevers, simply supported, and over-hanging beams.

MODULE III – LOAD ON BEAMS (8 Lecture Hours)

Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.

Module IV – MOMENT OF INERTIA (7 Lecture Hours)
Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems.
Module V – TORSION (7 Lecture Hours)
Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs.
Module VI – STRESSES IN CYLINDER (7 Lecture Hours)
Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure

Text Books:
1. Egor P. Popov, Engineering Mechanics of Solids 2nd Edition, Prentice Hall of India, New Delhi, 2009.
2. R. Subramanian, Strength of Materials 2nd Edition, Oxford University Press, 2010.

Reference Books:
1. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials 7th Edition, Tata Mc GrawHill Publishing Co. Ltd., New Delhi 2014.
2. Boresi, Arthur P. and Schmidt, Richard J., Advanced Mechanics of Materials, 6th Ed., John Wiley & Sons, 2009.
3. R. G. Budynas, "Advanced Strength and Applied Stress Analysis", 2nd Edition, McGraw Hill Education (India) Pvt ltd., 2013
4. L. S. Srinath, "Advanced Mechanics of Solids", 3rd Edition, TMH Publishing Co. Ltd., New Delhi, 2009.
5. William Nash, "Schaum's Outline of Strength of Materials, 6th Edition", McGraw-Hill Education, 2013.

18ME2013	STRENGTH OF MATERIALS LABORATORY	L	T	P	C
		0	0	2	1

Co requisite: Strength of Materials

Course Objectives: To impart knowledge on
1. The evaluation of tensile properties steel
2. Evaluation of bending strength of wood
3. Evaluation of hardness, impact and shear strength of steel

Course Outcome: After completing the course the student will be able to
1. Evaluate ductility and tensile strength of mild steel.
2. Determine resilience of springs.
3. Evaluate bending strength of wood.
4. Evaluate strength of beams.
5. Evaluate impact strength.
6. Evaluate shear strength and hardness of steel.

LIST OF EXPERIMENTS
1. Tension test on mild steel
2. Test on springs (open coiled springs)
3. Static bending test on wood
4. Deflection tests on cantilever beams
5. Charpy Impact tests
6. Double shear and Rockwell Hardness tests on mild steel.

Reference books
Lab manual

18ME2014	SOLIDS MECHANICS	L T P C 3 0 0 3

Pre requisite: Strength of Materials

Course Objectives: To impart knowledge on

1. Relationship between the loads applied to a non-rigid body and the internal stresses and deformations induced in the body.
2. Different approaches to calculate slope and deflection for various types of beams.
3. Mohr's circle method to find magnitude and direction of the principal stresses.

Course Outcome: After completing the course the student will be able to

1. Understand stress and strain relations in simple solids.
2. Estimate stress and strain values in simple solids subjected thermal loads.
3. Analyze the different types of loading and the consequent deflection.
4. Determine maximum stress and angular deflection of solid and hollow shafts.
5. Evaluate stress and strain using Mohr's circle.
6. Apply concepts of failure theories to determine safe design.

MODULE I –STRESSES AND STRAINS (8 Lecture Hours)

Definition/derivation of normal stress, shear stress, and normal strain and shear strain – Stress strain diagram- Elastic constants – Poisson's ratio – relationship between elastic constants and Poisson's ratio – Generalized Hook's law – Strain energy – Deformation of simple and compound bars – thermal stresses.

MODULE II – SIMPLE BENDING AND TYPES OF BEAMS (7 Lecture Hours)

Cantilever, simply supported, overhanging: Shear Force and Bending Moment Diagrams Theory of simple bending.

MODULE III – DEFLECTION OF BEAMS (8 Lecture Hours)

Deflection of beams by Double integration method – Macaulay's method – Area moment theorems for computation of slopes and deflections in beams – Conjugate beam method.

MODULE IV – TORSION OF SHAFTS (8 Lecture Hours)

Introduction to Torsion – derivation of shear strain – Torsion formula – stresses and deformations in circular and hollow shafts – Stepped shafts – shafts fixed at the both ends – Stresses in helical springs. Bending stress and shear stress in beams.

MODULE V – BI-AXIAL STRESS SYSTEM (7 Lecture Hours)

Biaxial state of stress – Stress at a point – stresses on inclined planes – Principal stresses and Principal strains and Mohr's circle of stress. Thin cylinders and shells – deformation of thin cylinders and shells.

Module VI – THEORY OF COLUMNS (8 Lecture Hours)

Theory of columns – Long column and short column - Euler's formula – Rankine's formula - Secant formula - beam column

Text Books:

1. Ferdinand P.Beer, "Mechanics of Materials", McGraw Hill, 2014
2. S. Ramamrutham and R. Narayanan, Strength of Materials 18th Edition, 2014.

References Books:

1. Rowland Richards, "Principles of Solid Mechanics", CRC Press, 2000.
2. Timoshenko, S.P. and Young, D.H., "Strength of Materials", East West Press Ltd, 2000.
3. R.K. Bansal, "Strength of Materials", Laxmi Publications, 2000.
4. S.M.A. Kazimi, "Solids Mechanics 2nd Edition", McGraw Hill Education, 2017.
5. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, "Mechanics of Materials", 7th Edition, Tata Mc GrawHill Publishing Co. Ltd., New Delhi, 2014.

18ME2015	KINEMATICS AND THEORY OF MACHINES	L T P C 3 1 0 4

Course Objectives: To impart knowledge on

1. Displacement, velocity and acceleration at any point in a rigid link of a mechanism
2. Cam profiles to give required follower motion and gear combinations to meet the transmission requirements.
3. Turning moment diagram of flywheels and control of machines by governors and gyroscopes.

Course Outcome: After completing the course the student will be able to

1. Determine mobility, position, velocity and acceleration of links in mechanism.
2. Design cam profiles to meet the motion requirements in mechanisms.
3. Determination of forces on parts of slider-crank mechanism and design of flywheel.
4. Predict balancing mass requirement in rotary and reciprocating unbalanced systems.
5. Determine frequency of translational and longitudinal vibration.
6. Apply the use of governors to control speed and gyroscopes to navigate.

MODULE I – KINEMATICS OF SIMPLE MECHANISM (12 Lecture Hours)
Basics of Mechanisms - Basic kinematic concepts and definitions - Description of some common mechanisms - Design of quick return crank-rocker mechanisms Kinematics of Linkage Mechanisms - Displacement, velocity and acceleration analysis of simple mechanisms - Coincident points - Coriolis component of Acceleration.

MODULE II – KINEMATICS OF CAM (10 Lecture Hours)
Kinematics of Cam Mechanisms - Layout of plate cam profiles - Specified contour cams - Pressure angle and undercutting - sizing of cams. Gears and Gear Trains- Law of toothed gearing - tooth profiles - Non-standard gear teeth -Gear trains - Epicyclic Gear Trains - Differentials - Automobile gear box.

MODULE III – STATIC FORCE ANALYSIS AND FLYWHEEL (10 Lecture Hours)
Force analysis - Static force analysis of simple mechanisms - D'Alambert's principle. .Dynamic force analysis - Dynamic Analysis in reciprocating engines. Flywheel - Turning moment diagrams of reciprocating engines - fluctuation of energy - coefficient of fluctuation of energy and speed.

MODULE IV – DYNAMIC ANALYSIS AND BALANCING (10 Lecture Hours)
Dynamic analysis of Slider–crank mechanism. Balancing - Static and dynamic balancing - partial balancing of reciprocating masses of in-line, V and radial engines.

MODULE V – MECHANICAL VIBRATIONS (10 Lecture Hours)
Free vibration – Undamped free vibration of single degree freedom systems. Damped Vibration - Types of Damping - Damped free vibration. Forced vibration of single degree freedom systems - Vibrating isolation and Transmissibility. Transverse vibration - Dunkerley's method - Whirling of shafts - Critical speed. Torsional vibration - Two rotor systems.

MODULE VI – GOVERNORS AND GYROSCOPE (8 Lecture Hours)
Mechanism for Control: Governors - Types - Characteristics - Effect of friction - Other Governor mechanisms. Gyroscopes - Gyroscopic effects in Automobiles, ships and airplanes.

Text books:

1. Singiresu S. Rao, "Mechanical Vibrations", Addison Wesley Longman, 2016.
2. Ambekar A.G., "Mechanical Vibrations and Noise Engineering", Prentice Hall of India, New Delhi, 2006.

Reference books:

1. Benson H Tongue, "Principles of vibration 2nd Edition, Oxford University Press, 2002.
2. Thomson W.T., "Theory of Vibration with Applications", CBS Publishers and Distributers, New Delhi, 2014
3. Kelly, "Fundamentals of Mechanical Vibrations", McGraw Hill Publications, 2000.
4. Rao V. Dukkipati, J. Srinivas, "Vibrations Problem Solving Companion", Narosa Publishers, 2007.
5. KewalPujara. "Vibrations and Noise for Engineers", DhanpatRai& Co, 4th Edition, 2007.

18ME2016	DESIGN OF MACHINE ELEMENTS	L T P C 3 0 0 3

Pre requisite: Kinematics and Theory of Machines
Course Objectives: To impart knowledge on

1. Design principles and basic design procedures.
2. Using design data for the design of mechanical elements.
3. Applying topics learned in Engineering Mechanics and Mechanics of Solids to actual machine elements.

Course Outcome: After completing the course the student will be able to

1. Understand the standard design procedure for Design of machine elements.
2. Analyse stresses acting on components and determine the size based on theories of failure.
3. Design machine components for a given load condition using design data hand books.
4. Decide specifications as per standards given in design data and select standard components to improve interchangeability.
5. Design and develop nonstandard machine components.
6. Prepare a detail design layout and drawing of machine.

MODULE I – STRESSES IN MACHINE MEMBERS (8 Lecture Hours)
Introduction to the design process, Design considerations- limits, fits and standardization, Factors influencing machine design, selection of materials based on physical and mechanical properties. Direct, bending, torsional and combined stress equations, Impact and shock loading. Failure theories.
MODULE II – VARIABLE AND CYCLIC LOADS AND BEARINGS (8 Lecture Hours)
Variable and cyclic loads – fatigue strength and fatigue limit – S-N curve, combined cyclic stress, Soderberg and Goodman equations – Design of sliding and rolling contact bearing.
MODULE III – SHAFTS AND COUPLINGS (7 Lecture Hours)
Design of solid and hollow shaft based on strength, rigidity and critical speed. Design of keys, keyways, Bolts and Nut. Design of Rigid and Flexible couplings.
Module IV – JOINTS AND SPRINGS (7 Lecture Hours)
Design of bolted, riveted and welded joints, Threaded fasteners, Cotter joints, Knuckle joints and pipe joints. Design of helical, leaf, disc and torsional springs under constant loads and varying loads. Design of Power Screws.
Module V – DESIGN OF ENGINE COMPONENTS (8 Lecture Hours)
Design of piston, connecting rod, crankshaft, and flywheel.
Module VI – BRAKES AND CLUTCHES (7 Lecture Hours)
Design of brakes, clutches – Single plate, Multiplate & Cone.

Text Books:

1. S.Md. Jalaludeen, “Machine Design”, Anuradha Publications, Chennai 2011.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett, “Mechanical Engineering Design”, 8 th Edition, Tata McGraw–Hill, 2015.

Reference Books:

1. Bhandari V, “Design of Machine Elements”, 4th Edition, Tata McGraw–Hill Book Co., 2016.
2. Sundarrajamoorthy T.V. and Shanmugam, ‘Machine Design’, Khanna Publishers, 2003.
3. Bernard Hamrock, “Fundamentals of Machine Elements”, McGrawHill, 2014.
4. Hall and Allen, “Machine Design”, Schaum Series, 2001.
5. Design Data – Data Book for Engineers, PSG College of Technology, Coimbatore, KalaikathirAchchagam 2012 & Approved Data Sheets.

18ME2017	DESIGN OF TRANSMISSION SYSTEMS	L T P C 3 0 0 3

Pre requisite: Kinematics and Theory of Machines, Design of Machine Elements

Course Objectives: To impart knowledge on

1. The concepts, procedures and the data, to design and analyze machine elements in power transmission systems.
2. Competency to specify, select and design the mechanical components for transmission systems.
3. Development of outline drawing of transmission elements.

Course Outcome: After completing the course the student will be able to

1. Identify the working principles of mechanical components employed in mechanical transmission systems.
2. Apply suitable theories and basic engineering principles and procedures to design the transmission elements.
3. Select appropriate engineering design data from standard data books for mechanical transmission components.
4. Design transmission systems based on the requirements.
5. Design and Draw speed reducer, multispeed gear box.
6. Evaluate the torque, power and other functional requirements of power transmission Elements.

MODULE I – BEARINGS (7 Lecture Hours)

Bearings – Introduction ,types and applications , Selection of bearings based on loads , Sliding contact bearing-terminology, design of Journal bearings, design of Rolling contact bearing.

MODULE II – BELTS, ROPE AND CHAIN DRIVES (7 Lecture Hours)

Belt, types and applications, constructional details of belts, design of Flat belt drives, design of V- belt drives .Chain – Types, selection of Chains, Design of Chains**.** Ropes –design and selection of ropes.

MODULE III – SPUR, HELICAL AND BEVEL GEARS (8 Lecture Hours)

Gears –types and applications. Design of spur gear, Design of Helical gear, Design of herring bone gear, Design of bevel gears.

MODULE IV – WORM AND SKEW GEARS (7 Lecture Hours)

Worm gear –applications, advantages, efficiency of worm gear, design of worm gear, design of Skew gears. Design of a Ratchet & pawl mechanism.

MODULE V – GEAR BOX (8 Lecture Hours)

Speed reducer- types and applications, design of speed reducer. Multispeed Gearbox – types, applications, layout of gear box, speed & kinematic diagrams, design of gearbox.

MODULE VI – GENEVA MECHANISM, CAM DRIVES AND POWER SCREWS (8 Lecture Hours)

Geneva mechanism – applications. Design of Geneva mechanism. Cam drives –applications, design of cams-calculation of geometrical dimensions, Contact stress and Torque calculation. Design of Power screws.

Text Books:

1. S.Md .Jalaludeen , Machine Design, Anuradha Agencies Publications, 2009.
2. Prabhu.T.J., Design of Transmission Elements,2002.

Reference Books:

1. V. Dobrovolsky, ‘Machine Elements’, MIR, 1999.
2. Hall A.S. Holowenko A.R. and Laughlin H.G., ‘Theory and Problems in Machine Design’, Schaum’s Series, 2000.
3. Hall and Allen, ‘Machine Design’, S.Schaum’s Series, 2001.
4. 4. Joseph Edward Shighley, ‘Mechanical Engineering’, McGraw Hill, 2002.
5. Sundarajamoorthy T.V. and Shanmugam, ‘Machine Design’, Anuradha Agencies Publications, 2000.

18ME2018	DYNAMICS LABORATORY	L T P C 0 0 2 1

Co requisite: Kinematics and Theory of Machines, Design of Machine Elements

Course Objectives: To impart knowledge on
1. The fundamental principles of dynamics.
2. Mechanical systems using a free body diagram.
3. Equations of motion for translational and rotational mechanical systems.

Course Outcome: After completing the course the student will be able to
1. Compute the moment of inertia of rigid bodies.
2. Demonstrate the working principles of gyroscope.
3. Determine balancing mass in the rotating systems.
4. Demonstrate the principles of kinematics and dynamics of machinery.
5. Use the measuring devices for dynamic testing.
6. Study the effect of dynamics on vibrations in single and multi–degree of freedom system.

LIST OF EXPERIMENTS
1. a) Study of gear parameters.
   b) Experimental study of velocity ratios of simple, compound, Epicyclic and differential gear trains.
2. a) Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating cylinder Mechanisms.
   b) Kinematics of single and double universal joints.
3. a) Determination of Mass moment of inertia of Fly wheel and Axle system.
   b) Determination of Mass Moment of Inertia of axisymmetric bodies using Turn Table apparatus.
   c) Determination of Mass Moment of Inertia using bifilar suspension and compound pendulum.
4. Motorized gyroscope – Study of gyroscopic effect and couple.
5. Governor - Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors.
6. Cams – Cam profile drawing, Motion curves and study of jump phenomenon
7. a) Single degree of freedom Spring Mass System – Determination of natural Frequency and verification of Laws of springs – Damping coefficient determination.
   b) Multi degree freedom suspension system – Determination of influence coefficient.
8. a) Determination of torsional natural frequency of single and Double Rotor systems.- Undamped and Damped Natural frequencies.
   b) Vibration Absorber – Tuned vibration absorber.
9. Vibration of Equivalent Spring mass system – undamped and damped vibration.
10. Whirling of shafts – Determination of critical speeds of shafts with concentrated loads.
11. a) Balancing of rotating masses. (b) Balancing of reciprocating masses.
12. a) Transverse vibration of Free-Free beam – with and without concentrated masses.
    b) Forced Vibration of Cantilever beam – Mode shapes and natural frequencies.
    c) Determination of transmissibility.

18ME2019	MACHINE DRAWING LABORATORY	L T P C 0 0 2 1

Co requisite: Engineering Drawing, Design of Machine Elements

Course Objectives: To impart knowledge on
1. Conventional representation of mechanical parts by symbol, limits, fits and Geometrical tolerances. Representation of surface finish and welding parameters.
2. Sectional views of joints, connecting rod, plummer block, couplings, screw jack, vice and I.C engine parts.
3. Surface modelling and study parts drawings of an assembly.

Course Outcome: After completing the course the student will be able to

1. Investigate proper representation of mechanical parts by symbols and dimension with limits, fits.
2. Apply geometrical tolerances and represent surface finish and welding parameters
3. Draw sectional views and sectional views of Cotter Joints & Knuckle joints, flange couplings
4. Produce sectional and auxiliary views of Cylinder head, Piston, Connecting rod, camshaft and Crankshaft.
5. Interpret parts drawing of machine parts and do assembly of vice, lathe tailstock, Safety valves
6. Apply surface modeling to body of hair drier, car and washing machine etc.

MODULE I – DRAWING STANDARDS AND CONVENTIONS (8 Lecture Hours)
Conventional representation of threaded parts, springs, gear. Abbreviations and symbols for use in technical drawings. Conventions for sectioning and dimensioning.
MODULE II – LIMITS, FITS AND TOLERANCES (8 Lecture Hours)
Limits, fits, tolerances - selection. Maximum material principle. Surface finish - Selection, methods of indicating. Welding symbols, preparation of Joints for welding.
MODULE III – COMPUTER AIDED DRAFTING OF JOINTS AND VALVES (12 Lecture Hours)
Drawings of Cotter Joints & Knuckle joints, flange couplings and. steam relief valves.
MODULE IV – COMPUTER AIDED DRAFTING OF I.C. ENGINE PARTS (12 Lecture Hours)
Cylinder head, Piston, Connecting rod, camshaft and Crankshaft
MODULE V – COMPUTER AIDED ASSEMBLY DRAWINGS (12 Lecture Hours)
Preparation of Assembly drawing and detailed drawing of mechanical devices- plummer block, vice, lathe tailstock and Screw jack .
MODULE VI – COMPUTER AIDED SURFACE MODELING (8 Lecture Hours)
Surface modelling of automobile body and Appliances (electrical and domestic)

Text book:

1. Goplalakrishna, " Machine Drawing", Subash publishers, 2016.
2. Dhawan RK, "A Textbook of Machine Drawing", S Chand, 2008.

Reference books:

1. Bhatt.N.D, Machine drawing", charotar publishing house, Anand, 2003.
2. Siddheshwar , N.P.Kannaiah& V.V.S. Satry " Machine Drawing" , Tata Mcgraw Hill, 1980.
3. Revised IS Codes 10711, 10713, 10714, 9609, 1165, 10712, 10712, 10715, 10716, 10717, 11663, 11668, 10968, 11669, 8043, 8000.
4. Pro/E Wildfire 5 manuals.
5. David Allan Low, "An Introduction to Machine Drawing and Design", Bastian Books. 2008.

18ME2020	MANUFACTURING PROCESSES	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. Principle, methods and applications of casting.
2. Working principle and applications of bulk forming and sheet metal.
3. Joining, unconventional machining and powder metallurgy processes.

Course Outcome: After completing the course the student will be able to
1. Select the appropriate casting process to produce complex parts.
2. Develop products with superior mechanical properties using bulk forming processes.
3. Perform various sheet metal operations on metal sheets.
4. Create permanent joints in working assemblies using welding techniques.
5. Suggest appropriate unconventional manufacturing process for the machining of difficult-to-machine materials.
6. Enhance the properties of components using powder metallurgy.

MODULE I – CASTING AND MOULDING (7 Lecture Hours)
Metal casting processes and equipment, casting allowances, special casting techniques, casting defects and remedial measures.

MODULE II – BULK FORMING (7 Lecture Hours)
Plastic deformation and yield criteria; Fundamentals of hot and cold working processes; load estimation for bulk forming and defects (forging, rolling, extrusion, drawing).
MODULE III – SHEET METAL FORMING (8 Lecture Hours)
Sheet metal characteristics; shearing, bending and drawing operations; Formability of sheet metal; Introduction to high energy rate forming (HERF).
MODULE IV – JOINING/FASTENING PROCESSES (7 Lecture Hours)
Physics of welding design considerations in welding, Solid and liquid state joining processes; Special welding techniques; brazing and soldering; defects in welding.
MODULE V – UNCONVENTIONAL MACHINING PROCESSES (8 Lecture Hours)
Abrasive jet machining; Ultrasonic machining; Electrical Discharge Machining, principle and processes parameters, MRR, surface finish, tool wear, dielectric, power and control circuits, wire- EDM; Laser Beam Machining, Plasma Arc Machining; Electron Beam Machining.
MODULE VI – POWDER METALLURGY AND MICRO SYSTEMS FABRICATION (8 Lecture Hours)
Powder metallurgy: production of metal powder; particle size, distribution and size; blending; iso-static pressing and other compacting and shaping processes; sintering; Secondary and finishing processes; impregnation; infiltration; applications. Photolithography, Ion Implantation and Diffusion; Oxidation, CVD,PVD, Etching; Overview of Micro Machining; Bulk Micro Machining; Surface Micro Machining; LIGA Process

Text Books:

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)-Pearson India, 2014.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, andSystems, 2008.

Reference Books:

1. Degarmo, Black &Kohser, Materials and Processes in Manufacturing, 2006.
2. R.K. Rajput, "A Textbook of Manufacturing Technology", Laxmi Publications, 2016
3. J. Beddoes, M. Bibby, "Principles of Metal Manufacturing Processes", Butterworth-Heinemann, 2000.
4. John Schey, "Introduction to Manufacturing Processes 3rd Edition", McGraw Hill Education, 2012
5. Kaushik Kumar, Divya Zindani, J. Paulo Davim, "Advanced Machining and Manufacturing Processes (Materials Forming, Machining and Tribology)" Springer, 2018

		L	T	P	C
18ME2021	**MANUFACTURING LABORATORY` I (METALLURGY, METROLOGY & MECHATRONICS)**	**0**	**0**	**4**	**2**

Co requisite: Manufacturing Processes

Course Objectives: To impart knowledge on

1. Microstructure and performance of materials.
2. The principles of linear and angular measurement.
3. Fundamental systems of fluid power controls.

Course Outcome: After completing the course the student will be able to

1. Prepare samples for metallurgical studies following appropriate metallographic procedure and extract metallographic images.
2. Analyze various phases of Iron Carbon alloy.
3. Demonstrate measurements using linear and angular measuring instruments.
4. Calibrate linear and angular measuring instruments.
5. Assess the optimal components of pneumatic system.
6. Build a logic circuit for industrial problems.

LIST OF EXPERIMENTS

1. Use of Tool Maker's Microscope.

2. Comparator and sine bar.
3. Surface finish measurement equipment.
4. Bore diameter measurement using micrometer and telescopic gauge.
5. Use of Autocollimator.
6. Determination of strength and permeability of foundry sand.
7. Identification of Cast Iron specimen (a) Grey Cast Iron(b) Spheroidal Graphite Iron (c) Malleable Cast Iron.
8. Sieve Analysis.
9. Identification of Heat Treated steels: (a) Annealed (b) Normalized (c) Hardened (d) Tempered steels and Case Hardened Steel.
10. Identification of brasses and bronzes and aluminum.
11. Basic pneumatic logic gate circuits.
12. Pneumatic material handling circuit.

18ME2022	MANUFACTURING TECHNOLOGY	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. The principles and applications of metal cutting.
2. Construction and working principles of lathe, milling, reciprocating machine tools, hole making and gear cutting operations.
3. Non-conventional machining and additive processes in industry & research.

Course Outcome: After completing the course the student will be able to
1. Select the machining processes suitable for machining a component.
2. Generate the process sequences for machining in machine tools to reduce the lead time.
3. Analyze and choose the optimized machining parameters.
4. Select cutting tools for the identified machining sequences.
5. Appraise the abrasive machining process based on the surface finish requirements.
6. Implement the non-conventional machining processes for machining hard materials.

MODULE I – THEORY OF METAL CUTTING (8 Lecture Hours)
Mechanics of chip formation, Types of chip – chip curl and chip-breaker- orthogonal Vs. Oblique cutting – Merchant circle – shear plane angle according to Merchant – Temperature in metal cutting – Tool life and tool wear – cutting tool materials – cutting fluids.

MODULE II – TURNING AND RECIPROCATING MACHINE TOOLS (8 Lecture Hours)
Centre Lathe – Constructional features –specifications – work holding devices – Turning parameters – cutting tools – geometry. Turning operations – taper turning methods, thread cutting methods, special attachments, machining time and power estimation capstan and turret lathes. Shaper, planer, slotter.

MODULE III – MILLING, HOLE MAKING AND GEAR CUTTING (9 Lecture Hours)
Milling – types of milling machine, milling cutters, milling operations, Dividing head-simple, compound and angular indexing, Drilling, reaming, boring, tapping, machining time calculations Broaching machines: broach construction – push, pull, surface and continuous broaching machines. Gear cutting: forming, generations, shaping, planning and hobbing.

MODULE IV – ABRASIVE PROCESSES (9 Lecture Hours)
Grinding wheel – designation and selection, types of grinding machines –Cylindrical grinding, surface grinding, centerless grinding, honing, lapping, super finishing, polishing and buffing.

MODULE V – NON-CONVENTIONAL MACHINING PROCESSES (9Lecture Hours)
Need for Unconventional processes – Electrical discharge machining (EDM) – Dielectric fluid – electrode – wire EDM –Electrochemical Machining (ECM) –Electrochemical Grinding (ECG), Ultrasonic Machining (USM) – Abrasive Jet Machining (AJM) – Laser Beam Machining (LBM) – Plasma Arc Machining (PAM).

MODULE VI – ADDITIVE MANUFACTURING (7 Lecture Hours)
3D printing, Rapid prototyping and rapid tooling.

Text Books:

1. P.N Rao “Manufacturing Technology”, Metal Cutting and Machine Tools, Tata McGraw- Hill, New Delhi,2013.
2. S. Kalpakjian, “Manufacturing Engineering and Technology”, Pearson Education India Edition, 2014.

Reference Books:

1. Roy A. Lindberg, “Process and Materials of Manufacture”, PHI / Pearson Education, 4th Edition, 2006.
2. HMT – “Production Technology”, Tata McGraw Hill, 2001.
3. S.K. Hajra Choudhray, S.K. Bose, ‘Elements of Workshop Technology, Vol. II, Machine Tools’, Media Promoters & Publishers (P) Ltd, 2008.
4. Andrew Y. C. Nee, “Handbook of Manufacturing Engineering and Technology” Springer, 2014.
5. Helmi A. Youssef, Hassan A. El-Hofy, Mahmoud H. Ahmed, “Manufacturing Technology: Materials, Processes, and Equipment”, CRC Press, 2017.

18ME2023	MANUFACTURING LABORATORY II	L T P C 0 0 2 1

Co requisite: Manufacturing Technology

Course Objectives: To impart knowledge on

1. Types of machine tools.
2. Metal cutting operations.
3. Selection of tools for machining operations.

Course Outcome: After completing the course the student will be able to

1. Demonstrate skills to machine cylindrical components using Lathe.
2. Demonstrate skills to machine V-block, rectangular block and key way using shaping/milling/slotting machine.
3. Demonstrate skills to cut spur gear using gear hobbing machine.
4. Demonstrate skills to do grinding operation in cylindrical grinding machine.
5. Interpret component drawings and select appropriate cutting tools.
6. Compare the dimensions of the components using measuring instruments.

LIST OF EXPERIMENTS

1. Step turning operation using Lathe.
2. Taper turning operation using Lathe.
3. Knurling and countersinking operation using Lathe.
4. Drilling and boring operation using Lathe.
5. External thread cutting operation using Lathe.
6. Tapping operation using Lathe.
7. Machining rectangular block using shaper.
8. Machining V- block using shaper.
9. Machining rectangular block using milling machine.
10. Key way cutting using slotting machine.
11. Cylindrical grinding using cylindrical grinding machine.
12. Spur gear cutting using gear hobbing machine.

Text/Reference Books:

1. Kalpakjian, S., & Schmid, S. R., “Manufacturing processes for engineering materials”, Pearson Education, 6th Edition, 2017.
2. P.N. Rao, “Manufacturing Technology”, Vol. 2, TMH. 3rd Edition 2017.

18ME2024	COMPUTER AIDED MANUFACTURING LABORATORY	L 0	T 0	P 2	C 1

Co requisite: Manufacturing Technology

Course Objectives: To impart knowledge on
1. NC programming for CNC turning and milling operation and execution.
2. Selection of tools for a machining operation.
3. Simulation and verification of machining processes.

Course Outcome: After completing the course the student will be able to
1. Know features and applications of CNC turning and machining centers.
2. Understand the CNC control in modern manufacturing system.
3. Prepare CNC Programming for different mechanical parts using G codes and M codes.
4. Implement the communication procedure for transmitting the CNC part program from an external computer to the control of the CNC machine tool.
5. Generate automated tool paths for a given engineering component.
6. Operate a modern industrial CNC machine tool for actual machining of simple and complex mechanical.

LIST OF EXPERIMENTS
1. Step turning and Taper turning in CNC.
2. Thread cutting in a CNC Turning Centre.
3. Face milling and step milling in Machining Centre.
4. Profile cut using linear and circular interpolation.
5. Pocketing and slotting in CNC.
6. Mirror using Subprogram and drilling using drilling cycles.
7. Spiral cutting in a CNC 4–axis Trainer Mill.

Reference Books:

Lab manual

18ME2025	MATERIALS ENGINEERING	L 3	T 0	P 0	C 3

Course Objectives: To impart knowledge on
1. The properties and applications of various engineering materials.
2. Testing methods and procedures to find the mechanical properties of engineering materials.
3. Construction of phase diagrams and also the importance of iron-iron carbide phase diagram and different heat treatment.

Course Outcome: After completing the course the student will be able to
1. Identify crystal structures of common engineering materials.
2. Understand the principle of various microscopes.
3. Identify the various behaviors of materials and defects.
4. Analyze failures and predict service behavior of materials for various applications.
5. Interpret and determine the right compositions of metals.
6. Select the heat treatment process based on the metals.

MODULE I – CRYSTAL STRUCTURE (7 Lecture Hours)

Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress.

MODULE II – MECHANICAL PROPERTY MEASUREMENT (7 Lecture Hours)

Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's Law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength.

MODULE III – STATIC FAILURE THEORIES (9 Lecture Hours)

Ductile and brittle failure mechanisms, Tresca, Von-miss, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb; Fracture mechanics: Introduction to Stress-intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, S-N curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture with fatigue, Introduction to non-destructive testing (NDT).

MODULE IV – PHASE DIAGRAMS (6 Lecture Hours)

Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binaryphase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotecticreactions. Iron Iron-carbide phase diagram and microstructural aspects of ledeburite, austenite, ferrite and cementite, cast iron.

MODULE V – HEAT TREATMENT (7 Lecture Hours)

Annealing, tempering, normalizing and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening.

MODULE VI – STEEL, COPPER ALLOYS & OTHERS (9 Lecture Hours)

Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons;grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze andcupro-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based superalloys and Titaniumalloys.

Text Books:

1. V. Raghavan., “Material Science and Engineering”, Prentice Hall of India Pvt. Ltd, New Delhi, 2009.
2. Williams D. Callister “Material Science and Engineering” John Wiley and sons inc. 2014.

Reference Books:

1. Reza Abbaschian, Lara Abbaschian, Robert E. Reed-Hill, “Physical Metallurgy Principles”, Cengage Learning, 2013.
2. Raymond A Higgins “Engineering Materials (Applied Physical Metallurgy) English Language book, society, 2003.
3. Khanna O.P., “A text book of Materials Science and Metallurgy” DhanpatRai and Sons Delhi, 2014.
4. Sydney H. Avner, “Introduction to Physical Metallurgy”, 2nd edition McGraw Hill Book Company, 2008.
5. Kenneth G. Budinski and Michael K. Budinski, “Engineering Materials: Properties and Selection”, Pearson Education India, 2016.

18ME2026	BASIC AUTOMOBILE ENGINEERING	L 3	T 0	P 0	C 3

Course Objectives: To impart knowledge on

1. To impart knowledge on the basic principles of engines used for automobiles and different systems.
2. To impart knowledge on the various transmission and drive line units of automobiles.
3. To broaden the importance of sensors and fuel injection systems.

Course Outcome: After completing the course the student will be able to

1. Identify the importance and functions of vehicle frame.
2. Describe the thermodynamic principles behind the working of petrol and Diesel.
3. Recognize the construction and working principles of SI and CI engines.
4. Express the functions and components of fuel injection and ignition systems.
5. Summarize the functions and components of engine cooling, lubrication and ignition systems.
6. Outline the functions and components of electric and hybrid vehicles.

MODULE I - INTRODUCTION (8 Lecture Hours)

Classification of vehicles, body and load - Layout of an automobile chassis, Function of major components of a vehicle and introduction to their different systems such as Frame, transmission systems - clutch and gear box, differential, braking system, steering and suspension systems.

MODULE II - THERMODYNAMICS (7 Lecture Hours)

Zeroth, First, second and third law of thermodynamics (concept only), Otto cycle, diesel cycle, fuel used properties of fuels, air requirement for complete combustion of fuel.

MODULE III - IC ENGINES (8 Lecture Hours)
Concept of two stroke and four stroke petrol and diesel engines and their applications to automobiles. Various terms, Valves and Actuating mechanisms – Inlet and Exhaust manifolds. Specification of automobile engines.
MODULE IV - ENGINE LUBRICATION AND COOLING SYSTEMS (7 Lecture Hours)
Lubrication of engine components, Lubrication system – wet sump and dry sump, crankcase ventilation, Types of cooling systems – liquid and air cooled, comparison of liquid and air cooled systems.
MODULE V - AUTOMOTIVE FUEL INJECTION & IGNITION SYSTEM (8 Lecture Hours)
Automobile fuel system: Fuel tank, filters, spark plug, ignition systems (Battery and magneto ignition system), Current trends in multi point fuel injection system (MPFI), Gasoline Direct Injection (GDI), Common Rail Direct Injection (CRDI).
MODULE VI - AUTO INDUSTRY AND FUELS FOR HYBRID VEHICLES (7 Lecture Hours)
History, leading manufacturers, development in automobile industry, trends, new products. Electric and Hybrid vehicles: types, applications. Pollution and environmental aspects – norms.

Text Books:

1. Kirpal Singh, "Automobile Engineering" vol1 and vol2. Standard Publishers, 20011.
2. Ganesan. V., "Internal Combustion Engines", Tata McGraw Hill, New Delhi, 2012

Reference Books:

1. S.S. Thipse, "IC Engines", Jaico Publications, 2014.
2. Robert Bosch, "Automotive Hand Book", SAE 9th Edition, 2014.
3. Ramalingam K.K., 'Automobile Engineering' SciTech Publications Pvt. Ltd., 2005.
4. Bechhold, "Understanding Automotive Electronics", SAE, 1998.
5. Newton. K, Steeds.W, Garret.T.K. and Butterworth. 'Motor Vehicle', IE, 1989.

18ME2027	FUNDAMENTALS OF THERMAL SCIENCES AND FLUID MECHANICS	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Work and heat interactions, balance of energy between system and its surroundings
2. Application of I law and II law of thermodynamics to various energy conversion devices
3. Application of mass and momentum conservation laws for fluid flows, measurement of velocity and pressure variations in various types of simple flows.

Course Outcome: After completing the course the student will be able to
1. Apply energy balance to systems and control volumes, in situations involving heat and work interactions
2. Evaluate the performance of energy conversion devices
3. Apply gas laws to solve problems related to gas mixtures
4. Determine fluid properties & analyze forces acting on immersed bodies.
5. Mathematically analyze simple flow situations
6. Determine rate of flow and calculate flow losses through pipes.

MODULE I – FUNDAMENTALS OF THERMODYNAMICS (8 Lecture Hours)
System & Control volume; Property, State, Path, Process, thermodynamic cycle, thermodynamic equilibrium, quasi static process, concept of continuum, Temperature, Definition of thermal equilibrium and Zeroth law, Thermodynamic definition of work and heat - Displacement work; Path dependence of work and heat, illustrations for simple processes.
MODULE II – FIRST LAW OF THERMODYNAMICS (7 Lecture Hours)
First Law for Cyclic & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy, First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices;
MODULE III – SECOND LAW OF THERMODYNAMICS (8 Lecture Hours)
Heat engines, Refrigerator and heat pump, Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale ideal gases and ideal gas mixtures.

MODULE IV – FLUID PROPERTIES AND FLUID STATICS (7 Lecture Hours)
Units and dimensions- Definition of fluid, Properties of fluids, mass density, specific volume, specific gravity, viscosity, Newton's law of viscosity, compressibility, Capillarity and surface tension, Fluid Statics: Pascal's law –Measurement of pressure – Manometers.
MODULE V – EQUATIONS OF FLUID FLOW (8 Lecture Hours) Types of flow, Velocity and acceleration, Control volume- application of continuity equation and momentum equation, Incompressible flow, Euler's equation – Bernoulli's equation and its applications.
MODULE VI – FLOW THROUGH CIRCULAR CONDUITS (7 Lecture Hours)
concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Pipes connected in series and parallel, Need for dimensional analysis – methods of dimension analysis. Turbines, air compressors, R & AC, simple numerical only

Text Books:

1. V. L. Streeter, E.B.Wylie and K.W. Bedford., "Fluid Mechanics", Tata McGraw-Hill, 9th edition, 2010.
2. P.K. Nag, "Engineering Thermodynamics", Tata McGraw-Hill, 2013

Reference Books:

1. R. K. Bansal, "A Textbook of Fluid Mechanics and Hydraulic Machines", Laxmi Publications, Revised Ninth Edition, 2017.
2. Frank M White., "Fluid Mechanics", Tata McGraw Hill, Eighth Edition, 2016.
3. Yunus A Cengel and John M Cimbala., "Fluid Mechanics: Fundamentals and applications", Tata McGraw-Hill, Third Edition 2014.
4. Moran, M. J. and Shapiro, H. N., "Fundamentals of Engineering Thermodynamics", John Wiley and Sons, 1999.
5. Yunus Cengel, "Thermodynamics", Tata McGraw-Hill, 2014

18ME2028	**HYDRAULICS AND PNEUMATICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives: To impart knowledge on
1. Basic principles of hydraulic and pneumatic systems.
2. Actuation modes and control systems.
3. Programming skills in PLC

Course Outcome: After completing the course the student will be able to
1. Understand the salient features and constructional details of both hydraulic and Pneumatic systems
2. Understand the various types of actuation modes and control system design procedures for design of circuits and to control them.
3. Understand the concepts of servo and proportional valves
4. Analyze various application circuits
5. Apply the above outcomes to design pneumatic and hydraulic circuits.
6. Build a PLC programme for a particular application

MODULE I – INTRODUCTION (5 Lecture Hours)
Introduction to fluid power, properties - hydraulic fluids, air. Selection of hydraulic fluids, comparison between hydraulics and pneumatics.
MODULE II – ELEMENTS OF HYDRAULIC SYSTEMS (7 Lecture Hours)
Pumps - types, characteristics. Valves for control of direction, flow and pressure - types, typical construction details, Cartridge valves – basic concepts. Actuators – types and constructional details.
MODULE III – HYDRAULIC SYSTEM DESIGN AND APPLICATIONS (9 Lecture Hours)
Power pack–elements, design. Pipes- material, pipe fittings. seals and packing. Maintenance of hydraulic systems. Selection criteria for cylinders, valves, pipes. Heat generation in hydraulic system Deceleration circuit, regenerative circuits, feed circuits, sequencing circuits, synchronizing circuits, fail-safe circuits. (6)

MODULE IV – PNEUMATIC CONTROL (4 Lecture Hours)

Components, constructional details, filter, lubricator, regulator, constructional features, types of actuators, control valves for direction, pressure and flow, air motors, air hydraulic equipments.

MODULE V – PNEUMATIC CONTROL SYSTEM DESIGN (8 Lecture Hours)

General approach to control system design, symbols and drawings, schematic layout, travel step diagram, circuit, control modes, program control, sequence control, cascade method, Karnaugh-Veitch mapping.

MODULE VI – ADVANCED TOPICS IN HYDRAULICS AND PNEUMATICS (9 Lecture Hours)

Electro pneumatics, ladder diagram. Servo and Proportional valves - types, operation, application. Hydro-Mechanical servo systems. PLC programming for specific hydraulic and pneumatic applications.

Text Books:

1. Anthony Esposito, "Fluid Power with Application", Pearson Education (Singapore) Pvt. Ltd, Delhi, India, 2003.
2. Srinivasan R, "Hydraulic and Pneumatic Controls", McGraw –Hill education (India) Pvt. Ltd, 2010.

Reference Books:

1. Andrew Parr, "Hydraulics and Pneumatics: A Technician's and Engineer's Guide 3rd Edition", Butterworth-Heinemann, 2011.
2. Majumdar S R, "Oil Hydraulic Systems: Principles and Maintenance", Tata McGraw- Hill., New Delhi, 2003.
2. Majumda S R, "Pneumatic Systems: Principles and Maintenance", Tata McGraw- Hill., New Delhi, 1996.
3. Werner Deppert and Kurt Stoll, "Pneumatic Controls: An Introduction to Principles", Vogel-Druck Wurzburg, Germany, 1975.
4. Peter Rohner, "Fluid Power Logic Circuit Design – Analysis, Design, Method and Worked Examples", The Macmillan Press Ltd., UK, 1979.

18ME2029	HYDRAULICS AND PNEUMATICS LABORATORY	L T P C 0 0 2 1

Course Objectives: To impart knowledge on

1. Basic principles of hydraulic and pneumatic systems.
2. Actuation modes and control systems.
3. Simulation software for design of hydraulic and pneumatic circuits.

Course Outcome: After completing the course the student will be able to

1. Understand constructional details of both hydraulic and Pneumatic systems.
2. Design and Simulation of Pneumatic and Hydraulic circuits using Fluid SIM software
3. Testing of simple pneumatic and hydraulic circuits using single and multiple actuators
4. Testing of electro pneumatic multiple actuator circuits
5. Testing of hydraulic regenerative circuit
6. Testing of electro hydraulic multiple actuator circuits

LIST OF EXPERIMENTS

1. Design of simple pneumatic and hydraulic circuits using basic components.
2. Construction and testing of multiple pneumatic actuator circuit using Cascade method.
3. Co-ordinated motion of actuators using electro – pneumatic elements.
4. Construction and testing of a hydraulic actuator regenerative circuit.
5. Co-ordinated motion of actuators using electro – hydraulic elements
6. Design and Simulation of hydraulic and pneumatic circuits using Fluid SIM

18ME2030	MECHANICS AND ENGINEERING DESIGN LAB	L T P C 0 0 2 1

Course Objectives: To impart knowledge on

1. The fundamental principles of dynamics.
2. Equations of motion for translational and rotational mechanical systems.
3. Design and assembly of engineering components using modelling software.

Course Outcome: After completing the course the student will be able to

1. Compute the moment of inertia of rigid bodies.
2. Demonstrate the working principles of gyroscope.
3. Determine balancing mass in the rotating systems.
4. Demonstrate the principles of kinematics and dynamics of machinery.
5. Design components to meet desired needs within realistic constraints and sustainability.
6. Extract production drawing from solid model and assembly of components.

LIST OF EXPERIMENTS

1. Study of the effect of link length parameters on the output of a Four Bar Mechanism and Slider Crank Mechanism.
2. Determination of moment of inertia of connecting rod.
3. Static and dynamic balancing using rotating unbalanced test rig.
4. Preparation of cam displacement curve and determination of jump speed of the cam.
5. Study on epicyclic gear train and worm wheel reducers.
6. Modeling of engineering components using modeling software.
7. Extraction of Production drawing from solid model.
8. Assembly of engineering components using modeling software.

18ME2031	KINEMATICS AND DYNAMICS OF MACHINERY	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Displacement, velocity and acceleration at any point in a rigid link of a mechanism
2. Cam profiles to give required follower motion and gear combinations to meet the transmission requirements.
3. Different types of gears and gear trains

Course Outcome: After completing the course the student will be able to

1. Understand the fundamental concepts of kinematic links, kinematic pairs and kinematic chains
2. Apply Gashoff's law for four bar, slider crank and common mechanisms
3. Calculate displacement, velocity and acceleration in simple mechanisms.
4. Analysis of planar mechanisms, force , moment and balancing of kinematic pairs
5. Design and calculate the velocity and motion of cams
6. Understand the fundamental concepts of various transmission devices

MODULE I – BASICS OF MECHANISMS (8 Lecture Hours)

Definitions: Link, Kinematic pair, Kinematic chain, Mechanism and Machine - Degree of freedom – Mobility – Kutzbach criterian - Grashoff's law - Kinematic inversions: Four bar and slider crank mechanism - Mechanical advantage - Transmission angle - Description of common mechanisms, applications of mechanisms.

MODULE II – KINEMATIC ANALYSIS (7 Lecture Hours)

Displacement, velocity and acceleration analysis in simple mechanisms using graphical and analytical methods.

MODULE III – DESIGN/SYNTHESIS OF PLANAR MECHANISMS (8 Lecture Hours)

Number and dimensional synthesis – two and three positions (relative motion) synthesis of slider crank and four bar mechanisms. Design of simple planar linkages, Computer aided synthesis and analyses of simple planar mechanisms.

MODULE IV – FORCE ANALYSIS OF LINKAGES (7 Lecture Hours)

Free body diagrams, Inertia forces and moments, constraint forces, effect of friction and gravity. Static and dynamic force analyses of simple planar mechanisms. Balancing of planar linkages: static and dynamic balancing of planar mechanisms.

MODULE V – CAMS (8 Lecture Hours)
Introduction to Cams- Classifications, law of cam design, cam function / follower motion schemes: uniform velocity, parabolic, simple harmonic motion, cycloid motion paths and introduction to high speed cams. Layout of plate cam profiles for different types of followers - knife-edged and roller.
MODULE VI – GEARS (7 Lecture Hours)
Spur gear terminology and definitions. Fundamental law of toothed gearing and tooth forms. Helical, bevel, worm, and rack and pinion gears (basics only). Gear trains, epicyclic gear trains, differentials, automotive transmission gear trains, Harmonic and special gear drives.

Text books:
1. Rattan S S, "Theory of Machines", Tata McGraw -Hill Publishers, New Delhi, 2009.
2. Norton L, "Kinematics and Dynamics of Machinery", 5th Edition, TMH, 2012.

Reference Books
1. Shigley J E and Uicker J J, "Theory of Machines and Mechanisms", McGraw -Hill Inc., New Delhi, 2003. 3. Bevan.T, "Theory of Machines", CBS Publishers and Distributors, New Delhi, 2002.
2. Myszka, DH,"Machines and Mechanisms: Applied kinematic analysis", 4th Edition, 2012.
3. Ghosh and Mallick.A K, "Theory of Machines and Mechanisms", Affiliated East West Private Limited New Delhi, 1988.
4. R S Khurmi, "Theory Of Machines", S Chand, 2005.
5. Wilson, "Kinematics and Dynamics of Machinery 3rd Edition", Pearson, 2008.

18ME2032	MECHANICS OF SOLIDS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. Nature of stresses developed in simple geometries
2. Elastic deformation occurring in various simple geometries for different types of loading.
3. Stresses action on shafts, springs and cylinders

Course Outcome: After completing the course the student will be able to
1. Describe the concepts of stress-strain relationships for homogenous, isotropic materials.
2. Calculate stresses and strains in members subjected to axial structural loads and thermal loads.
3. Determine the volumetric strain of the components and also derive the relationship between the elastic constants.
4. Explain the fundamentals of beams and also calculate the shear force and bending moment of beams.
5. Calculate the stresses and strains in members subject to flexural and torsional loadings.
6. Determine and illustrate principal stresses, maximum shearing stress, and the stresses acting on a structural member.

MODULE I – STRESSES AND STRAINS (8 Lecture Hours) Stress and strain due to axial force, elastic limit, Hooke's law-factor of safety - stepped bars, uniformly varying sections, stresses in composite bar due to axial force and temperature.
MODULE II – CHANGES IN DIMENSIONS AND VOLUME (7 Lecture Hours) Lateral strain - Poisson's ratio, volumetric strain, changes in dimensions and volume, shear stress, shear strain, relationship between elastic constants.
MODULE III – BENDING MOMENT AND SHEAR FORCE (8 Lecture Hours) Relationship between load, shear force and bending moment - shear force and bending moment diagrams for cantilever, simply supported and overhanging beams under concentrated loads, uniformly distributed loads, uniformly varying loads, concentrated moments, maximum bending moment and point of contra flexure.
MODULE IV – FLEXURE IN BEAMS (7 Lecture Hours) Theory of simple bending and assumptions - derivation of equation, section modulus, normal stresses due to flexure.
MODULE V – TORSION (8 Lecture Hours) Theory of torsion and assumptions-derivation of the equation, polar modulus, stresses in solid and hollow circular shafts, power transmitted by a shaft, close coiled helical spring with axial load.

MODULE VI – PRINCIPAL STRESSES AND STRAINS (Two dimensional only **(7 Lecture Hours)**

State of stress at a point - normal and tangential stresses on a given plane, principal stresses and their planes, plane of maximum shear stress, analytical method, Mohr's circle method, application to simple problems.

Text books:

1. Punmia B C., Ashok Kumar Jain and Arun Kumar Jain, "Mechanics of materials", Laxmi Publications, New Delhi, 2005.
2. Egor P Popov, "Engineering Mechanics of Solids", Prentice Hall of India Learning Ltd., New Delhi, 2010.

Reference books:

1. Hibbeler RC., "Mechanics of Materials", Pearson Education, Low Price Edition, 2007.
2. Ramamrutham S and Narayan R., "Strength of Materials", Dhanpat Rai and Sons, New Delhi, 2008.
3. Crandall, S. H., Dahl, N. C. and Lardner, T. J, An Introduction of the Mechanics of Solids, 3rd ed., Tata McGraw Hill, 2012
4. Shames, I. H, Engineering Mechanics: Statics and Dynamics, 4th ed., Prentice Hall of India, 2004.
5. Meriam, J. L. and Kraige, L. G, Engineering Mechanics Statics, 5h ed., John Wiley and Sons, 2004.

18ME2033	ENGINEERING DESIGN LABORATORY	L T P C 0 0 4 2

Course Objectives: To impart knowledge on

1. Preparing drawings for various mechanical components using a commercially available 3D modeling software package
2. Using Finite Element Analysis software to solve various field problems in mechanical engineering
3. Optimizing and verifying the design of various machine elements

Course Outcomes: After completing the course the student will be able to

1. get familiarized with the computer applications in design
2. prepare drawings for various mechanical components.
3. model and analyze various physical problems
4. select appropriate elements and give boundary conditions
5. solve structural, thermal, modal and dynamics problems.
6. conduct coupled structural and thermal analysis

List of Experiments:

1. Assembly of knuckle joint
2. Assembly of plummer block
3. Structural analysis of 2D Truss
4. Analysis of Bicycle frame
5. 2D static analysis of bracket
6. Thermal Analysis of 2D chimney
7. 3D Fin Analysis
8. 2-D Transient mixed boundary
9. Design optimisation
10. Velocity Analysis of fluid flow in a channel
11. Modal analysis of cantilever beam
12. Harmonic analysis of cantilever beam
13. Coupled structural and thermal analysis
14. Magnetic Analysis of solenoid actuator

18ME2034	OPERATIONS RESEARCH	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Linear Programming techniques.
2. Job sequencing problems, Transportation and assignment problems.
3. Inventory models, PERT/CPM and Queuing theory.

Course Outcome: After completing the course the student will be able to

1. Correlate this subject knowledge with the engineering problems.
2. Construct flexible appropriate mathematical model to represent physical problem.
3. Schedule their engineering projects by using network analysis.
4. Analyze the transportation problem and optimize the resources and output.
5. Apply knowledge in solving their engineering queuing problems.
6. Develop their skills in decision making analysis by allocation of resources.

MODULE I - LINEAR PROGRAMMING PROBLEM (9 Lecture Hours)

Formulation of LPP – Graphical Method – Simplex Method –Artificial variable technique and two phase simplex method. Duality – Dual and simplex method – Dual Simplex Method – Sequencing: Job sequencing – single and multiple jobs through two machines and three machines.

MODULE II - TRANSPORTATION PROBLEM (9 Lecture Hours)

Transportation Model, finding initial basic feasible solutions using least cost method, Vogells's approximation method and North–West corner method, moving towards optimality through MODI method, Resolving degeneracy in transportation.

MODULE III - ASSIGNMENT PROBLEM (8 Lecture Hours)

Solution of an assignment problem, Multiple Solution, Hungarian Algorithm, Maximization in Assignment Model, Impossible Assignment.

MODULE IV - NETWORK ANALYSIS (9 Lecture Hours)

Network diagram – probability of achieving completion date – crash time –cost analysis – PERT & CPM-Forward and backward scheduling.

MODULE V – INVENTORY MODELS (9 Lecture Hours)

Economic order quantity models-purchase models with and without shortage, production models with and without shortage-ABC analysis-Two Bin system.

MODULE VI – QUEUING MODELS (9 Lecture Hours)

Structure of queuing models-Attributes and components of queuing models-application of queuing models- Kendall's Notation -Single service channel with finite and infinite queue size - Single service channel with finite and infinite population size.

Text Books:

1. S. Bhaskar, "Operations Research", Anuradha Agencies, Chennai 2013.
2. Natarajan A.M., Balasubramani P., Thamilarasi A., "Operations Research", Pearson Education, 1st Edition, 2014.

Reference Books:

1. HamdyTaha A., "Operations Research", 9th Edition Prentice – Hall of India Private Limited, New Delhi, 2014.
2. KantiSwarup, Manmohan, Gupta P.K., "Operations Research" Sultan Chand & Sons., 14th Edition 2014.
3. Srinivasan G., "Operations Research 3rd Edition", Prentice – Hall of India Private Limited, New Delhi, 2017.
4. Winston, "Operations Research, Applications and Algorithms" – Cengage Learning, 4th Edition, 2004.
5. S. Pannerselvam, "Operations Research 2nd Edition", Prentice – Hall of India Private Limited, New Delhi, 2006.

18ME2035	TECHNICAL APTITUDE	L T P C 0 0 2 1

Course Objectives: To impart knowledge on

1. To learn the basics of mechanical engineering subjects
2. To analyze various concepts of the subjects
3. To have a conceptual knowledge on the overall subjects

Course Outcome: After completing the course the student will be able to

1. Prepare for Aptitude Tests.
2. Simplify the acquired knowledge for clearing competitive exams.
3. Solve technical problems.
4. Use the techniques and skills for engineering practices.
5. Identify, formulate and solve engineering problems.
6. Function on multidisciplinary areas.

MODULE I – APPLIED MECHANICS (2 Lecture Hours)

Free-body diagrams and equilibrium - trusses and frames - virtual work - kinematics and dynamics of particles and of rigid bodies in plane motion - impulse and momentum (linear and angular) and energy formulations - collisions.

Module II – MECHANICS OF MATERIALS (2 Lecture Hours)

Stress and strain - elastic constants - Poisson's ratio - Mohr's circle for plane stress and plane strain - thin cylinders - shear force and bending moment diagrams - bending and shear stresses - deflection of beams - torsion of circular shafts - Euler's theory of columns - energy methods - thermal stresses - strain gauges and rosettes - testing of materials with universal testing machine - testing of hardness and impact strength.

MODULE III – THERMODYNAMICS, REFRIGERATION AND AIR-CONDITIONING (3 Lecture Hours)

Thermodynamic systems and processes - properties of pure substances - behavior of ideal and real gases - Zeroth and first laws of thermodynamics - calculation of work and heat in various processes - second law of thermodynamics - thermodynamic property charts and tables - availability and irreversibility - thermodynamic relations -Vapour and gas refrigeration and heat pump cycles - properties of moist air - Psychrometric chart, basic psychrometric processes.

MODULE IV – FLUID MECHANICS, TURBOMACHINERY AND I.C. ENGINES (3 Lecture Hours)

Fluid properties - fluid statics – Manometry – buoyancy - forces on submerged bodies - stability of floating bodies & control - volume analysis of mass - momentum and energy - fluid acceleration - differential equations of continuity and momentum - Bernoulli's equation - dimensional analysis - viscous flow of incompressible fluids - boundary layer - elementary turbulent flow - flow through pipes - head losses in pipes - bends and fittings - Impulse and reaction principles - velocity diagrams - Pelton-wheel - Francis and Kaplan turbines - Air-standard Otto - Diesel and dual cycles.

MODULE V – MATERIALS, METROLOGY AND INSPECTION (2 Lecture Hours)

Structure and properties of engineering materials - phase diagrams - heat treatment - stress-strain diagrams for engineering materials - Limits, fits and tolerances - linear and angular measurements – Comparators - Gauge design – Interferometry - form and finish measurement - alignment and testing methods - tolerance analysis in manufacturing and assembly.

MODULE VI – CIM AND INDUSTRIAL ENGINEERING (3 Lecture Hours)

Basic concepts of CAD/CAM and their integration tools - Forecasting models - aggregate production planning – scheduling - materials requirement planning - Deterministic models - safety stock inventory control systems - Operations Research - Linear programming - simplex method – transportation assignment - network flow models - simple queuing models - PERT and CPM.

Text Books:

1. IES Master Team, "GATE 2018 - Mechanical Engineering (31 Years Solution)", IES Master Publications, 2017.
2. B.Singh, "GATE 2018 Mechanical Engineering", Made Easy, 2017.

Reference Books:

1. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, "Mechanics of Materials 5^{th} Edition", Tata McGraw Hill Publishing Co. Ltd., New Delhi 2012.
2. A Textbook of Fluid Mechanics and Hydraulic Machines, R.K. Bansal, Laxmi Publications, 2011.
3. P.K. Nag, "Engineering Thermodynamics", Tata McGraw-Hill, 2013.
4. Williams D. Callister "Material Science and Engineering" John Wiley and sons Inc. 2014.
5. Mikell P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems 6^{th} Edition", John Wiley & Sons Inc, 2015.

18ME2036	**THERMODYNAMICS**	**L T P C** **3 0 0 3**

Course Objectives: To impart knowledge on

1. To learn about work and heat interactions, and balance of energy between system and its surroundings.
2. To learn about application of I law and II law to various energy conversion devices.
3. To evaluate the changes in properties of substances in various processes.

Course Outcome: After completing the course the student will be able to

1. Understand the basic concepts in thermodynamics and its application in different fields.
2. Apply energy balance to systems and control volumes, in situations involving heat and work interactions.
3. Evaluate the performance of energy conversion devices.
4. Differentiate between high grade and low grade energies.
5. Apply gas laws to solve problems related to gas mixtures.
6. Evaluate changes in thermodynamic properties of substances.

MODULE I – FUNDAMENTALS (7 Lecture Hours)

Fundamentals - System and Control volume; Property, State and Process; Exact & Inexact differentials; Work - Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work.

MODULE II – FIRST LAW OF THERMODYNAMICS (7 Lecture Hours)

Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; various Thermometers- Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy.

MODULE III – FIRST LAW FOR FLOW PROCESSES (8 Lecture Hours)

First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume.

MODULE IV – SECOND LAW OF THERMODYNAMICS (7 Lecture Hours)

Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale.

MODULE V – ENTROPY AND SECOND LAW ANALYSIS (9 Lecture Hours)

Clausius inequality; Definitiojn of entropy S; Demonstration that entropy S is a property; Evaluation of S for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Determination of s from steam tables- Principle of increase of entropy; Illustration of processes in T-s coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles- Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergy balance equation and Exergy analysis.

MODULE VI – PROPERTIES OF PURE SUBSTANCE (8 Lecture Hours)

Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts- Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables and R134a tables; Saturation tables; Superheated tables; Identification of states and determination of properties, Mollier's chart. Basic Rankine cycle.

Text Books:

1. P.K. Nag, "Engineering Thermodynamics", Tata McGraw-Hill, 2013
2. Yunus Cengel, "Thermodynamics", Tata McGraw-Hill, 2014

Reference Books:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen G. J.,"Fundamentals of Thermodynamics 7th Edition", John Wiley and Sons, 2008.
2. Jones, J. B. and Duggan, R. E., Engineering Thermodynamics, Prentice-Hall of India, 1996.
3. Moran, M. J. and Shapiro, H. N., "Fundamentals of Engineering Thermodynamics, 8th Edition" ,John Wiley and Sons, 2014.
4. J.P. Holman, "Thermodynamics", 4thEdition, McGraw Hill, 2002
5. T. Roy Choudhury, "Basic Engineering Thermodynamics", Tata McGraw-Hill, 2000.

18ME2037	APPLIED THERMODYNAMICS	L T P C 3 0 0 3

Prerequisite: Thermodynamics

Course Objectives: To impart knowledge on

1. Various practical power cycles and heat pump cycles.
2. Analysis of energy conversion in various thermal devices such as combustors, air coolers, nozzles, diffusers, steam turbines and reciprocating compressors
3. High speed compressible flow phenomena and refrigeration and air conditioning

Course Outcome: After completing the course the student will be able to

1. Recognize the significance of I law for reacting systems and heating value of fuels.
2. Carry out analysis of various gas and vapour power cycles.
3. Conduct analysis of steam nozzles and turbines.
4. Analyse compressible flow phenomena.
5. Evaluate performance of reciprocating compressors.
6. Apply principles of refrigeration and air conditioning for analysis and performance evaluation.

MODULE I - COMBUSTION FUNDAMENTALS (8 Lecture Hours)

Introduction to solid, liquid and gaseous fuels– Stoichiometry. A/F ratio. Energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion. combustion efficiency. Chemical equilibrium concepts.

MODULE II - VAPOUR AND AIR-STANDARD CYCLES (12 Lecture Hours)

Vapor power cycles - Rankine cycle with superheat, reheat and regeneration, Super-critical and ultra-super-critical Rankine cycle- Gas power cycles, Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle, effect of reheat, regeneration and intercooling- Principle of combined gas and vapor power cycles.

MODULE III - STEAM NOZZLES AND TURBINES (12 Lecture Hours)

Flow of steam through nozzles, effect of friction, critical pressure ratio, supersaturated flow. Impulse and Reaction principles, compounding, Determination of work done and efficiency using velocity diagrams.

MODULE IV - COMPRESSIBLE FLOWS (10 Lecture Hours)

Basics of compressible flow. Stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables for isentropic flow and normal shock flow.

MODULE V - AIR COMPRESSORS (9 Lecture Hours)

Reciprocating compressors, Work input representation on p-v diagram, Effect of clearance and volumetric efficiency. Adiabatic, isothermal and mechanical efficiencies. staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors.

MODULE VI - PSYCHROMETRY, REFRIGERATION AND AIRCONDITIONING (9 Lecture Hours)

Vapor compression refrigeration cycle, super heat, sub cooling – Performance calculations - refrigerants and their properties, Working principle and description of vapour absorption systems- Ammonia – Water, Lithium bromide – water systems. Properties of dry and wet air, use of pschyrometric chart, processes involving heating/cooling and humidification/dehumidification, dew point

Text Books:

1. P.K. Nag, "Engineering Thermodynamics", Tata McGraw-Hill, 2013.
2. YunusCengel, "Thermodynamics", Tata McGraw-Hill, 2014.

Reference Books:

1. J.P. Holman, "Thermodynamics", 4th Edition, McGraw Hill, 2002.
2. T. Roy Choudhury, "Basic Engineering Thermodynamics", Tata McGraw-Hill, 2000.
3. Vanwylen and Sontag, "Classical Thermodynamics", Wiley Eastern, 1999.
4. R.K. Rajput, "A Textbook of Engineering Thermodynamics", Laxmi Publications, 2016.
5. J. P. O'Connell and J. M. Haile, Cambridge University Press, 2005.

18ME2038	THERMAL ENGINEERING LABORATORY	L	T	P	C
		0	0	2	1

Co requisite: Thermodynamics

Course Objectives: To impart knowledge on

1. The performance evaluation of refrigeration, air conditioning systems and heat pumps
2. Performance evaluation of blower and compressor
3. Performance analysis of steam turbine

Course Outcome: After completing the course the student will be able to

1. Evaluate the performance of vapor compression refrigeration cycle
2. Evaluate performance of heat pump
3. Determine COP of air conditioning cycle
4. Evaluate performance of air blower
5. Evaluate performance of reciprocating air compressor
6. Evaluate performance of steam turbine

LIST OF EXPERIMENTS

1. Determination of coefficient of performance in a vapour compression refrigeration cycle
2. Determination of coefficient of performance in a heat pump apparatus
3. Determination of coefficient of performance in air–conditioning cycle
4. Determination of performance parameters on air blower
5. Determination of performance parameters on two stage reciprocating air compressor
6. Performance test and study on the steam turbine apparatus

Reference Book

Lab Manual

18ME2039	FLUID MECHANICS AND FLUID MACHINES	L	T	P	C
		3	1	0	4

Course Objectives: To impart knowledge on

1. Fluid statics, kinematics and dynamics. Measurement of pressure, computations of hydrostatic forces on structural components and the concepts of Buoyancy.
2. Analysis of engineering problems involving fluids – such as those dealing with pipe flow, open channel flow, jets, turbines and pumps.
3. Various concepts in hydraulics, hydraulic machinery and hydrology.

Course Outcome: After completing the course the student will be able to

1. Apply principles of fluid statics, kinematics and dynamics.
2. Describe the terminology in fluid mechanics

3. Contrast the different types of fluid flow
4. Apply the continuity, momentum and energy principles
5. Apply dimensional analysis.
6. Examine the characteristics of a boundary layer.

MODULE I – BASIC CONCEPTS AND DEFINITION (7 Lecture Hours)

Distinction between a fluid and a solid; Density, Specific weight, Specific gravity, Kinematic and dynamic viscosity; variation of viscosity with temperature, Newton law of viscosity; vapour pressure, boiling point, cavitation; surface tension, capillarity, Bulk modulus of elasticity, compressibility.

MODULE II – FLUID STATICS (7 Lecture Hours)

Fluid Pressure: Pressure at a point, Pascals law, pressure variation with temperature, density and altitude. Piezometer, U-Tube Manometer, Single Column Manometer, U-Tube Differential Manometer, Micro manometers. pressure gauges, Hydrostatic pressure and force: horizontal, vertical and inclined surfaces. Buoyancy and stability of floating bodies.

MODULE III – FLUID KINEMATICS (7 Lecture Hours)

Classification of fluid flow : steady and unsteady flow; uniform and non-uniform flow; laminar and turbulent flow; rotational and irrotational flow; compressible and incompressible flow; ideal and real fluid flow; one, two and three dimensional flows; Stream line, path line, streak line and stream tube; stream function, velocity potential function. One-, two- and three -dimensional continuity equations in Cartesian coordinates.

MODULE IV – FLUID DYNAMICS (7 Lecture Hours)

Surface and body forces; Equations of motion - Euler's equation; Bernoulli's equation – derivation; Energy Principle; Practical applications of Bernoulli's equation :Venturimeter, orifice meter and pitot tube.

MODULE V - DIMENSIONAL ANALYSIS (7 Lecture Hours)

Forces exerted by fluid flow on pipe bend; Vortex Flow – Free and Forced; Dimensional Analysis and Dynamic Similitude - Definitions of Reynolds Number, Froude Number, Mach Number, Weber Number and Euler Number; Buckingham's π-Theorem.

MODULE VI - BOUNDARY LAYER THEORY (10 Lecture Hours)

Flat plate, conduits, curved solid bodies, universal velocity profile, and momentum eddy concept – simple applications. Modern trends in application of computation to Boundary layer flows.

Copy to be added AICTE page 295/6flow through pipes

Text Books:

1. A Textbook of Fluid Mechanics and Hydraulic Machines, R.K. Bansal, Laxmi Publications, 2011
2. Frank M White., "Fluid Mechanics", Tata McGraw Hill, Eighth Edition, 2016.

Reference Books:

1. C.S.P.Ojha, R. Berndtsson and P. N. Chadramouli, "Fluid Mechanics and Machinery," Oxford University Press, 2010.
2. P M Modi and S M Seth, "Hydraulics and Fluid Mechanics 21st Edition", Standard Book House, 2018.
3. K. Subramanya, "Theory and Applications of Fluid Mechanics",Tata McGraw Hill, 2003.
4. R.L. Daugherty, J.B. Franzini and E.J. Finnemore, "Fluid Mechanics with Engineering Applications", International Student Edition, McGraw Hill.
5. Fox and McDonald., "Introduction to Fluid Mechanics", Wiley India, ninth edition, 2016.

18MR2001	METROLOGY AND MEASUREMENT SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Science of measurement and measuring machines commonly used.
2. Limits, fits and tolerances, geometric dimensioning aspects
3. Methods of acceptance test for conventional machine tools.

Course Outcome: After completing the course the student will be able to

1. Use different measuring instruments in industries.

2. Utilize geometrical dimensioning and tolerancing symbols and apply them in inspection and testing process.
3. Apply the concepts of laser metrology in quality control.
4. Examine the surface roughness of workpieces from various production processes.
5. Choose the modern manufacturing methods using advanced metrology systems.
6. Recommend calibration standards towards measuring instruments.

MODULE I – INTRODUCTION TO MECHANICAL MEASUREMENTS (8 Lecture Hours)
Science of measurement: Mechanical measurement – types, measurement standards– terms used in rating instrument performance. Precision and Accuracy.
MODULE II – GEAR MEASURING MACHINES (8 Lecture Hours)
Study of Measuring Machines, gear tooth measurement- measurement of gear profile, Isometric Viewing of Surface Defects, Image Shearing Microscope for Vertical Dimensions.
MODULE III – ELECTRON AND LASER MICROSCOPY (7 Lecture Hours)
Laser metrology and microscopy: Laser Metrology - Vision systems- Principles and applications, Principles of Scanning and Transmission Electron Microscopy and its applications.
MODULE IV – CALIBRATION AND SURFACE ROUGHNESS MEASUREMENT (7 Lecture Hours)
Acceptance tests for machine tools and surface finish measurements, calibration of machine tools, introduction to ball bar measurement, Measurement of surface roughness.
MODULE V – GEOMETRIC DIMENSIONING AND TOLERANCING (8 Lecture Hours)
Introduction to Tolerancing and Dimensioning: Introduction; Indian Standard System of Limits and Fits (IS :919-2709) ; Designation of Holes ,Shafts and Fits. Meaning of GD and T, Various Geometric symbols used in GD and T, Datum feature, Material Conditions.
MODULE VI – METROLOGY FOR QUALITY (8 Lecture Hours)
Tool wear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. Process metrology for emerging machining processes such as micro-scale machining, Inspection and workpiece quality.(7 hrs)

Text Books:

1. Ernest O Doeblin, “Measurement systems”, McGraw Hill Publishers, 2003.
2. R. K . Jain, “Engineering Metrology”, Khanna Publishers, New Delhi, 2009.

Reference books:

1. Geometric Dimensioning` and Tolerance for Mechanical Design,"Gene R. Cogorno, McGraw Hill, 2004
2. I.C Gupta, “Engineering Metrology”, DanpatRai Publications, 2004.
3. Beckwith Thomas G, “Mechanical Measurements”, Pearson Education, 2008.
4. M.Mahajan,”A Text Book of Metrology”, DhanpatRai&Co. 2010
5. The Metrology Handbook, Jay L. Bucher, Amer Society for Quality, 2004.

18MR2002	FLUID POWER CONTROL AND AUTOMATION LABORATORY	L	T	P	C
		0	0	2	1

Course Objectives: To impart knowledge on
1. Application of fluid power symbols
2. Designing a suitable hydraulic or pneumatic circuits
3. Automating an industrial application.

Course Outcome: After completing the course the student will be able to
1. Recognize the standard symbols used in fluid power circuits.
2. Design and simulation of pneumatic and hydraulic circuits using fluid sim software
3. Testing of electro pneumatic and electro hydraulic multiple actuator circuits
4. Construct the hydraulic circuits for an industrial application.
5. Build a pneumatic circuit and apply them to real life problems.
6. Design and develop a plc controlled pneumatic circuit for industrial application.

LIST OF EXPERIMENTS:

1. Study of standard fluid power symbols.
2. Development of basic pneumatic logic Circuits.
3. Design of pneumatic speed control circuits.
4. Application of time delay valve and pressure Sequence Valves in a pneumatic circuit.
5. Design of pneumatic circuit for material handling system circuit using Cascade method.
6. Design of electro–pneumatic circuit by using relay, limit switch and solenoids.
7. Design of Electro–pneumatic circuit for cascade system of sequence A+B+C+A–B–C–.
8. Construct hydraulic speed control circuits and actuator regenerative circuit.
9. Create electro–hydraulic circuit for continuous reciprocation of DAC using limit switches.
10. Provide solution for an electro–hydraulic circuit using proximity sensors.
11. Design and develop PLC controlled pneumatic logic circuits.
12. Simulation of PLC controlled pneumatic circuit for material handling unit.

18MR2003	DESIGN OF MECHATRONICS SYSTEM	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Structure of microprocessors and their applications in mechanical devices
2. Principle of automatic control and real time motion control systems, with the help of electrical drives and actuators
3. Micro-sensors and their applications in various fields

Course Outcome: After completing the course the student will be able to

1. Get an overview of mechatronics applications
2. Demonstrate knowledge of electrical circuits and logic design.
3. Implement engineering solutions and techniques to solve design problems.
4. Design mechatronic components and systems.
5. Use of micro-sensors and microprocessors.
6. Develop PLC programs for a given task.

MODULE I – INTRODUCTION (8 Lecture Hours)

Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man-Machine Interface.

MODULE II – SENSORS AND TRANSDUCERS (7 Lecture Hours)

Classification, Development in Transducer technology, Optoelectronics- Shaft encoders, CD Sensors, Vision System.

MODULE III – DRIVES AND ACTUATORS (8 Lecture Hours)

Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control; Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems.

MODULE IV – SMART MATERIALS (7 Lecture Hours)

Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation.

MODULE V –MICROMECHATRONIC SYSTEMS (8 Lecture Hours)

Micro sensors, Micro actuators. Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc. Application examples; Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology.

MODULE VI -PROGRAMMABLE LOGIC CONTROLLER (7 Lecture Hours)

Introduction – Architecture – Input / Output Processing – LD Programming with Timers, Counters and Internal relays – Data Handling – Selection of PLC.

Text Books:

1. William Bolton, “Mechatronics: A Multidisciplinary Approach”, Pearson Education, 2012.
2. Devdas Shetty & Richard Kolk “Mechatronics System Design”, 3rd edition. PWS Publishing, 2009.

Reference Books:

1. R.K.Rajput, “A Textbook of Mechatronics”, S. Chand & Company Private Limited, 2014.
2. William Bolton, “Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering”, Prentice Hall, 2015
3. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Penram International Publishing Private Limited, 6th Edition, 2015.
4. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications”, McGraw Hill Education, 2015.
5. Alciatore David G & Histand Michael B, “Introduction to Mechatronics and Measurement systems”, 4th edition, Tata McGraw Hill, 2006.

18MR2004	METALLURGY LABORATORY	L T P C 0 0 2 1

Course Objectives: To impart knowledge on

1. Preparation of samples for metallurgical studies
2. Characterizing metal samples to understand microstructures
3. Basic knowledge on foundry sand and their properties

Course Outcome: After completing the course the student will be able to

1. Manipulate with the working of a metallurgical microscope
2. Interpret the strength properties of foundry sand
3. Evaluate the permeability of foundry sand
4. Understand procedures for preparing samples for metallurgical studies
5. Identify various types of steels based on their microstructure
6. Differentiate metal samples that are heat treated based on the microstructure

LIST OF EXPERIMENTS

1. Study and use of metallurgical microscope
2. Measurement of hardness
3. Determination of compression strength and tensile strength
4. Examination of microstructure under Optical microscope.
5. Measurement of grain size using Optical microscope.
6. Electrical Conductivity measurement

18MR2005	CAD/CAM LABORATORY	L T P C 0 0 2 1

Course Objectives: To impart knowledge on

1. Usage of computers and modeling software in design and manufacturing.
2. Visualization of objects in three dimensions and producing orthographic views, sectional views and auxiliary views of it.
3. Writing codes for CNC,VMC and turning centres to produce components.

Course Outcome: After completing the course the student will be able to

1. Model the components using the commands such as extrude, revolve, fillet, hole pattern.
2. Use the commands rib, chamfer, draft and 3D sketch to modify the parts
3. Create an assembly model of knuckle joint and screw jack and convert them into orthographic views.
4. Write CNC codes for linear, circular interpolation step turning ball turning and external threading.
5. Write CNC codes for creating holes on components using CNC drilling machine.
6. Write CNC program for creating square pockets using vertical milling centre.

LIST OF EXPERIMENTS

1. 3D Modelling with Extrude, Round (Fillet) and Mirror Commands
2. 3D Modelling With Revolve, Hole Pattern Commands
3. 3D Modelling With Rib, Chamfer, Draft and 3D sketching Commands
4. Modelling, Assembly and Drafting of Knuckle Joint
5. Modelling, Assembly and Drafting of Screw Jack

6. Advanced modelling commands-Sweep and Blend (Loft)
7. Study of CNC XL Mill Trainer and CNC XL Turn trainer
8. Profile cut using linear and circular interpolation
9. Drilling in a CNC drilling machine.
10. Square pocketing and Drilling in a VMC/CNC drilling machine
11. Step turning and external thread cutting in a CNC lathe
12. Ball tuning in a CNC turning Centre

18ME3001	THERMODYNAMICS AND COMBUSTION	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. Combustion principles and chemical kinetics.
2. Combustion in SI and CI engines.
3. Combustion in gas turbine and pollution aspects.

Course Outcomes: After completing the course the student will be able to
1. Analyse the closed and open systems by using laws of thermodynamics
2. Calculate the properties of gases and gas mixtures
3. Calculate change in entropy and enthalpy during the phase change of pure substances
4. Compute air requirements and adiabatic flame temperatures
5. Develop an understanding of the combustion process, engine emissions
6. Develop an understanding of statistical methods

MODULE I – REVIEW OF FIRST AND SECOND LAW OF THERMODYNAMICS (8 Lecture Hours)

Energy balance analysis, application to closed and open systems. Second-law efficiency, concept of entropy, exergy analysis, availability analysis of simple cycles.

MODULE II – REAL GAS BEHAVIOUR AND MULTI-COMPONENT SYSTEMS (8 Lecture Hours)

Equations of State Compressibility, fugacity coefficient, Real gas mixtures, Ideal solution of real gases, Gibbs phase rule.

MODULE III – THERMODYNAMIC PROPERTY RELATIONS (8 Lecture Hours)

Thermodynamic Potentials, Maxwell relations, Generalized relations for changes in Entropy, Internal Energy and Enthalpy, C_p and C_v, Clausius Clayperon Equation, Joule- Thomson Coefficient.

MODULE IV – COMBUSTION PRINCIPLES (8 Lecture Hours)

Thermodynamics concepts of combustion, First law and second law of thermodynamics applied to combustion process, Heat of combustion, Adiabatic flame temperature, Stoichiometry and excess air, Combustion calculations, Minimum air required for complete combustion of fuel.

MODULE V – CHEMICAL KINETICS (7 Lecture Hours)

Chemical equilibrium and dissociation, Theories of combustion - homogeneous mixture, Heterogeneous mixture, Laminar and Turbulent flame propagation in engines, Second law analysis of reacting mixture, Availability analysis of reacting mixture

MODULE VI – STATISTICAL AND THIRD LAW OF THERMODYNAMICS (6 Lecture Hours)

Statistical thermodynamics, statistical interpretations of first and second law and Entropy, Third law of thermodynamics, Nernst heat theorem.

Reference Books:

1. Cengel, ‘Thermodynamics’8th edition , Tata McGraw Hill Co., New Delhi, 2015.
2. G.J. Van Wylen& R.E. Sonntag., ‘Fundamentals of Thermodynamics’, Willy Eastern Ltd, 8th edition 2014.
3. V. Ganesan., 'Internal Combustion Engines', 4th edition, Tata McGraw Hill Publishing Company Ltd, 2012.
4. Rao Y.V.C., “Postulational and Statistical Thermodynamics”, Allied Publishers Inc, 1994.
5. Mathur M.L. and Sharma., 'A course in Internal Combustion Engines', Revised 7th edition , R.P Dhanpat Rai Publications, 2010.

18ME3002	ADVANCED FLUID DYNAMICS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Continuity, momentum and energy equations of fluid flow.
2. Irrotational flows, flow past cylinders and Rankine body.
3. Concepts of boundary layer, Prandtl mixing length, turbulent theory, universal velocity profile.

Course Outcomes: After completing the course the student will be able to

1. Choose method to describe the fluid motion.
2. Solve fluid flow problems using conservation principles.
3. Analyze the forces acting on a fluid particle.
4. Distinguish between irrational and vortex flows.
5. Analyze the fluid flow over cylindrical and spherical bodies.
6. Recognize boundary layer formation in external and internal flows.

MODULE I – FLUID KINEMATICS (7 Lecture Hours) Method of describing fluid motion– Lagrangian, Eulerian Method – Local and individual time rates of change, acceleration, - Eulerian and Lagrangian equation of continuity, Bernoulli's equation from Euler's equation – solved problems related to liquid motion, related to equation of continuity.

MODULE II – GOVERNING EQUATIONS OF FLUID MOTION (7 Lecture Hours) Forces and stress acting on fluid particles, Differential momentum equation. Navier Stokes Equations of Motion for simple cases in rectangular, cylindrical and spherical coordinate, Energy Equation.

MODULE III – IDEAL FLOWS (7 Lecture Hours)

Irrotational motion in two dimensions, sources and sink Complex potential due to a source, due to a doublet, Images with respect to straight line, solved problem. Vortex motion-Vortex tube, Helmohltz's vorticity theorem, velocity potential and stream function.

MODULE IV – FLOW OVER BODIES (7 Lecture Hours)

Flow over Circular cylinders, sphere, solution of Laplace equation, Flow past cylinder with and without circulation, flow past Rankine body. Liquid streaming past a fixed sphere and solved problems.

MODULE V – BOUNDARY LAYER THEORY (7 Lecture Hours)

Boundary layer principles, flat plate, conduits, curved solid bodies, universal velocity profile, and momentum eddy concept – simple applications. Modern trends in the application of CFD to Boundary layer flows.

MODULE VI – BASICS OF TURBULENCE (10 Lecture Hours)

Joukowshi transformation, Analytic function Conformal Transformation of infinite and semi – infinite strip, Prandtl mixing length turbulent theory, Von Karman integral equation to Boundary layer – with and without pressure gradient.

Reference Books:

1. Yunus A Cengel and John M Cimbala., "Fluid Mechanics: Fundamentals and applications" 3rd edition, Tata McGraw-Hill, 2014.
2. K. Muralidhar and Gautam Biswas, "Advanced Engineering Fluid Mechanics" 3rd edition, Narosa Publishing House, 2015.
3. M.D.Raisinghania., "Fluid Dynamics' S Chand, 5th Revised Edition, 2003.
4. Frank M White., "Fluid Mechanics", Tata McGraw Hill, 8th edition, 2016.
5. Fox and McDonald., "Introduction to Fluid Mechanics", Wiley India, 9th edition, 2016.

18ME3003	ADVANCED HEAT TRANSFER	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Conduction, convection, radiation, heat transfer during boiling and condensation.
2. Design of heat exchangers.
3. Principles of mass transfer.

Course Outcomes: After completing the course the student will be able to

1. Solve problems of heat transfer in complex systems by selecting appropriate choice between exact and approximate calculations.

2. Model heat transfer in complex internal flow systems and external flow configurations.
3. Design and analyze the performance of heat exchangers.
4. Model two-phase heat transfer problems in boiling and condensation.
5. Model mass transfer problems involving mass diffusion in gases.
6. Analyze radiative heat exchange between surfaces.

MODULE I – CONDUCTION (8 Lecture Hours)
Review of one dimensional heat conduction-Two dimensional heat conduction**-** Analytical method for two dimensional heat equations (The method of separation of variables). Finite difference method – formulation of nodal equation – solutions for two dimensional conduction problems. Transient conduction, the lumped capacitance method,semi-infinite solid.
MODULE II – CONVECTION (8 Lecture Hours)
Energy equation – thermal boundary layer. Forced convection – Practical correlations – flow over surfaces – internal flow. Natural convection, combined forced and free convection – combined convection and radiation in flows.
MODULE III – HEAT EXCHANGER (8 Lecture Hours)
Types – LMTD method and the effectiveness – NTU method. Heat Pipes-principle operation- heat transfer correlations in boiling and condensation.
MODULE IV – BOILING AND CONDENSATION (7 Lecture Hours)
Boiling – Pool and flow boiling, correlations. Condensation – modes and mechanisms – correlations and problems.
MODULE V – RADIATION (7 Lecture Hours)
Stefan- Boltzmann law, Wien's displacement law, black and grey surfaces, Radiative heat exchange between surfaces –Radiation shield- radiation shape factor – reradiating surfaces. Radiation in gases.
MODULE VI – MASS TRANSFER (7 Lecture Hours)
Mass transfer types – Fick’s law of diffusion – mass diffusion equation, Equimolar counter diffusion – convective mass transfer. Evaporation of water into air. Fins, Heat pipes, check with AICTE 139.

Reference books:
1. Holman J.P., ‘Heat and Mass Transfer’, 10th edition, Tata McGraw Hill, 2009.
2. Allen D.Kraus., ‘Extended Surface Heat Transfer’, Wiley-Interscience., 2001.
3. Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt., ‘Fundamentals of Heat and Mass Transfer’,7th edition., John Wiley & Sons, May 2011.
4. C.P. Kothandaraman., ‘Fundamentals of Heat and Mass Transfer’, 4th Ed., New Age International, 2012.
5. Kays, W.M, Crawford W and Bernhard Weigand., ‘Convective Heat and Mass Transfer’, McGraw Hill Inc., 2004.

18ME3004	DESIGN OF THERMAL POWER EQUIPMENT	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Boiler manufacturing regulations/code.
2. The design of various equipment used in thermal power plants.
3. Steam washing and ash separation from flue gases.

Course Outcomes: After completing the course the student will be able to
1. Compare and contrast different types of boilers for power plant application.
2. Design boilers for power plant applications according to standards.
3. Recognize waste heat recovery options in power plants using accessories such as economizers, super heaters, re-heaters and air pre-heaters.
4. Design chimney and fans for the draught system in thermal power plants.
5. Design condensers and cooling towers for steam power plants.
6. Recognize significance of water and steam purification and ash cleaning mechanisms in thermal power plants.

MODULE I –BOILER SERVICE REQUIREMENTS, IBR ACT AND FURNACE DESIGN (8 Lecture Hours)

Services requirements, Parameters to be considered in Boiler Design, IBR Code Furnace Design, Heat Transfer in Furnace, Heat balance, Types of refractory walls, Furnace, Water wall arrangements, Heat release rates, Furnace bottoms, Slag removal, Primary, secondary and tertiary air system, box assembly, Different types of furnaces for solids and liquids

MODULE II – WATER SIDE DESIGN (8 Lecture Hours)

Circulation-natural, Forced circulation ratio, Design of condensers, Economic selection of condensers, Types - Direct contact, Surface condensers, Vacuum efficiency, Air leakage into the condenser-air removal, Cooling tower Types and design for power plant application

MODULE III – PERFORMANCE OF BOILER (8 Lecture Hours)

Equivalent evaporation, Boiler efficiency, Boiler trial Heat losses in boiler, Economizers-types, design, Super Heater- Design, Economy of super heat, limit of super heat, Super heater performance, Steam mass flow, gas mass flow and pressure drop in super heater, Super heat temperature control, De superheater-design, Design of Reheater.

MODULE IV – WATER AND STEAM PURIFICATION (7 Lecture Hours)

Chemical treatment, Mechanical carry over, Silica carry over gravity separation, Drum internals, Steam washing typical arrangements of boiler drum internal in H.P. boilers.

MODULE V – AIR-PREHEATERS AND DRAFT SYSTEM DESIGN (7 Lecture Hours)

Types of Air heater, Recuperative and regenerative air-preheaters, Design considerations, Forced, induced, balanced drafts, Pressure losses.

MODULE VI – FAN, CHIMNEY DESIGN AND ASH SEPARATION (7 Lecture Hours)

Power requirement for forced and induced draft fans, Chimney design - Diameter and height, Ash separation by electrostatic precipitators, Flue gas desulphurization systems.

Reference Books:

1. P.K.Nag., Power Plant Engineering, **Tata McGraw Hill Education India,** 4th edition, 2014.
2. Thermal Power Plant: Design and Operation, Elsevier, 2015.
3. Steam plant operation, 10th Edition, Everett B. Woodruff, Herbert B. Lammers, Thomas F.Lammers, McGraw Hill Professional, 2016
4. El, Wakil, Power plant technology, McGraw-Hill, 2003.
5. Gebhartt, G. F., Steam power plant engineering, John Wiley & Sons, 2002.

		L	T	P	C
18ME3005	**REFRIGERATION SYSTEM DESIGN**	**3**	**0**	**0**	**3**

Course Objectives: To impart knowledge on

1. Significance of refrigerants and their impact on the environment.
2. Working principle of various refrigeration cycles..
3. Performance of system components and their balancing in cycles..

Course Outcomes: After completing the course the student will be able to

1. Select the refrigerants.
2. Estimate the performance of a vapour compression cycle.
3. Compare different types of refrigeration cycles.
4. Identify the components of a refrigeration system.
5. Analyze the performance of different components in a refrigeration system.
6. Discuss the controls employed in refrigeration system.

MODULE I – REFRIGERANTS (6 Lecture Hours)

Classification of Refrigerants, Refrigerant properties, Oil Compatibility, Environmental Impact- Montreal / Kyoto protocols-Eco Friendly Refrigerants, alternatives to HCFCS, Secondary Refrigerants.

MODULE II – VAPOUR COMPRESSION REFRIGERATION CYCLE (9 Lecture Hours)

Development of Vapor Compression Refrigeration Cycle from Reverse Carnot Cycle- conditions for high COP-deviations from ideal vapor compression cycle, Multi pressure System, Cascade Systems-Analysis.

MODULE III – VAPOUR ABSORPTION AND AIR REFRIGERATION CYCLES (9 Lecture Hours)

Vapor Absorption Systems-Aqua Ammonia & Li-Br Systems, Steam Jet Refrigeration Thermo Electric Refrigeration, Air Refrigeration cycles and Heat pumps.

MODULE IV– REFRIGERATION SYSTEM COMPONENTS (6 Lecture Hours)

Compressor- Types, performance, Characteristics, Types of Evaporators & Condensers and their functional aspects, Expansion Devices and their Behavior with fluctuating load, cycling controls, other components such as Accumulators, Receivers, Oil Separators, Strainers, Driers, Check Valves, Solenoid Valves Defrost Controllers.

MODULE V – SYSTEM BALANCING (9 Lecture Hours)

Balance points and system simulation - compressor, condenser, evaporator and expansion devices performance – Complete system performance; graphical and mathematical analysis – sensitivity analysis.

MODULE VI – ELECTRICAL DRIVES & CONTROLS (6 Lecture Hours)

Electric circuits in Refrigeration systems, Refrigerant control devices, Types of Motors, Starters, Relays, Thermostats and Microprocessor based control systems, Pressure controls and other controls, Acoustics and noise controls.

Reference Books:

1. Arora C.P., Refrigeration and Air conditioning, McGraw Hill, 3rd Ed., 2010.
1. Dossat R.J., Principles of refrigeration, John Wiley, S.I. Version, 2001.
2. Jordan and Priester, Refrigeration and Air conditioning 1985.
3. 2. Kuehn T.H., Ramsey J.W. and Threlkeld J.L., Thermal Environmental Engineering, 3rd Edition, Prentice Hall, 1998.
4. Langley Billy C., 'Solid state electronic controls for HVACR, Prentice-Hall 1986.
5. Rex Milter, Mark R.Miller., Air conditioning and Refrigeration, McGraw Hill, 2006.

18ME3006	COMPUTER AIDED DESIGN LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives: To impart knowledge on

1. Usage of computers and modeling software in design and manufacturing.
2. Visualization of objects in three dimensions and producing orthographic views, sectional views and auxiliary views of it.
3. Finite element analysis of beams, trusses, plates and frames.

Course Outcome: After completing the course the student will be able to

1. Model the components using the commands such as extrude, revolve, fillet, hole pattern.
2. Use the commands rib, chamfer, draft and 3d sketch to modify the parts
3. Create an assembly model of knuckle joint and screw jack and convert them into orthographic views.
4. Conduct structural analysis of trusses, frames and beams.
5. Conduct modal of structures
6. Conduct heat transfer analysis of solids and pipes

LIST OF EXPERIMENTS

1. 3D Modeling with Extrude, Round (Fillet) and Mirror Commands
2. 3D Modeling With Revolve, Hole Pattern Commands
3. 3D Modeling With Rib, Chamfer, Draft and 3D sketching Commands
4. Modeling, Assembly and Drafting of Knuckle Joint
5. Modeling, Assembly and Drafting of Screw Jack
6. Advanced modeling using variable sweep, helical sweep etc.
7. Structural analysis of Trusses
8. Structural analysis of Beams
9. Structural analysis of Frames
10. Plane stress/Plane strain analysis
11. Modal analysis of different structures
12. Steady state thermal analysis

18ME3007	ANALYSIS AND SIMULATION LABORATORY	L T P C 0 0 4 2

Course Objectives: To impart knowledge on

1. Mechanical engineering problems using advanced analysis package like ansys.
2. Simulation software like matlab to construct and execute goal-driven system models.
3. Various simulation and analysis tools to different real time applications.

Course Outcomes: After completing the course the student will be able to

1. Demonstrate the use of analysis software for various structural, thermal and flow related problems
2. Apply the suitable commands in solving the problems in analysis software.
3. Compare the various element types, material properties and boundary conditions with the real life problems to get an optimal solution.
4. Interpret the various mechanisms and problems into a simple model to carry out simulation.
5. Examine the model with suitable commands and constraints.
6. Evaluate the working and performance of various mechanisms using the simulation software.

ANALYSIS MODULE USING ANSYS WORKBENCH

1. Force and stress analysis using link elements in trusses, cables etc.
2. Stress and deflection analysis in beams with different support conditions
3. Stress analysis of flat plate (with circular hole) and simple shells.
4. Stress analysis of axi- symmetric component
5. Thermal stress and heat transfer analysis of a 2D component and cylindrical shells
6. Flow through a duct, elbow
7. Conductive and convective heat transfer analysis of a 2D component
8. Modal analysis of a beam
9. Harmonic, transient and spectrum analysis of simple systems.

SIMULATION MODULE USING MATLAB 2018R

1. Vibration based simple problems- a. simulation of an accumulator, b. linear damping force
2. Simulation of cam and follower mechanism
3. Simple exercise to determine stiffness
4. Simulation of four bar mechanism

Reference Books:

1. Lab Manual

18ME3008	ADVANCED HEAT TRANSFER LABORATORY	L T P C 0 0 4 2

Course Objectives: To impart knowledge on

1. Boiling and condensation of vapors in surfaces.
2. The working of air conditioning system.
3. Heat transfer in two-phase system.

Course Outcomes: After completing the course the student will be able to

1. Appreciate the mechanism of condensation process.
2. Distinguish between types of condensation.
3. Employ lumped thermal capacitance method for temperature estimation under transient mode.
4. Evaluate the performance of air-conditioning system.
5. Recognize bubble formation in the nucleate boiling regime.
6. Recognize transition from nucleate boiling to film boiling.

LIST OF EXPERIMENTS

1. Drop-wise and film-wise condensation
2. Investigation of lumped thermal capacitance method of transient temperature analysis
3. Cop test on air conditioning test rig
4. Nucleate boiling
5. Critical heat flux apparatus
6. Estimation of heat transfer coefficient of heat pipes (12 exp)

18ME3009	ADVANCED COMPUTATIONAL FLUID DYNAMICS LABORATORY	L T P C 0 0 4 2

Course Objectives: To impart knowledge on
1. Finite volume computational fluid dynamics codes working strategies.
2. Actual setting up of the problem and solution procedure.
3. Data extraction, post processing and comparison with experimental/theoretical data.

Course Outcomes: After completing the course the student will be able to
1. Recognize applications of computing tools in fluid dynamics.
2. Model and analyze various heat transfer and fluid flow problems.
3. Select appropriate mesh type and boundary conditions.
4. Apply suitable solvers for problem solution.
5. Extract post processing data and compare them with available data.
6. Infer the pictorial results after post-processing.

LIST OF EXPERIMENTS
1. One dimensional steady state diffusion
2. One dimensional steady state diffusion with volume source
2. One dimensional steady state diffusion with surface source
3. One dimensional unsteady heat conduction
4. Conjugate heat transfer
5. Periodic flow and heat transfer
6. Laminar flow
7. Turbulent flow
8. Flow through porous media
9. Flow around an aerofoil
10. Modelling radiation and natural convection.

18ME3010	ADVANCED MANUFACTURING PROCESSES	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. Different types of conventional manufacturing processes.
2. The mechanism and capabilities of non-conventional manufacturing processes.
3. The latest manufacturing process for micro-fabrication and devices.

Course Outcomes: After completing the course the student will be able to
1. Evaluate and select suitable manufacturing processes for particular applications.
2. Recognize the need for unconventional manufacturing processes for various applications.
3. Apply the latest manufacturing process for micro-fabrication.
4. Develop new products by making use of new materials and processes.
5. Establish newer manufacturing methods to replace conventional fabrication methods.
6. Adapt the powder metallurgy technique to fabricate components for diverse applications.

MODULE I – CASTING AND MOULDING (7 Lecture hours)
Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses.

MODULE II – BULK FORMING (7 Lecture hours)
Plastic deformation and yield criteria; Fundamentals of hot and cold working processes; load estimation for bulk forming (forging, rolling, extrusion, drawing).

MODULE III – SHEET METAL FORMING (7 Lecture hours)
Sheet metal characteristics – shearing, bending and drawing operations, design considerations – Stretch forming operations; Formability of sheet metal ; Hydro forming – Rubber pad forming – Metal spinning–Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming.

MODULE IV – NEWER MACHINING PROCESSES (8 Lecture hours)
Construction; working principle; steps; types; process parameters; derivations; problems, merits, demerits and applications of AJM – WJM - USM – CHM – ECM – EDM - Wire cut EDM - ECM – ECG - LBM – EBM ---*expand.*

MODULE V – MICRO-FABRICATION (8 Lecture hours)
Semiconductors; fabrication techniques; surface and bulk machining; LIGA Process; Solid free form fabrication; Wafer preparation techniques; PCB board hybrid and MCM technology; programmable devices and ASIC; electronic material and processing; stereo lithography SAW devices; Surface Mount Technology.

MODULE VI – ADVANCED JOINING / FASTENING PROCESSES (8 Lecture hours)
Physics of welding; joint preparation; design considerations in welding, Solid and liquid state joining processes; Thermit welding, submerged arc welding, Advanced welding techniques - Friction stir welding, friction stir processing, explosive welding; brazing and soldering; defects in welding and remedies.

Reference Books:

1. SeropeKalpakjian, Steven Schmid, Manufacturing Processes for Engineering Materials (5th Edition), 2003.
2. Julian W. Gardner , Vijay K. Varadan, Osama O. Awadelkarim "Micro sensors, MEMS& Smart Devices", Wiley-Blackwell, 2002.
3. Nario Taniguchi, "Nano Technology", Oxford University Press 1996.
4. Pandey P.C., Shan H. S, "Modern Machining Processes", Tata McGraw Hill Education Private Limited, 2013.
5. Marc J. Madou," Fundamentals of Micro-fabrication and Nanotechnology", Third Edition, CRC Press, 2011.

18ME3011	ADVANCED METAL CUTTING THEORY	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Fundamentals of metal cutting theory and nomenclature of cutting tools.
2. Measurement of cutting force and cutting temperature.
3. Mechanisms of tool wear and chatter in machining.

Course Outcomes: After completing the course the student will be able to
1. Understand mechanism and theories of metal cutting.
2. Select the cutting tool based on the operation to be done.
3. Understand thermal aspects in machining.
4. Analyze tool materials and tool life.
5. Measure cutting forces during machining processes.
6. Diagnose tool wear, vibration and chatter.

MODULE I – METAL CUTTING FUNDAMENTALS (7 Lecture hours)
Basic mechanism of chip formation-types of chips-Chip breaker-Orthogonal Vs Oblique cutting- force and velocity relationship and expression for shear plane angle in orthogonal cutting-Energy Consideration in machining-Modern theories in Mechanics of cutting -Review of Merchant and Lee Shaffer Theories.

MODULE II – TOOL NOMENCLATURE OF CUTTING TOOLS(7 Lecture hours)
Nomenclature of single point tool - Systems of tool Nomenclature and Conversion of rake angles - Nomenclature of multi point tools like drills, milling cutters and broaches.

MODULE III – THERMAL ASPECTS OF MACHINING (7 Lecture hours)
Thermodynamics of chip formation - Heat distributions in machining-Effects of various parameters on temperature - Method of temperature measurement in machining - Hot machining - cutting fluids, Surface finish and integrity.

MODULE IV – TOOL MATERIALS AND TOOL LIFE (8 Lecture hours)
Essential requirements of tool materials - Developments in tool materials-Tool Coating- ISO specifications for inserts and tool holders-Tool life- Taylor's tool life equation, optimum tool life - Conventional and accelerated tool life tests.

MODULE V – CUTTING FORCES AND ECONOMICS OF MACHINING (8 Lecture hours)
Forces in turning, drilling and milling - specific cutting pressure- measurement of cutting forces. Concepts of machinability and machinability index - Economics of machining, Machining Time – Estimation of machining time in different machining operations.

MODULE VI – TOOL WEAR MECHANISMS AND CHATTER IN MACHINING (8 Lecture hours)
Reasons for failure of cutting tools and forms of wear-mechanisms of wear - chatter in machining - Factors effecting chatter in machining - types of chatters-Mechanism of chatter based on Force Vs Speed graph.

Reference books:

1. B.L. Juneja and G.S. Sekhon - "Fundamentals of metal cutting and machine tools", New Age International (p) Ltd., 2015.
2. M.C. Shaw, "Metal cutting Principles ", Oxford Clarendon Press, 2005.
3. Bhattacharya. - "Metal Cutting Theory and Practice ", new central Book Agency pvt. Ltd., Calcutta 2016.
4. Boothroy.D.G. and Knight. W.A "Fundamentals of Machining and Machine tools", Marcel Dekker, New York, 1989.
5. Stephenson, D. A., &Agapiou, J. S. Metal cutting theory and practice: CRC Taylor & Francis, 2016.

18ME3012	DESIGN FOR MANUFACTURING AND ASSEMBLY	L	T	P	C
		3	0	0	3

Course objective: To impart knowledge on

1. The real engineering design processes.
2. In-depth practice in design, the use of a structured approach to design, an introductory knowledge of business practices.
3. Critical thinking, creativity, and independent learning.

Course outcome: After completing the course the student will be able to

1. Design the components suitable for various manufacturing process such as welding, casting, machining.
2. Identify and describe how the integrated design, manufacturing, process works.
3. Describe how the details of example production plans affect the product and can be designed for the ease of manufacturing and assembly besides reducing the overall costs of the product.
4. Update the knowledge of design process and methods.
5. Know the importance of material selection, quality, statistics in design and its help in designing a new product.
6. Learn the process of design based on the scientific method, to combine creative thinking with engineering principles to turn ideas into robust reality.

MODULE I – INTRODUCTION (8 Lecture Hours)
General Design principles for manufacturing – strength and mechanical factors, mechanisms selection, Process capability – Feature tolerances – Geometric tolerances – assembly limits – Datum Features – Functional datum, machining sequence, manufacturing datum, changing the datum. Examples.

MODULE II – FACTORS INFLUENCING FORM DESIGN (8 Lecture Hours)
Working Principle, Material, design for Manufacture – Possible solutions – Materials choice –Influence of materials on form design – form design of welded members, forgings and castings.

MODULE III – COMPONENT DESIGN – MACHINING CONSIDERATION (8 Lecture Hours)
Design features to facilitate machining – drills – milling cutters – keyways – Doweling-procedures, counter sunk screws – Reduction of machined area - simplification by separation – simplification by amalgamation – Design for machinability – Design for economy – Design for clampability – Design for Accessibility – Design for Assembly.

MODULE IV – COMPONENT DESIGN – CASTING AND WELDING CONSIDERATIONS (8 Lecture Hours)

Redesign of castings based on parting line considerations – minimizing core requirements, machined holes, Redesign of cast members to obviate cores. Redesign of weld members based on Weld joints-Material thickness-Specifying Welds-cost of welding-Weld distortion-Weld Strength-Finishing and Tolerancing considerations.

MODULE V – REDESIGN FOR MANUFACTURE AND CASE STUDIES (8 Lecture Hour)

Identification of uneconomical design – Modifying the design – group technology –Design for reliability and safety.

MODULE VI – CASE STUDIES (8 Lecture Hour)

Robust and quality design. Computer Application for Design for Manufacturing and Assembly.

Reference Books:

1. George E. Dieter, "Engineering Design: A Materials and Processing Approach", 3rd edition, McGraw-Hill, 2000.
2. Geoffrey Boothroyd, peter Dewhurst, Winston A Knight, " Product Design for Manufacture and Assembly, CRC Press, Taylor and Francis group, 2010.
3. Chitale.A.K.,Gupta.R.C., " Product Design and Manufacturing, Prentice Hall of India, 2007.
4. David.M.Anderson, "Design for Manufacturability and concurrent Engineering", CIM Press, 2004.
5. Harry Peck, "Designing for Manufacture", Pitman Publications, 2015.

18ME3013	ENGINEERING MATERIALS AND APPLICATIONS	L	T	P	C
		3	0	0	3

Course Objectives: To impart the knowledge on

1. Structure, composition and behavior of metals.
2. Fracture behavior of materials.
3. The principles of design, selection and processing of materials.

Course Outcomes: After completing the course the student will be able to

1. Apply the concepts of materials science for material selections towards new product development.
2. Analyze the elastic and plastic behavior of materials.
3. Suggest modern metallic materials for engineering applications.
4. Evaluate fracture behavior of materials in engineering applications.
5. Appraise the utility of new age material for specific application.
6. Synthesize and develop the unique customized composites for special needs.

MODULE I – ELASTIC AND PLASTIC BEHAVIOR (8 Lecture Hours)

Atomic model of Elastic behavior – Rubber like Elasticity an elastic behavior - plastic deformation-slip- shear strength of perfect and real crystals- movement of dislocation.

MODULE II – FRACTURE BEHAVIOR (7Lecture Hours)

Ductile and Brittle fracture – Energy and stress intensity approach, fracture toughness- Ductile Brittle Transition Fatigue- Creep in Materials.

MODULE III – MATERIAL SELECTION ANDMODERN METALLIC MATERIALS (7 Lecture Hours)

Criteria for selection of materials, ASTM standards, Patented Steel wire - Steel martensite - microalloyed steels- precipitation hardened aluminum alloys- Maraging steels - HSLA steels, Dual phasesteels, duplex stainless steels. TRIP Steels.

MODULE IV – NEW AGE MATERIALS (8 Lecture Hours)

Shape memory alloys smart Materials- Ceramics and glasses: Properties, applications, Ceramic Structures- silicate ceramics- carbon –diamond- graphite imperfections and impurities in ceramics – applications. Materials for energy production, transmission, saving and harvesting.

MODULE V – SPECIAL PURPOSE MATERIALS (7 Lecture Hours)

Structure and types of smart materials, Piezoelectric Materials, Magneto Rheological materials – Introduction & Applications, Bio-compatible materials for medical implants. CNT, Graphene, Metallic glasses. Conducting polymers, Smart Gels and polymers.

MODULE VI – COMPOSITE MATERIALS (8 Lecture Hours)

Polymer Matrix Composites (PMC) -PMC processes - Hand layup processes – Spray up processes – Compression moulding –injection moulding - Resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Metal Matrix Composites (MMC) - characteristics of MMC. Advantages of MMC, Processing of MMC – Powder metallurgy process - diffusion bonding – stir casting – squeeze casting.

Reference Books:

1. V. Raghavan, "Materials Science and Engineering – Prentice Hall of India (P) Ltd., New Delhi. 2004.
2. Thomas H. Courtney "Mechanical Behaviour of Materials" McGraw Hill International Edition, 2005.
3. Williams D, Callister "Material Science and Engineering" John Wiley and Sons Inc. 2009.
4. Joshua Pelleg, "Mechanical Properties Materials", Springer, 2013.
5. Kenneth.G,Michael, K.Budinski, " Engineering Materials", Properties and selection, Prentice Hall, 2010.

18ME3014	ADVANCED METROLOGY AND MEASUREMENT SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Science of measurement and measuring machines commonly used.
2. Limits, fits and tolerances, geometric dimensioning aspects
3. Methods of acceptance test for conventional machine tools.

Course Outcomes: After completing the course the student will be able to

1. Use different measuring instruments in industries.
2. Utilize Geometrical Dimensioning and Tolerancing symbols and apply them in inspection and testing process.
3. Apply the concepts of Laser metrology in quality control.
4. Examine the surface roughness of work pieces from various production processes.
5. Choose the modern manufacturing methods using advanced metrology systems.
6. Recommend calibration standards towards measuring instruments.

MODULE I – INTRODUCTION TO MECHANICAL MEASUREMENTS (7 Lecture Hours)

Science of measurement: Mechanical measurement – types, measurement standards– terms used in rating instrument performance, Precision, accuracy and uncertainty in measurements.

MODULE II – GEAR MEASURING MACHINES (7 Lecture Hours)

Study of Measuring Machines, gear tooth measurement- measurement of gear profile, Isometric Viewing of Surface Defects, Image Shearing Microscope for Vertical Dimensions.

MODULE III – ELECTRON AND LASER MICROSCOPY (7 Lecture Hours)

Laser metrology and microscopy: Laser Metrology - Vision systems- Principles and applications, Principles of Scanning and Transmission Electron Microscopy and its applications.

MODULE IV – CALIBRATION AND SURFACE ROUGHNESS MEASUREMEN (7 Lecture Hours)

Acceptance tests for machine tools and surface finish measurements, calibration of machine tools. Three ball or four ball measurement, Measurement of surface roughness.

MODULE V – GEOMETRIC DIMENSIONING AND TOLERANCING(7 Lecture Hours)

Introduction. Indian Standard System of Limits and Fits (IS:919-2709) ; Designation of Holes ,Shafts and Fits. Meaning of GD and T, Various Geometric symbols used in GD and T, Datum feature, Material Conditions.

MODULE VI – METROLOGY FOR QUALITY (8 Lecture Hours)

Tool wear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. Process metrology for emerging machining processes such as micro-scale machining, Inspection and workpiece quality.

Reference books:

1. R. K . Jain, “Engineering Metrology”, Khanna Publishers, New Delhi, 2009.
2. Geometric Dimensioning` and Tolerance for Mechanical Design,"Gene R. Cogorno, McGraw Hill, 2004
3. Beckwith Thomas G, “Mechanical Measurements”, Pearson Education, 2008.
4. M.Mahajan,”A Text Book of Metrology”, DhanpatRai&Co. 2010
5. The Metrology Handbook, Jay L. Bucher, Amer Society for Quality, 2004.

18ME3015	ADVANCED COMPUTER AIDED MANUFACTURING LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives: To impart knowledge on

1. Usage of Manufacturing software in writing the codes for CNC, VMC and Turning centres to produce components
2. Concepts of CNC programming and simulation on CNC turning center and Machining center
3. Concepts of Robot programming and PLC programming

Course Outcomes: After completing the course the student will be able to

1. Machine complex profiles using CNC machines with the aid of auto generated CNC codes
2. Generate CNC program for turning and milling of component using Master CAM / Edge CAM softwares
3. Write CNC codes for linear, circular interpolation step turning ball turning and external threading.
4. Write CNC codes for creating holes on components using CNC drilling machine.
5. Write CNC program for creating square pockets using vertical milling centre.
6. Generate Robot programming and PLC programming

LIST OF EXPERIMENTS:

1. Study of different control systems and CNC codes
2. Programming and simulation for turning, taper turning, circular interpolation, thread Cutting and facing operation
3. Profile cut using linear and circular interpolation
4. Drilling in a CNC drilling machine.
5. Square pocketing and Drilling in a VMC/CNC drilling machine
6. Step turning and external thread cutting in a CNC lathe
7. Taper turning and internal thread cutting in a CNC lathe
8. Ball tuning in a CNC turning Centre
9. Programming using canned cycles
10. Robot programming for Material handling applications (2 exp)
11. PLC ladder logic programming

18ME3016	MECHATRONICS AND ROBOTICS LABORATORY	L	T	P	C
		2	0	0	2

Course Objectives: To impart knowledge on

1. Fundamentals of fluid power and Mechatronics systems and primary actuating systems.
2. Programming skills in Programmable logic controllers.
3. Principles of pneumatics and hydraulics and apply them to real life problems.

Course Outcomes: After completing the course the student will be able to

1. Apply Boolean algebra for logic design of pneumatic circuits.
2. Apply Boolean algebra for logic design of hydrauliccircuits
3. Build logic circuits for industrial applications
4. Build cascade circuits for multiple cylinder applications.
5. Design automation circuits with PLC for industrial problems
6. Write Programme for robot movements

LIST OF EXPERIMENTS:

1. Standard Fluid Power Symbols
2. Pneumatic Basic Logic Circuit

3. Pneumatic Circuit for Material Handling System
4. Electro-Pneumatic Circuit Using Relay, Limit Switch and Solenoid Valves
5. Electro-Pneumatic Circuit for an Automation of Double Acting Cylinder by using Proximity Sensors and Cascade System of sequence A+B+C+A-B-C-.
6. Electro-Hydraulic Circuit using Proximity Sensors.
7. PLC Controlled Pneumatic Logic Circuits
8. PLC Controlled Pneumatic Circuit for Material Handling System
9. Control of Funuc robot
10. Robot programming for pick and place application
11. Assembly and disassembly of pic controller based mobile robot.
12. Programming for interfacing of sensors.

18ME3017	ADVANCED STRESS ANALYSIS	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Mohr's circle and energy methods to predict stress, strain and deflection.
2. Stress distribution in thin walled section subjected to torsion and find shear center in beams.
3. The behavior of thin walled cylinders under pressure and stress distribution in rotating disks.

Course Outcomes: After completing the course the student will be able to
1. Find principals stress and strains in solids of two dimensions and three dimensions.
2. Determine deflection and stress at critical points in a structure using various methods.
3. Analysis of stress distribution of thin walled sections subjected to torsion.
4. Determine shear center of thin walled beams.
5. Design thin walled cylinders under pressure and determine stress in a rotating disk.
6. Identify method to determine contact stress and deflection for various load conditions.

MODULE I – THEORY OF ELASTICITY (8 Lecture Hours)
Analysis of stress, Analysis of strain, Elasticity problems in two dimension and three dimensions, Mohr's circle for three dimensional stresses. Stress tensor, Air's stress function in rectangular and polar coordinates.

MODULE II – ENERGY METHODS (8 Lecture Hours)
Energy method for analysis of stress, strain and deflection. Theorem of virtual work, theorem of least work, Castigliona's theorem, Rayleigh Ritz method, Galerkin's method and Elastic behavior of anisotropic materials like fiber reinforced composites.

MODULE III – THEORY OF TORSION (8 Lecture Hours)
Torsion of prismatic bars of solid section and thin walled section. Analogies for torsion, membrane analogy, fluid flow analogy and electrical analogy. Torsion of conical shaft, bar of variable diameter, thin walled members of open cross section in which some sections are prevented from warping, Torsion of noncircular shaft

MODULE IV – UNSYMMETRICAL BENDING AND SHEAR CENTRE (7 Lecture Hours)
Concept of shear center in symmetrical and unsymmetrical bending, stress and deflections in beams subjected to unsymmetrical bending, shear center for thin wall beam cross section, open section with one axis of symmetry, general open section, and closed section.

MODULE V – PRESSURIZED CYLINDERS AND ROTATING DISKS (7 Lecture Hours)
Governing equations, stress in thick walled cylinder under internal and external pressure, shrink fit compound cylinders, stresses in rotating flat solid disk, flat disk with central hole, disk with variable thickness, disk of uniform strength, Plastic action in thick walled cylinders and rotating disc**.**

MODULE VI – CONTACT STRESSES (7 Lecture Hours)
Geometry of contact surfaces, method of computing contact stresses and deflection of bodies in point contact, stress for two bodies in line contact with load normal to contact area and load normal and tangent to contact area. Introduction to analysis of low speed impact.

Reference Books:
1. R. G. Budynas, "Advanced Strength and Applied Stress Analysis", 2nd Edition, McGraw Hill Education (India) Pvt ltd., 2013

2. L. S. Srinath, “Advanced Mechanics of Solids”, 2nd Edition, TMH Publishing Co. Ltd., New Delhi, 2003.
3. Ferdinand P. Beer, E. Russell Johnston, John T. DeWolff and David F. Mazurek Mechanics of Materials, 5th ed. in SI Units, McGraw-Hill, 2009.
4. Boresi, Arthur P. and Schmidt, Richard J., Advanced Mechanics of Materials, 6th Ed., John Wiley & Sons, 2003.
5. Young, Warren C. and Budynas, Richard G., Roark's Formulas for Stress and Strain, 7th Ed., McGraw-Hill, 2002.

18ME3018	FINITE ELEMENT METHODS IN ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Fundamentals of finite element analysis.
2. Various types of elements used in FEA.
3. Implementation of galerkin’s formulation into the finite element method for the solution of ordinary and partial differential equations.

Course Outcomes: After completing the course the student will be able to
1. Acquire the fundamental theory of finite element analysis and develop element characteristic equation, global stiffness equation.
2. Derive element matrix equation using different methods by applying basic laws in mechanics and integration by parts.
3. Solve problems under dynamic conditions by applying various techniques.
4. Attain knowledge in error norms, convergence rates and refinement.
5. Use professional-level finite element software to solve engineering problems in structural mechanics, fluid mechanics and heat transfer.
6. Solve the real world engineering problems using FEA.

MODULE I – INTRODUCTION (7 Lecture Hours)
Basic concepts- General applicability of the method to structural analysis, heat transfer and fluid flow problems- general approach of finite element method with case studies - classical analysis techniques- finite element packages - Solution of equilibrium problems- solution of Eigen value problem - Solution of propagation problems.

MODULE II – GENERAL PROCEDURE (7Lecture Hours)
Discretization of Domain- basic element shapes- interpolation polynomials natural coordinates- formulation of element characteristic matrices and vectors-direct approach -variational approach and weighted residual approach-Continuity conditions.

MODULE III – FINITE ELEMENTS (8 Lecture Hours)
Formulation of one dimensional, two dimensional, three dimensional elements - isoparametric elements- curve sided elements-higher order elements-Lagrangian element-serendipity element-Shape functions and stiffness matrix- Error norms and Convergence rates – h-refinement with adaptivity – adaptive refinement.

MODULE IV – FIELD PROBLEMS (8 Lecture Hours)
Heat Transfer Problems- Basic equations of heat transfer derivation using finite element Method for 1D & 2D problems. Fluid mechanics problems- Basic equations- Solutions procedure-compressible flows-Galerkin approach. Structural Problems- Equations of elasticity- plane elasticity problems - Bending of elastic plates.

MODULE V – TORSION OF NON-CIRCULAR SECTION (8 Lecture Hours)
Two dimensional field equation- governing differential equations- Integral Equations for the element matrices- Element matrices- Triangular element, Rectangular element. Torsion of Non circular sections: General theory- Twisting of a square bar - shear stress components- Evaluation of the twisting torque.

MODULE VI – DYNAMIC ANALYSIS (7 Lecture Hours)
Dynamic equations of motion- consistent and lump mass matrices- Free vibration analysis – dynamic response calculation.

Reference Books:

1. Larry .J. Segerland. Applied Finite Element Analysis,Wiley India Pvt.Ltd.,2011.
2. Rao. S.S. "The Finite element method in Engineering", 2nd Ed., Pergamon Press, Oxford, 2003.
3. David. V. Hutton, Fundamentals of Finite Element Analysis, Tata McGraw Hill,2003.
4. Tirupathi. R. Chandrupatla, Ashok. D. Belegundu. Introduction to Finite Elements in Engineering', Prentice Hall of India, 2004.
5. J. N. Reddy. An Introduction to the Finite Element Method, 3rd ed., McGraw-Hill Education, 2005.

18ME3019	ADVANCED VIBRATIONS AND ACOUSTICS	L	T	P	C
		3	0	0	3

Course Objective: To impart knowledge on

1. Fundamentals of vibrations and its practical applications.
2. Analyzing the vibration behavior of mechanical systems subjected to excitation.
3. Vibration control strategies.

Course Outcomes: After completing the course the student will be able to

1. Classify the systems of vibration and formulate equations of motion for vibratory systems.
2. Solve vibration problems with multi-degrees of freedom.
3. Suggest methods to control vibration and to perform vibration tests.
4. Categorize with international standards in acoustics and noise engineering.
5. Present the theoretical, experimental principles of mechanical vibrations to gain practical understanding in the field of vibration.
6. Understand unwanted vibration, noise in machines and proficient with instrumentation used in noise, vibration control tests.

MODULE I – VIBRATION OF SINGLE DEGREE OF FREEDOMSYSTEM (7Lecture Hours)

Introduction –Equation of motion - Newton's law, Energy methods – free vibration- forced vibration – damping models - Solutions of problems for one degree of freedom systems for transient and harmonic response.

MODULE II – VIBRATION OF TWO AND MULTI DEGREE FREEDOM SYSTEMS (8 Lecture Hours)

Equations of motion for Two Degree of freedom systems- –Influence coefficients- mode of vibration-principle modes-principle of orthogonal generalized coordinates– semi definite systems-Multi degree of freedom system-continuous system- Vibration equation, Natural frequency and mode shape for beams, rod.

MODULE III – NUMERICAL AND COMPUTER METHODS IN VIBRATIONS, (7 Lecture Hours)

Numerical methods in vibration problems to calculate natural frequencies - matrix iteration – Rayleigh-Ritz and Dunkerley's methods, method for Eigen-value calculations, Holzer's method, Stodola's method -mechanical impedance method –Matrix iteration technique.

MODULE IV – VIBRATION CONTROL (7 Lecture Hours)

Vibration isolation and transmissibility- Vibration Isolation methods- Dynamic Vibration absorber-Torsional and Pendulum Type Absorber-Active vibration control.

MODULE V – ENGINEERING ACOUSTICS (8 Lecture Hours)

Basic physical acoustics- acoustic levels and spectra- decibels, sound power, Sound pressure, power and intensity - Character of noise – Addition of two noise sources -Noise source identification. Noise radiation from vibrating bodies sound- properties of the various sources that create noise - Noise in machines and machine elements.

MODULE VI – VIBRATION MEASUREMENT AND ACOUSTIC STANDARDS (8 Lecture Hours)

Vibration instruments- vibration exciters - measuring devices- analysis- vibration Tests- Free, forced environmental vibration tests. Example of vibrations test- data acquisition – Modal and FFT analysis–Industrial case studies. Introduction to Acoustic Standards, Acoustic / Noise sensors, instrumentation, measurement and noise control instruments and noise propagation.

Reference Books:

1. Singiresu.S.Rao. Mechanical Vibrations, Addison Wesley Longman, 2003.
2. Benson H Tongue.Principles of vibration (2nd edition) Oxford University Press, 2002.
3. Thomson, W.T.Theory of Vibration with Applications, CBS Publishers and Distributers, NewDelhi, 2002.
4. Kelly.Fundamentals of Mechanical Vibrations, Mc Graw Hill Publications, 2000.
5. Rao V. Dukkipati, J. Srinivas. Vibrations : problem solving companion, Narosa Publishers, 2007.

18ME3020	COMPUTER AIDED DESIGN	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Various computer aided design tools for industrial applications.
2. Graphical entities of CAD /CAM and computer numerical programming.
3. Application of computers in manufacturing sectors.

Course Outcomes: After completing the course the student will be able to

1. Demonstrate the basic structure and components of cad.
2. Outline the process of representing graphical entities in a cad environment.
3. Construct the geometric model using different techniques to represent a product.
4. Illustrate various techniques and devices involved in cad hardware.
5. Analyze the models for design solutions using fem.
6. Discuss the various computer aided tools implemented in various industrial applications.

MODULE I – INTRODUCTION (7 Lecture Hours)

Introduction to CAD, Scope and applications in mechanical engineering, Need for CAD system, use of computer, Computer fundamentals, Computer aided design process, CAD configuration, CAD tools, advantages and limitations in CAD, CAD Standards – IGES, GKS and PDES, CAD/ CAM integration.

MODULE II – COMPUTER GRAPHICS (8 Lecture Hours)

Computer Graphics Display and Algorithms: Graphics Displays, DDA Algorithm – Bresenham’s Algorithm – Coordinate systems – Transformation of geometry – Translation, Rotation, Scaling, Reflection, Homogeneous Transformations – 2D and 3D Transformations – Concatenation – line drawing-Clipping and Hidden line removal algorithms – viewing transformations.

MODULE III – GEOMETRIC MODELLING (8 Lecture Hours)

Wireframe models and entities – Curve representation – parametric representation of analytic curves – circles and conics – Hermite curve – Bezier curve – B-spline curves – rational curves. Surface Modeling – Surface models and entities – Parametric representation of analytic surfaces – Plane surfaces – Synthetic surfaces – Bicubic Surface and Bezier surface and B-Spline surfaces. Solid Modeling – Models and Entities – Fundamentals of solid modelling – B-Rep, CSG and ASM.

MODULE IV – CAD HARDWARE (8 Lecture Hours)

Introduction to hardware specific to CAD, Product cycle, CRT, Random scan technique, raster scan technique, CAD specific i/o devices, DVST, Raster display, Display systems, sequential scanning and interlaced scan.

MODULE V – FINITE ELEMENT METHOD (7 Lecture Hours)

Introduction to FEM, Principle of minimum potential energy, steps involved in FEM, discretization, types of nodes and elements, elemental stiffness matrix, elemental strain displacement matrix, types of force, elemental force matrix, assembly, shape function, introduction to 2 dimensional FEM.

MODULE VI – OPTIMIZATION AND NEW TECHNIQUES OF CAD (7 Lecture Hours)

Introduction to Optimization, Johnson method of optimization, normal specification problem, redundant specification problem, introduction to genetic algorithm. New Techniques: RPT, laser and non- laser process of RPT, STL format to CAD file, Introduction to reverse engineering and related software’s viz. rapid form.

Reference Books:

1. Ibrahim Zeid, “CAD - CAM Theory and Practice”, Tata McGraw Hill Publishing Co. Ltd., 2009.
2. Kunwoo Lee, “Principles of CAD/CAM/CAE Systems”, Addison Wesley, 2005.
3. Rao. S.S. “The Finite Element Method in Engineering”, 2nd Edition, Pergamon Press, Oxford, 2009.
4. P.N. Rao, “CAD/CAM Principles and Applications", Tata McGraw Hill Publishing Co. Ltd., 2010.
5. Bathe K.J., “Finite Element Procedures”, K.J. Bathe, Watertown, MA, Fourth edition, 2016

18ME3021	VIBRATION LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives: To impart knowledge on

1. Fundamentals of digital data acquisition, signal processing, data reduction and display
2. Sensors, signal conditioning and associated instrumentation for vibration
3. Vibration measurement techniques

Course Outcomes: After completing the course the student will be able to

1. Study the effect of dynamics on vibration.
2. Recognize the instrumentation used in vibration control tests.
3. Understand the working principle of vibration measuring instruments
4. Adapt and evaluate the way to measure vibration
5. Gain knowledge of fundamental information about vibration phenomenon and find remedy of the vibration problems encountered in machineries
6. Understand the behavior of vibration in simple mechanical systems

LIST OF EXPERIMENTS

1. Longitudinal Vibration for single degree of freedom system
2. Torsional vibration for single degree of freedom system
3. Forced vibration for spring mass system
4. Multiple degree of freedom system
5. Transmissibility ratio in vibration table
6. Study of frequency and amplitude in vibration table
7. Vibration measurement using accelerometer for rotating machinery
8. Frequency measurement using Impact hammer
9. Real Time PC based vibration measurement
10. Measurement of Acoustic Emission signals
11. Generation of vibration signal by vibration controller
12. Study on the effect of material on load and deflection using tensile test

18ME3022	MULTIBODY DYNAMICS LABORATORY (ADAMS)	L	T	P	C
		0	0	4	2

Course Objectives: To impart knowledge on

1. Various linkage mechanisms
2. Simulation software like ADAMS
3. Kinematics and dynamics of mechanisms using software like ADAMS.

Course Outcomes: After completing the course the student will be able to

1. Illustrate the movements involved in various links and joints using software like ADAMS
2. Understand the various constraints and degree of freedom in the simple mechanism
3. Simulations of the mechanics involved in real life applications
4. Describe the mechanisms and motions of simple mechanical system
5. Find the DOF in various links and joints
6. Understand the working of different mechanism by relating it to simple computer simulation models using ADAMS software

LIST OF EXPERIMENTS

1. Simple motion analysis of one degree of freedom pendulum

2. Simulation of a slider crank mechanism
3. Simulation of a simple belt (open belt drive)
4. Simulation of a simple gear drive.
5. Velocity and Acceleration analysis
6. Angular velocity of a simple four bar mechanism
7. Position analysis of two degree of freedom link system
8. Vibration analysis of a spring mass system
9. Spring damper analysis
10. Quick return mechanism- simulation
11. Simulation of Hartnel governor
12. Simulation of IC engine crank multibody.

Reference Books:

1. Lab Manual

18ME3023	NUCLEAR POWER ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. The fundamental terms and concepts of nuclear power engineering.
2. The neutron life cycle, heat flow, radiation, fluidized bed reactor.
3. The safety principles and methods utilized in designing, constructing and operating a safe nuclear power plant.

Course Outcomes: After completing the course the student will be able to

1. Explain fundamental physics that applies to a broad range of nuclear technologies.
2. Understand the coolant channel orificing, hot spot factors.
3. Acquire knowledge on reactor hydraulics, different bed reactors.
4. Determine thermal reaction equation, temperature, pressure coefficient.
5. estimate safety calculations in support of the preparation of an abbreviated safety analysis
6. Demonstrate an understanding of social, professional, and ethical issues related to the safe and wise development of nuclear science and engineering.

MODULE I – REVIEW OF NUCLEAR PHYSICS (8 Lecture Hours)

Nuclear Equations ,Energy from Nuclear Reactions and Fission ,Thermal neutrons , Nuclear Cross Sections ,Neutron Flux distribution in cores, slowing down , Neutron life cycle, Thermal Reaction Equation , Buckling Factors – Reactivity and Reactor Period , Radio activity, half-life ,neutron interactions, cross sections.

MODULE II – HEAT GENERATION IN REACTOR (8 Lecture Hours)

Reactor Heat generation and Removal – Volumetric Thermal source Strength – Heat flow in and out of solid fuel element – Temperature variations across Fuel elements.

MODULE III – REACTOR COOLING (8 Lecture Hours)

Coolant channel orificing – Hot spot factors – Absorption of Core radiation – Total heat generated in the core. Heat removal in solids subjected to radiation – Thermal Shield quality and void fractions in flow and non-flow systems.

MODULE IV – TYPES OF REACTOR (8 Lecture Hours)

Boiling water reactor hydraulics- Change of Phase reactor. Fluidized Bed Reactor, Gas Cooled Reactor steam Cycle- Simple and Dual Pressure Cycle, Pebble Bed Reactors, Fluid Fuelled Reactors – Types – Corrosion and Erosion Characteristics.

MODULE V – FUSION ENERGY CONVERSION (8 Lecture Hours)

Energy From Nuclear fusion, Thermonuclear Fusion, D-T Reaction, P-P Reaction, Fuel Cycle, Conditions for Fusion, Plasma confinement and Heating- Magnetic Confinement fusion, Inertial Confinement Fusion.

Module VI – SAFETY OF NUCLEAR PLANTS (8 Lecture Hours) Nuclear plant safety – safety systems-changes and consequences of an accident-criteria for safety.

Reference books:

1. Samuel Glasstone and Alexander Setonske, 'Nuclear reactors Engineering', 4th Edition, CBS Publishers and Distributors, 2004.

2. Singhal R.K., “Nuclear Reactors”, New age international Private limited, 1st Edition 2014.
3. Vaidyanathan G “Nuclear Reactor Engineering”, S. Chand &Company, 2012.
4. Kenneth D.Kok “Nuclear Engineering Handbook”, CRC Press 2016.
5. John R Lamarsh “Introduction to Nuclear Engineering”, Pearson 3rd Edition 2001.

18ME3024	ENERGY CONSERVATION AND MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Energy conservation.
2. Energy auditing.
3. Energy management.

Course Outcomes: After completing the course the student will be able to

1. Discuss the present status of national energy scenario.
2. Compare the different forms of energy.
3. Apply various energy auditing methods.
4. Analyze the energy conservation areas in thermal systems.
5. Estimate the energy conservation areas in electrical systems.
6. Choose the different financial management methods.

MODULE I – ENERGY SCENARIO (6 Lecture Hours)

Introduction – primary and secondary energy, commercial and non-commercial energy, renewable and non-renewable energy. Global energy reserves – Indian energy scenario. Energy strategy for the future – Energy conservation act.

MODULE II – BASICS OF ENERGY AND VARIOUS FORMS (6 Lecture Hours)

Various forms of energy – grades of energy. Electrical energy basics – Electricity tariff – Basics of thermal energy

MODULE III – ENERGY AUDIT (6 Lecture Hours)

Definition and Objectives of energy audit – Need for energy audit – Types of energy auditing – Instruments used for energy auditing

MODULE IV – ENERGY CONSERVATION IN THERMAL SYSTEMS (9 Lecture Hours)

Introduction - Energy conservation in thermal systems – Boilers, Furnaces and Heat Exchangers. Energy conservation in buildings - Tips for energy efficiency in thermal systems

MODULE V – ENERGY CONSERVATION IN ELECTRICAL SYSTEMS (9 Lecture Hours)

Introduction - Energy conservation in electrical systems - Electric motors – Refrigeration and Air-conditioning System – Pumps – Compressors - Tips for energy efficiency in electrical systems.

MODULE VI – ENERGY MANAGEMENT (9 Lecture Hours)

Energy management principles, need for organization and goal setting - Life cycle costing and other methods - Factors affecting economics - Introduction to financial management - Simple payback period - Net present value method – Internal rate of return method.

Reference books:

1. Albert Thumann, Plant Engineers and Managers guide to energy conservation, 10th Edition. Fairmount Press, 2011.
2. Shinskey E.G., Energy Conservation through control, Academic Press, 1978.
3. General Aspects of Energy Management and Energy Audit Guide Book, Bureau of Energy Efficiency, Third Edition, 2010.
4. Energy Efficiency in Thermal Utilities Guide Book, Bureau of Energy Efficiency, Third Edition, 2010.
5. Energy Efficiency in Electrical Utilities Guide Book, Bureau of Energy Efficiency, Third Edition, 2010

18ME3025	SOLAR ENERGY UTILIZATION	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. Solar energy and techniques to utilize it efficiently and cost effectively.
2. Conversion of sunlight to heat for either direct usage or further conversion to other energy carriers.
3. Design a solar thermal system for a desired application.

Course Outcomes: After completing the course the student will be able to
1. Understand the available solar energy and the utilization processes.
2. Compare the different types of solar collectors.
3. Evaluate the performance of solar collectors.
4. Analyze the performance of solar air heaters.
5. Explain the energy storage system.
6. Apply the solar energy technology for various applications.

MODULE I – INTRODUCTION (9 Lecture Hours)
Energy alternatives – New energy technologies – Solar thermal process Solar Radiation – Solar constant – extra-terrestrial radiation – clear sky irradiation – solar radiation measurement – estimation of average solar radiation – solar radiation on tilted surface.

MODULE II – FLAT PLATE COLLECTORS (9 Lecture Hours)
Energy balances equation and collectors efficiency – collector performance – collector improvements, effect of incident angle, dust and shading – thermal analysis of flat plate collector and useful heat gained by the fluid - collector design – heat transfer factors.

MODULE III – CONCENTRATION COLLECTORS (9 Lecture Hours)
Parabolic concentrators, non-imaging concentrators, other forms of concentrating collectors. Tracking – receiver shape and orientation – performance analysis – reflectors – reflectors orientation – performance analysis.

MODULE IV – SOLAR AIR HEATERS (6 Lecture Hours)
Introduction – Performance analysis of a conventional air heater – Other types of air heaters – Testing procedures.

MODULE V – SOLAR ENERGY STORAGE (6 Lecture Hours)
Stratified storage – well mixed storage – comparison – Hot water system – practical consideration – solar ponds – principle of operation and description of Non-convective solar pond – extraction of thermal energy application of solar ponds.

MODULE VI – APPLICATIONS OF SOLAR ENERGY (6 Lecture Hours)
Solar electric power generation, photo voltaic cells. Solar furnace, Solar Chimney, heaters – power generation system. Tower concept – solar refrigeration system, thermoelectric refrigeration system.

Reference Books:

1. John.A. Duffie and Willam A.Beckman., 'Solar Engineering of Thermal Processes', Wiley, 2006.
2. Suhatme, S.P., 'Solar Energy Principle of Thermal Collection and Storage', Tata McGraw Hill, 2008.
3. Kriender, J.M., 'Principles of Solar Engineering', McGraw Hill, 2000.
4. Mangal, V.S., 'Solar Engineering', Tata McGraw Hill, 1992.
5. J.A. Duffie and W.A. Beckman, "Solar Engineering of Thermal Processes", John Wiley, 1991.

18ME3026	AIR-CONDITIONING SYSTEM DESIGN	L T P C 3 0 0 3

Course Objectives: To impart knowledge on
1. Working principle of air-conditioning cycles.
2. Components of cooling load.
3. Air distribution system.

Course Outcomes: After completing the course the student will be able to
1. Analyze psychrometry processes.

2. Compare different types of air-conditioning systems.
3. Evaluate the space cooling load.
4. Design the duct.
5. Choose the fan for desired application
6. Design the water and refrigerant piping

MODULE I – PSYCHROMETRY AND AIR CONDITIONING PROCESSES (9 Lecture Hours)
Moist Air properties, use of Psychrometric Chart, Various Psychrometric processes, Air Washer, Adiabatic Saturation. Summer and winter Air conditioning, Enthalpy potential and its insights.

MODULE II – TYPES OF AIR CONDITIONING SYSTEMS (6 Lecture Hours)
Thermal distribution systems – Single, multi zone systems, terminal reheat systems, Dual duct systems, variable air volume systems, water systems and unitary type systems.

MODULE III – COOLING LOAD ESTIMATION (9 Lecture Hours)
Thermal comfort – Design conditions – Solar Radiation-Heat Gain through envelopes – Infiltration and ventilation loads – Internal loads – Procedure for heating and cooling load estimation using ISHRAE Handbook

MODULE IV – DUCT DESIGN (6 Lecture Hours)
Flow through Ducts, Static and Dynamic Losses, Diffusers, Duct Design–Equal Friction Method.

MODULE V – FAN (6 Lecture Hours)
Fan and its types, Fan characteristics and laws. Fan Arrangement Variable Air Volume systems, Air Handling Units and Fan Coil units – Control of temperature, humidity, air flow and quality.

MODULE VI – WATER PIPING AND REFRIGERANT PIPING DESIGN (9 Lecture Hours)
Basics of water and refrigerant piping – Design of chilled water piping – Design of refrigerant piping.

Reference Books:

1. Arora C.P., Refrigeration and Air conditioning, McGraw Hill, 3rd Ed., 2010.
2. ASHRAE , Fundamentals and equipment , 4 volumes-ASHRAE Inc. 2005
3. Jones, Air Conditioning Engineering, Edward Amold pub. 2001.
4. Langley, Billy C. Refrigeration and Air Conditioning Ed. 3, Engie wood Cliffs (N.J) Prentice Hall 1986.
5. Air-conditioning HandBook, ISHRAE, 2014.

18ME3027	GAS TURBINES	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Fundamental principles of fluid mechanics and thermodynamics in the analysis of aircraft engines.
2. Gas turbine aircraft propulsion systems.
3. Selection of gas turbine systems.

Course Outcomes: After completing the course the student will be able to
1. Compare and contrast open and closed gas turbine cycles and appreciate their impact on environment.
2. Apply the gas dynamics principles and evaluate shock phenomenon.
3. Analyze gas turbine cycles for aircraft propulsion.
4. Select compressors for gas turbine systems.
5. Recognize various types of combustion system.
6. Evaluate performance of gas turbine systems.

MODULE I – SHAFT POWER CYCLES (8 Lecture Hours)
Introduction-shaft power cycles-ideal cycle, open cycle and closed cycle gas turbines-combined cycles-, comparative performance of practical cycles- Jet propulsion cycles and their analysis, environmental considerations and applications.

MODULE II – GAS DYNAMICS (8 Lecture Hours)
Energy and momentum equations for compressible fluid flows, stagnation state, velocity of sound, critical states, Mach number, flow through variable area ducts, flow through constant area ducts, normal shock, flow with oblique shock.

MODULE III – AIRCRAFT PROPULSION (7 Lecture Hours)
Gas turbine cycles for aircraft propulsion -simple turbojet cycle-the turbofan engine-turboprop engine-the turbo shaft engine-thrust augmentation-auxiliary power units.
MODULE IV – COMPRESSORS (8 Lecture Hours)
Centrifugal compressors-principle of operation-the diffuser-compressor characteristics and improvement, axial flow compressors- basic operation-degree of reaction- Blade materials, manufacturing techniques, blade fixing, blade design-axial flow compressor characteristics and improvement- mixed flow compressor, parameters affecting performance.
MODULE V – COMBUSTION SYSTEMS (6 Lecture Hours)
Types of combustion systems- various fuels and fuel systems, the combustion process-factors affecting combustor design-combustion chamber performance-gas turbine emissions.
MODULE VI – AXIAL AND RADIAL FLOW TURBINES (8 Lecture Hours)
Elementary theory of axial flow turbine-vortex theory-choice of blade profile, pitch and chord, estimation of stage performance, overall turbine performance- Problems of high temperature operation, blade cooling, and practical air cooled blades, the radial flow turbine

Reference Books:

1. HIH Saravanamuttoo, GFC Rogers, H Cohen, Gas turbine theory, Pearson education ltd, 5th edition, 2013.
2. V. Ganesan, “Gas Turbines”, Tata McGraw Hill, 2014.
3. S.M.Yahya “Turbines, Compressors and Fans”, Tata McGraw Hill, 2012.
4. Vincent “The theory and design of Gas Turbine and Jet Engines”, McGraw Hill, 2015.
5. W W Bathic, “Fundamentals of Gas Turbines”, John Wiley and Sons, 2007

18ME3028	ADVANCED INSTRUMENTATION IN THERMAL ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. The working of measuring instruments and errors associated with them.
2. Error analysis and uncertainty of measurements.
3. The measurement and data acquisition applicable to a thermal systems.

Course Outcomes: After completing the course the student will be able to
1. Identify experimental data and predict correlation.
2. Interpret uncertainties in various measurements.
3. Apply measurement techniques of intensive and extensive properties.
4. Analyze specific functional characteristics of thermal instruments.
5. Estimate the control system parameters using analog and digital controllers.
6. Formulate concepts to reduce errors in measurements.

MODULE I – MEASUREMENT CHARACTERISTICS (8 Lecture Hours)
Introduction to measurements, errors in measurements, statistical analysis of data, regression analysis, correlation, estimation of uncertainty and presentation of data.
MODULE II – MEASUREMENTS IN THERMAL SYSTEMS (7 Lecture Hours)
Basic Electrical measurements, Transducers and its types, Measurement of temperature, pressure, velocity, flow - simple and advanced techniques.
MODULE III – MEASUREMENT OF THERMO-PHYSICAL PROPERTIES (8 Lecture Hours)
Thermal conductivity, viscosity, surface tension, specific heat capacity, radiation properties of surfaces.
MODULE IV – MEASUREMENT OF FUEL PROPERTIES (8 Lecture Hours)
Flame ionization detector, non-dispersive infrared analyzer, smoke meters, and gas chromatography
MODULE V – DATA LOGGERS (8 Lecture Hours)
Data logging and acquisition, sensors for error reduction, elements of computer interfacing, timers and counters.

MODULE VI – DESIGN OF EXPERIMENTS (8 Lecture Hours)
Modeling of thermal equipment. Examples applied to heat transfer problems and energy systems.

References Books:

1. Doebelin O.E., 'Measurement Systems and Design', McGraw Hill Co., 2003.
2. Holman J.P., 'Experimental Methods for Engineers', McGraw Hill Co, 2001.
3. Beckwit T.G. and Buck M.L., 'Mechanical Measurements', Addition Wesley, 2011.
4. B.C. Nakra 'Instrumentation measurement and Analysis', Tata McGraw-Hill Publishing Company, 2002
5. R.K. Jain, 'Mechanical and Industrial Measurements' Khanna Publishers, 2000.

18ME3029	BIOMASS ENERGY	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Types of biomass resources and their properties.
2. Biomass conversion processes and application of conversion products.
3. Economics and sustainability of biofuels.

Course Outcomes: After completing the course the student will be able to

1. Select suitable biomass for conversion, based on its properties.
2. Analyze the performance of engines using biodiesel.
3. Design a community biogas plant.
4. Select conditions for biomass pyrolysis & develop a small size biomass gasifier.
5. Demonstrate techniques used for liquefaction of biomass.
6. Explain the economics of production processes of bio fuels.

MODULE I – BIOMASS AS ENERGY SOURCE (8 Lecture Hours)
Biomass energy usage in different countries – Advantages and disadvantages in use of biomass as energy source- Sources of biomass available for energy use- physical properties of biomass- proximate analysis- ultimate analysis- heating value analysis- Empirical relations for estimating heating values- Application of biomass conversion products.

MODULE II – BIODIESEL PRODUCTION (8 Lecture Hours)
Vegetable oil and animal fat characteristics- fatty acid composition-oil extraction processes-oil refining processes-Transesterification- ASTM characterization- Engine performance and exhaust emissions.

MODULE III – BIOGAS PRODUCTION (8 Lecture Hours)
Biomass parameters important in anaerobic digestion- Acid and methane forming microbes-advantages and disadvantages of anaerobic digestion processes- design of biogas digester- biogas utilization.

MODULE IV – PYROLYSIS AND GASIFICATION (10 Lecture Hours)
Pyrolysis processes based on heating rate- effect of temperature on product yields- applications of products from fast pyrolysis-bio oil characterization processes- bio oil upgrade processes- advantages and disadvantages of pyrolysis process. Chemistry of biomass gasification- various types of gasifiers- applications of biomass gasifiers- empirical chemical formula of biomass- air requirement for gasification- equivalence ratio calculations in a gasifier- syngas requirement in internal combustion engines.

MODULE V – BIOMASS LIQUEFACTION (7 Lecture Hours)
Bioethanol production - household and pilot scale ethanol production systems- Methanol production from synthesis gas- Fischer Tropsch processes- direct liquefaction processes- Advantages and disadvantages of biomass liquefaction processes.

MODULE VI – BIOFUELS COMBUSTION AND ECONOMICS (7 Lecture Hours)
Applications of biomass combustion systems- amount of CO_2 produced for every metric ton of biomass combusted- biomass combustion efficiency- Economics of production processes for major biofuels- measuring sustainability of biofuels.

Reference Books:

1. Sergio C. Capareda, "Introduction to Biomass Energy Conversions" CRC press, Taylor & Francis, 2014.

2. Prabir Basu, "Combustion and Gasification in Fluidized beds" CRC press, Taylor & Francis, 2009.
3. G.D. Rai, "Non-Conventional Energy Sources", 8th reprint, Khanna Publishers, 2013
4. O.P. Chawla, "Advances in Biogas Technology", Publications and Information Division, Indian Council of Agricultural Research, New Delhi, 2013.
5. K.M. Mital, "Biogas Systems: Principles and Applications", 1st Edition, New Age International Private Ltd, New Delhi, 2012.

18ME3030	DESIGN AND ANALYSIS OF HEAT EXCHANGERS	L	T	P	C
		3	0	0	3

Course objectives: To impart knowledge on
1. Classification of Heat exchangers.
2. Design of Shell and tube, compact heat exchangers.
3. Basic design methods of heat exchangers.

Course Outcomes: After completing the course the student will be able to
1. Identify the constructional aspects of various types of heat exchangers.
2. Predict the effectiveness of heat exchangers NTU method.
3. Calculate the design parameters of shell-and-tube heat exchanger.
4. Analyze compact heat exchanger.
5. Evaluate the performance of condensers.
6. Formulate concepts of single and multi-effect evaporators.

MODULE I – VARIOUS TYPES OF HEAT EXCHANGER (8 Lecture Hours)
Introduction, Recuperation and regeneration, Transfer processors, Geometry of construction, tubular heat exchangers, plate heat exchangers, extended surface heat exchangers ; Heat transfer mechanisms, Flow arrangements, Selection of heat exchangers.

MODULE II – BASIC DESIGN METHODS OF HEAT EXCHANGERS (7 Lecture Hours)
Arrangement of flow path in heat exchangers; basic equations in design; Overall heat transfer coefficient; LMTD and NTU methods for heat exchanger analysis, Heat exchanger design calculation, Variable overall heat transfer coefficient, Heat exchanger design methodology.

MODULE III – SHELL AND TUBE HEAT EXCHANGERS (8 Lecture Hours)
Basic components-shell types, tube bundle types, tubes and tube passes, tube layout in baffle type heat exchanger, allocation of stream; basic design procedure of a heat exchanger- unit size, performance rating.

MODULE IV – DESIGN OF DOUBLE PIPE HEAT EXCHANGERS(7 Lecture Hours)
Thermal and hydraulic design of inner tube and annulus, hairpin heat exchanger with bare and finned inner tube, total pressure drop.

MODULE V – COMPACT HEAT EXCHANGE (8 Lecture Hours)
Plate-fin heat exchanger, tube-fin heat exchangers, Heat transfer, pressure drop in finned-tube and plate-fin heat exchanger.

MODULE VI – CONDENSERS AND EVAPORATORS (7 Lecture Hours)
Shell-and-tube condensers-horizontal shell-side condensers, vertical tube-side condensers, horizontal in-tube condensers , steam turbine exhaust condensers ; Plate condensers ; Air-cooled condensers ; Direct contact condensers ; Thermal design of shell-and-tube condensers**,** Single and multi-effect evaporators.

Reference Books:
1. Frass, A.P. and Ozisik, M.N., 'Heat Exchanger Design', John Wiley and Sons Inc., 1965.
2. Wlker G., 'Industrial Heat Exchangers', A basic guide, McGraw Hill V Book Co., 1980.
3. Standards of the Tubular Exchanger Manufacturer Association', 6th Ed., Tubular Exchanger Manufacturers Association, New York, 2007
4. Donold Q Kern., 'Process Heat Transfer', McGraw Hill Book Co., 1988.
5. E.A.D. Saunders., 'Heat Exchangers', Longman Scientific and Technical, New York, 1988.

18ME3031	TWO PHASE FLOW AND HEAT TRANSFER	L T P C 3 0 0 3

Course Objectives: To impart knowledge of

1. Two phase flow and circulation in boiler.
2. Heat transfer with change of phase in condensation and boiling.
3. Fluidized beds and gas-liquid fluidization.

Course Outcomes: After completing the course the student will be able to

1. Understand vertical, horizontal and inclined two phase flow.
2. Determine effective pressure head in boiler tubes.
3. Choose various types of fluidized beds.
4. Evaluate heat transfer during condensation.
5. Analyze heat transfer with change of phase in boiling.
6. Explain various gas- liquid fluidizations.

MODULE I – TWO PHASE FLOW (8 Lecture Hours)
Simultaneous flow of liquids and gases, horizontal two phase flow, lock hart and Martenelli procedure flow factor method, vertical two phase flow, two phase flow through inclined pipes.

MODULE II – CIRCULATION IN BOILER (7 Lecture Hours) Natural and forced circulation, effective pressure head in boiler tubes, variation of major parameters of drum during transient conditions, the hydrodynamics stability of vapor – liquid system.

MODULE III – FLUIDIZED BEDS (8 Lecture Hours) Simultaneous flow of fluids and solids, dynamics of particles submerged in fluids, flow through packed bed. Fluidization, calculation of pressure drop in fixed bed, determination of minimum fluidization velocity, Expanded bed, dilute phase, moving solids fluidization, Elutriation in fluidized Bed, Semi fluidization, applications, Pulsating column, oscillating fluidized beds.

MODULE IV – CONDENSATION (7 Lecture Hours) Film wise condensation of pure vapors, Drop wise condensation in plated surfaces, condensation in presence of non-condensable gas.

MODULEV – BOILING (8 Lecture Hours) Pool boiling, Boiling in forced flow inside tubing.

MODULE VI – GAS-LIQUID FLUIDIZATION (7 Lecture Hours) Gas liquid particle process, Gas liquid particle operation, Gas liquid fluidization. Flow of Gas - Bubble formation, bubble growth gas hold up, Gas mixing liquid holdup, liquid mixing, flow of liquid mixing, Gas liquid mass transfer.

Reference books:

1. Ginou J.N., ‘Two Phase Flow & Heat Transfer’, McGraw Hill, New York, 1978.
2. Mc Adams., ‘Heat Transmission’, McGraw Hill, 1954.
3. Daugherty and Franzini., ‘Fluid Mechanics with Engineering Applications’, McGraw Hill, 1997.
4. S.C. Kutateladeze., ‘Problems of Heat Transfer and Hydraulics of Two Phase Media’, Pergamon Press, 2013.
5. L.S. Tong., ‘Boiling Heat Transfer and Two Phase Flow’, 2nd edition Wiley, New York, 1997.

18ME3032	COMPUTATIONAL FLUID DYNAMICS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Governing equations in fluid dynamics.
2. Solution methodologies of discretized equations.
3. Turbulence and combustion models.

Course Outcome: After completing the course the student will be able to

1. Develop governing equations for fluid flow and heat transfer.
2. Demonstrate the physical behaviors of flow.
3. Perform cfd analysis.

4. Impose boundary conditions while solving cfd problems.
5. Applying turbulence and combustion models in problem solving.
6. Develop various types of grids for solving cfd problems.

MODULE I – GOVERNING EQUATIONS AND BOUNDARY CONDITIONS (8 Lecture Hours)
Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Physical boundary conditions – Time averaged equations for Turbulent flow - Turbulence -Kinetic –Energy Equations.

MODULE II – DIFFUSION (8 Lecture Hours)
Finite difference and finite volume formulation of steady/transient one-dimensional conduction equation, Source term linearization, Incorporating boundary conditions, Finite volume formulations for two and three dimensional conduction problems

MODULE III – CONVECTION AND DIFFUSION (8 Lecture Hours)
Finite volume formulation of steady one-dimensional convection and Diffusion problems, Central, upwind, hybrid and power-law schemes - Discretization equations for two dimensional convection and diffusion.

MODULE IV – SOLUTION METHODOLOGIES (7 Lecture Hours)
Solution methodologies: Representation of the pressure - Gradient term and continuity equation - Staggered grid - Momentum equations - Pressure and velocity corrections - Pressure - Correction equation, SIMPLE algorithm and its variants.

MODULE V – GRID GENERATION (7 Lecture Hours)
Introduction, Structured and Unstructured Grids, Hybrid Grids, Algebraic, Elliptic, Hyperbolic Grid generation. Unstructured grids of triangular and Tetrahedral, Unstructured grids of Quadrilateral and Hexahedral, Cartesian Mesh, Adaptive Mesh.

MODULE VI – TURBULENCE AND COMBUSTION (7 Lecture Hours)
Turbulence models: mixing length model, two equation (k-E) models. Combustion models: pre mixed combustion, diffused combustion.

Reference Book

1. Anderson, J.D., “Computational fluid dynamics – the basics with applications”, 1995.
2. Versteeg, H.K, and Malalasekera, W., “An Introduction to Computational Fluid Dynamics:The Finite Volume Method”, Longman, 1998
3. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw- Hill Publishing Company Ltd., 1998.
4. Patankar, S.V., “Numerical Heat Transfer and Fluid Flow”, McGraw-Hill, 1980. Ane-Books2004 Indian Edition, 2004.
5. Bose, T.K., “Numerical Fluid Dynamics”, Narosa publishing House, 1997.

18ME3033	**ADVANCED IC ENGINES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course objectives: To impart knowledge on
1. Performance of SI and CI engines.
2. Understand recent trends in engine technology.
3. Engine exhausts emission control and alternate fuels.

Course Outcomes: After completing the course the student will be able to
1. Classify different types of internal combustion engines.
2. Analyze performance of spark ignition and compression ignition engines.
3. Identify recent technology trends in engine.
4. Study about friction reduction and light weighting technologies.
5. Predict concentrations of primary exhaust pollutants.
6. Analyze the performance and emissions of alternate fuels.

MODULE I – SPARK IGNITION ENGINES (8 Lecture Hours)
Mixture requirements of air-fuel ratio, Fuel injection system, Monopoint, Multipoint & Direct injection -Stages of combustion, Normal and Abnormal combustion, Spark Knock, Factors affecting knock, Combustion chambers, New technologies employed in 3 way catalytic convertor, stoichiometric and lean combustion.

MODULE II – COMPRESSION IGNITION ENGINES (7 Lecture Hours)
Diesel Fuel Injection Systems, Stages of combustion, Knocking, Factors affecting knock, Direct and Indirect injection systems, Combustion chambers, Fuel Spray behavior, Spray structure and spray penetration, Air motion, Introduction to Turbo charging, Advanced trends in Diesel oxidation catalyst (DOC), and Diesel particulate filter(DPF).

MODULE III – POLLUTANT FORMATION AND CONTROL (8 Lecture Hours)
Pollutant, Sources, Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter, Methods of controlling Emissions. Catalytic converters, Latest emission control techniques used in selective Catalytic Reduction and Particulate Traps, Methods of measurement, Emission norms.

MODULE IV – NON CONVENTIONAL I.C. ENGINES (7 Lecture Hours)
Introduction, Duel fuel / Multi fuel engine, stratified charge, adiabatic engine, Variable Compression Ratio engine, Free piston engine, Sterling engine, Wankel engine, HCCI engine.

MODULE V – ALTERNATIVE FUELS (8 Lecture Hours)
Bio Diesel, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Ethanol and Methanol– Properties, Suitability, Merits and Demerits – Engine Modifications. Latest technology in alternative sources of energy.

MODULE VI – AUTOMOTIVE FUEL INJECTION SYSTEM (7 Lecture Hours)
Air assisted Combustion, Supercharging, Adiabatic combustion, friction reduction, light weighting, composite engine materials, Current trends in multi-point fuel injection system, Gasoline Direct Injection Systems, Hybrid Electric, downsizing and de-rating of engines.

Reference Books:

1. R.P.Sharma and M.L.Mathur: “A course in Internal Combustion Engines”, D.Rai & sons.2016.
2. S.S. Thipse, “Alternative Fuels”, Jaico Publications, 2010.
3. S.S. Thipse, “IC Engines”, Jaico Publications, 2014.
4. Robert Bosch, “Automotive Hand Book”, SAE 9th Edition, 2014.
5. Ganesan. V., “Internal Combustion Engines”, Tata McGraw Hill, New Delhi, 2012

		L	T	P	C
18ME3034	**ADVANCED TURBO MACHINERY**	**3**	**0**	**0**	**3**

Course Objectives: To impart knowledge on
1. Various types of turbine, pump and compressor.
2. Performance analysis of turbines, pumps and compressors.
3. Application of turbo machines.

Course Outcomes: After completing the course the student will be able to
1. Classify types of turbine, pump, and compressors.
2. Demonstrate knowledge of turbines, pumps and compressors.
3. Compare the performance of turbo machines.
4. Select turbo machines for specific applications.
5. Analyze flow patterns in turbo machines.
6. Design micro and small turbo machines.

MODULE I – CLASSIFICATION OF TURBO MACHINERY (7 Lecture Hours)
Introduction, definition of turbo machine, parts of turbo machines, comparison with positive displacement machines, classification, dimensionless parameters and their significance, effect of Reynolds’s number, unit and specific quantities, model studies, application of first and second law’s of thermodynamics to turbo machines, efficiencies of turbo machines, problems

MODULE II – THERMODYNAMICS OF FLUID FLOW (7 Lecture Hours)
Static and Stagnation states- Incompressible fluids and perfect gases, overall isentropic efficiency, stage efficiency and polytropic efficiency for compression and expansion processes. Reheat factor for expansion process.
MODULE III – ENERGY EXCHANGE IN TURBO MACHINES (7 Lecture Hours) Euler's turbine equation, alternate form of Euler's turbine equation, velocity triangles for different values of degree of reaction, components of energy transfer, degree of Reaction, utilization factor, relation between degree of reaction and utilization factor, problems.
MODULE IV – GENERAL ANALYSIS OF TURBO MACHINES (8 Lecture Hours) Radial flow compressors and pumps, expression for degree of reaction, velocity triangles, effect of blade discharge angle on energy transfer, degree of reaction, and performance, theoretical head capacity relationship, general analysis of axial flow pumps and compressors, degree of reaction, velocity triangles, problems.
MODULE V – STEAM TURBINES (8 Lecture Hours)
Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, need and methods of compounding, multi-stage impulse turbine, expression for maximum utilization factor, Reaction turbine, Parsons turbine, condition for maximum utilization factor, reaction staging problems.
MODULE VI – HYDRAULIC TURBINES (8 Lecture Hours)
Classification, Different efficiencies, Pelton turbine, velocity triangles, design parameters, maximum efficiency, Francis turbine -velocity triangles, design parameters, runner shapes for different blade speeds. Draft tubes- Types and functions. Kaplan and Propeller turbines -velocity triangles, design parameters, problems.

Reference Books:

1. A.Valan Arasu, "Turbo machines" Vikas publishing house pvt Ltd, 2012
2. Lee, 'Theory and Design of Steam and Gas Turbine', McGraw Hill, 2011.
3. S.M Yahya., 'Turbines, Compressions and Fans', Tata McGraw Hill, 2015.
4. D.G. Stephard, 'Principles of Turbo machines', Macmillan Co., 2005.
5. Bathe W N, 'Fundamentals of Gas Turbines', Willey and Sons, 2006.

		L	T	P	C
18ME3035	**DESIGN OF SOLAR AND WIND SYSTEMS**	**3**	**0**	**0**	**3**

Course Objectives: To impart knowledge on
1. Fundamental principles of thermodynamics and heat transfer for performance analysis of solar energy collectors.
2. Small scale wind mills.
3. Various alternative energy sources for power generation.

Course Outcomes: After completing the course the student will be able to
1. Identify renewable energy sources for power generation.
2. Obtain solar radiation data.
3. Analyze the performance of solar energy collectors.
4. Select wind power generators for specific applications.
5. Recognize various types of fuel cells and solar pv systems.
6. Recognize different sources of alternate energy and evaluate performance of thermoelectric power generators.

MODULE I – INTRODUCTION TO ENERGY SOURCES (7 Lecture Hours)
Energy consumption as a measure of prosperity-world energy futures- energy sources and their availability-conventional energy sources- new energy technologies-renewable energy sources-prospects of renewable energy sources.
MODULE II – SOLAR RADIATION AND ITS MEASUREMENT (7 Lecture Hours)
Solar constant-solar radiation at the earth's surface- solar radiation geometry- solar radiations measurements- solar radiation data- estimation of average solar radiation- solar radiation on tilted surfaces- solar energy utilization.

MODULE III – SOLAR ENERGY COLLECTORS AND STORAGE (8 Lecture Hours)
Flat plate collectors- energy balance equation and collector efficiency- concentrating collectors- performance analysis of solar collectors- selective absorber coatings- solar air heaters- solar energy storage systems- thermal energy storage- solar pond.
MODULE IV – WIND ENERGY (8 Lecture Hours)
Basic principles of wind energy conversion- wind data and energy estimation- site selection considerations- components of wind energy conversion system- types of wind machines- performance of wind machines- applications of wind energy- interconnected system- safety systems- environmental aspects.
MODULE V – SOLAR PHOTO-VOLTAICS, MHD AND FUEL CELLS (7 Lecture Hours)
Photovoltaic cells- solar cell modules, applications, advantages and disadvantages of photovoltaic solar energy conversion- principle of MHD power generation, MHD systems, advantages, materials for MHD generators- principle of operation of a fuel cell, types, advantages and disadvantages, applications, batteries.
MODULE VI – OTHER ALTERNATE ENERGY SOURCES (8 Lecture Hours)
Thermionic generation- analysis of thermionic generator- thermoelectric power generator, performance analysis, thermoelectric materials- energy from biomass- biomass conversion technologies, biogas generation, classification of biogas plants- hydrogen energy, hydrogen production, storage, transportation and utilization- geothermal- geothermal sources, geothermal power plants, advantages and disadvantages, applications.

Reference Books:

1. G.D.Rai, Non-conventional energy sources, Khanna publishers, 5th edition, 2011
2. D.Y. Goswami, F. Kreith and J.F. Kreider, “Principle of Solar Engineering”, Taylor and Francis, 2010.
3. Sukhatme S.P., “Solar Energy”, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2014.
4. N.K. Bansal “Non-Conventional Energy Sources” Vikas publishing, 2014
5. J.F. Kreider, F. Kreith, “Solar Energy Handbook”, McGraw Hill, 2006

18ME3036	QUALITY CONCEPTS IN DESIGN	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Basic concepts in total quality management
2. Statistical process control
3. Reliability computation and reliability improvement

Course Outcomes: After completing the course the student will be able to
1. Apply the basic tools of quality in product development
2. Analyze the basic tools of quality in improving or redesigning the production process
3. Adopt/adept TQM and SPC tools in product/process industries
4. Conduct experiments and to analyze the significance of proceeds parameters
5. Compute reliability of parallel, series and mixed configurations
6. Improve the reliability of the systems by redundancy

MODULE I – BASIC CONCEPTS (6 Lecture Hours)
Basic concepts in quality engineering and management, TQM, Cost of quality, quality engineering, concept of quality auditing, customer satisfaction.
MODULE II – QUALITY LEVEL (7 Lecture Hours)
Six sigma concept, Six Sigma sustainability, Six Sigma and lean production. Review of Probability and Statistics, Frequency distributions and Histograms, Test of Hypothesis.
MODULE III – STATISTICAL PROCESS CONTROL (9 Lecture Hours)
DMAIC process for process and design improvement, Acceptance Sampling, Statistical Process Control (SPC), Process Capability, Gage Reproducibility and Repeatability, Quality Function Deployment.
MODULE IV – FAILURE ANALYSIS (7 Lecture Hours)
Failure mode effect analysis, Fault-tree analysis APQP, Embodiment checklist- Advanced methods: systems modeling, mechanical embodiment principles.

MODULE V – DESIGN OF EXPERIMENTS **(8 Lecture Hours)**
Procedure for DOE, Fractional, Full and Orthogonal Experiments, Regression model building, Taguchi methods for robust design.
MODULE VI – RELIABILITY **(8 Lecture Hours)**
Definition, Survival and Failure rates-Series and parallel and mixed systems-Mean time between failure, Mean time to failure,-Availability models-redundancy

Reference Books:

1. Evans, J R and W M Lindsay, "An Introduction to Six Sigma and Process Improvement", 2nd Edition, Cengage Learning, 2015.
2. J.M.Juran, "Quality planning and analysis",McGraw Hill, 5th Edition,1**5** thReprint 2015
3. Montgomery, "Design and analysis of Experiments", Wiley India, 5thEdition 2004
4. AmitavaMitra, "Fundamentals of quality control and Improvement", Wiley India, 3rdEdition 2013
5. M.Mahajan, "Statistical Quality Control", Dhanpat Rai Sons, 11th Edition 2007

18ME3037	MANUFACTURING SYSTEM AND SIMULATION	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Various modeling techniques.
2. Random number generation.
3. Manual and computer assisted simulation techniques.

Course Outcomes: After completing the course the student will be able to
1. Create model of the real manufacturing system.
2. Generate random numbers for simulation experiments.
3. Resolve practical problems in manufacturing sectors using simulation.
4. Analyse material handling problem and to give solutions.
5. Optimize the performance of a discrete system.
6. Verify and validate the simulation model.

MODULE I – BASICS OF SIMULATION **(8 Lecture Hours)**
Simulation-Introduction, advantages and limitations, areas of application, systems and system environment, components of a system, discrete and continuous system, models of a system, Types of models, Discrete event system simulation, steps in simulation study.
MODULE II – INFORMATION SYSTEMS **(8 Lecture Hours)**
Fundamentals of information technology, information networking, parts oriented production information systems, and computerized production scheduling, online production control systems. Computer based production management systems, principles and effectiveness of CIM, factory automation, FMS.
Module III – SIMULATION OF INVENTORY AND MAINTENANCE PROBLEMS (8 Lecture Hours)
Random number generations Random numbers generation- methods and techniques - Montecarlo simulation to solve inventory problem and maintenance problem. Queuing models: Review of terminology and concepts, characteristics of queuing systems, Queuing notations, Transient and steady state behavior-long run measures of performance of queuing systems.
MODULE IV – DISCRETE EVENT SIMULATION **(7 Lecture Hours)**
Concepts in discrete event simulation: Event scheduling/Time advance algorithm-manual simulation using event scheduling-list processing Programming for discrete event systems in GPSS.
MODULE V – MANUFACTURING SIMULATION **(7 Lecture Hours)**
Simulation of manufacturing & material handling system, manufacturing models - Types and uses, material handling –Goal and performance measures-Issues in Manufacturing &Material handling simulation-case studies-Introduction to softwares-SIMFACTORY,AIM,ARENA and TAYLOR II.
MODULE VI – VERIFICATION AND VALIDATION **(7 Lecture Hours)**
Simulation experiments, Verification and validation of simulation models. –Face validity-Validation of model assumptions, validation of input-output transformation-input-output validation.

Reference books:

1. Jerry Banks and John S. Carson, "Discrete –Event System Simulation", Prentice Hall Inc, 2009.
2. Gordon G, "System Simulation", Prentice Hall of India Ltd, 2009
3. D.S.Hira, "System Simulation", S.Chand& Company Ltd, 2010.
4. Law.M.Kelton, "Simulation Modeling and Analysis", McGraw Hill, NY, 2007
5. GeoferyGordan, Systems Simulation, Prentice Hall, 2013.

18ME3038	FLEXIBLE MANUFACTURING SYSTEM	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Demonstrates basics and components of FMS to learners
2. Discover the use of computers in FMS
3. Formulate the scheduling techniques of FMS

Course Outcomes: After completing the course the student will be able to

1. Understand the basic concepts and components of FMS
2. Identify Automated material handling systems used in FMS
3. Infer FMS control using computers
4. Formulate the modeling of FMS.
5. Analyse the database for manufacturing systems
6. Compose the scheduling of FMS

MODULE I – INTRODUCTION TO FMS (8 Lecture Hours)

Definition of an FMS - Need for FMS - types and configuration - types of flexibilities and performance measures - Economic justification of FMS - Development and implementation of FMS - planning phases – integration - system configuration - FMS layouts - simulation.

MODULE II – AUTOMATED MATERIAL HANDLING AND STORAGE (8 Lecture Hours)

Functions – types - analysis of material handling systems - primary and secondary material handling systems – conveyors - Automated Guided Vehicles - working principle – types - traffic control of AGVs - Role of robots in material handling - Automated storage systems - storage system performance – AS/RS-carousel storage system - WIP storage systems - interfacing handling and storage with manufacturing.

MODULE III – COMPUTER CONTROL OF FMS (8 Lecture Hours)

Planning - scheduling and computer control of FMS - Hierarchy of computer control - supervisory computer. DNC system- communication between DNC computer and machine control unit - features of DNC systems.

MODULE IV – COMPUTER SOFTWARE AND SIMULATION (7 Lecture Hours)

System issues - types of software – specification and selection - trends - application of simulation and its software.

MODULE V – DATA BASE OF FMS (7 Lecture Hours)

Manufacturing Data systems - planning FMS data base - Modeling of FMS- analytical – heuristics – queuing - simulation and petrinets modeling techniques.

Module VI – SCHEDULING OF FMS (7 Lecture Hours)

Scheduling of operations on a single machine- two machine flow shop scheduling - two machine job shop scheduling, - three machine flow shop scheduling- scheduling 'n' operations on 'n' machines, knowledge based scheduling - scheduling rules - tool management of FMS - material handling system schedule.

Text Books:

1. Nand K. Jha "Hand-book of Flexible Manufacturing Systems" Academic Press, 1991
2. Raouf, A. and Ben-Daya, M., Editors, "Flexible manufacturing systems: recent development", Elsevier Science, 1995.

Reference Books:

1. Parish.D.J., "Flexible Manufacturing", Butter worth-Heinemann Ltd,1990.
2. Groover. M. P., "Automation production systems and computer integrated manufacturing", Prentice hall of India pvt.Ltd, 1989.

3. TaiichiOhno, “Toyota production system: beyond large-scale production” Productivity Press (India) Pvt. Ltd. 1992.
4. Buffa .E.S. and Sarin, “Modern Production and Operations Management”, Wiley Eastern, 1987.
5. Radhakrishnan P. and Subramanyan S., “CAD/CAM/CIM”, Wiley Eastern Ltd.,New Age International Ltd., 1994.

18ME3039	COMPUTER INTEGRATED MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. The use of computers in the area of manufacturing.
2. New technology in the area of manufacturing.
3. Artificial intelligence and expert systems in manufacturing systems.

Course Outcomes: After completing the course the student will be able to

1. Employ computers in the area of manufacturing to reduce manual processing.
2. Understand group technology
3. Apply computer aided process planning
4. Examine Material Requirement Planning (MRP) and Enterprise Resource Planning (ERP)
5. Apply computer aided quality control and Flexible manufacturing systems
6. Recommend Artificial intelligence and Expert systems

MODULE I – INTRODUCTION (8 Lecture Hours)

Objectives of a manufacturing system-identifying business opportunities and problems classification production - systems-linking manufacturing strategy and systems-analysis of manufacturing operations.

MODULE II – GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING (7 Lecture Hours)

Introduction-part families-parts classification and cooling - group technology machine cells benefits of group - technology. Process planning function CAPP - Computer generated time standards.

MODULE III – COMPUTER AIDED PLANNING AND CONTROL(7 Lecture Hours)

Production planning and control-cost planning and control-inventory management-Material requirements planning - (ERP)-shop floor control-Factory data collection system-Automatic identification system-barcode technology automated data collection system.

MODULE IV – PRODUCTION MONITORING (7 Lecture Hours)

Types of production monitoring systems-structure model of manufacturing process-process control & strategies direct digital control-supervisory computer control-computer in QC - contact inspection methods non-contact inspection method - computer-aided testing - integration of CAQC with CAD/CAM.

MODULE V – INTEGRATED MANUFACTURING SYSTEM (8 Lecture Hours)

Definition - application - features - types of manufacturing systems-machine tools-materials handling system computer control system - DNC systems manufacturing cell.

MODULE VI – FLEXIBLE MANUFACTURING SYSTEMS (8 Lecture Hours)

Flexible manufacturing systems (FMS) - the FMS concept-transfer systems - head changing FMS – variable mission manufacturing system. Human labor in the manufacturing system-computer integrated manufacturing system benefits. Rapid prototyping - Artificial Intelligence and Expert system in CIM.

Reference Books:

1. Mikell .P. Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India, 2009.
2. YoremKoren, "Computer control Manufacturing Systems", McGraw Hill, 1999.
3. Kant Vajpayee, S, Computer Integrated Manufacturing, Prentice Hall of India, New Delhi, 2007.
4. James A Retrg, Herry W Kraebber, Computer Integrated Manufacturing‖, Pearson Education, Asia, 2001.
5. Radhakrishnan P, SubramanyanS.andRaju V., “CAD/CAM/CIM”, 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.

18ME3040	COMPUTER APPLICATIONS IN DESIGN	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. How computers can be used in mechanical engineering design.
2. Basics of CAD modeling (surface and solid) and Visual realism.
3. The techniques for assembly of parts, tolerance analysis, mass property calculation, Solid modeling techniques and rapid prototyping.

Course Outcomes: After completing the course the student will be able to

1. Summarize the applications of computers Mechanical Engineering Design.
2. Categorize and use various surface and curve techniques for 3d modelling
3. Make use of solid modelling techniques for complex part designs.
4. Develop complex parts based on Visual realism techniques
5. Create part assemblies; apply tolerance analysis and mass property calculations.
6. Analyze simple truss and beam structures using FEA and Construct using rapid prototyping techniques.

MODULE I – INTRODUCTION TO CAD FUNDAMENTALS (8 Lecture Hours)
Introduction to CAD- Design Process-Product cycle - Sequential and concurrent engineering- Graphics displays - Output primitives (points, lines, curves etc.,), 2-D & 3-D transformation (Translation, scaling, rotators) windowing - view ports - clipping transformation.

MODULE II – CURVES AND SURFACES MODELLING (9 Lecture Hours)
Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations. Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder – synthetic surfaces: Hermitebicubic surface- Bezier surface and B-Spline surface- surface manipulations.

MODULE III – NURBS AND SOLID MODELING (8 Lecture Hours)
NURBS- Basics- curves, lines, arcs, circle and bi linear surface. Regularized Boolean set operations - primitive instancing - sweep representations – boundary representations - constructive solid Geometry - comparison of representations - user interface for solid modeling.

MODULE IV – VISUAL REALISM (7 Lecture Hours)
Hidden – Line – Surface – solid removal algorithms shading – coloring. Introduction to parametric and variational geometry based software's and their principles creation of prismatic and lofted parts using these packages.

MODULE V – PART ASSEMBLY AND PRODUCT DATA EXCHANGE (7 Lecture Hours)
Assembly modeling - interferences of positions and orientation - tolerances analysis – mass property calculations - mechanism simulation. Graphics and computing standards– Open GL Data Exchange standards – IGES, STEP etc– Communication standards.

MODULE VI – FINITE ELEMENT ANALYSIS (6 Lecture Hours)
Introduction to Finite element analysis/method – computer aided analysis of simple truss and beam – Computer aided mechanism simulation, Rapid prototyping- application of computers in RP.

Reference Books:

1. Ibrahim Zeid,CAD/CAM- Theory and Practice McGraw Hill, Indian Edition,2005
2. Donald Hearn and M. Pauline Baker "Computer Graphics", Prentice Hall, Inc., 1992.
3. Mikell. P. Grooves and emory, W. Zimmers Jr. "CAD/CAM Computer aided Design and Manufacturing " prentice Hall of Inc., 2002
4. Hall and Allen, 'Machine Design', S.Schaum's Series, .Ist edition 2001
5. Joseph Edward Shighley, 'Mechanical Engineering', McGraw Hill, 2002

18ME3041	DESIGN OF FLUID POWER SYSTEMS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Laws and governing equations for hydraulics and pneumatics with ISO symbolic representations.
2. Working principles of hydraulic and pneumatic drives and develop circuits for engineering applications.
3. Trouble shooting the hydraulic and pneumatic systems.

Course Outcomes: After completing the course the student will be able to

1. Interpret the standard symbols and laws used in FPC Systems.
2. Infer the working principles of pumps and motors.
3. Identify the suitable elements of fluid power systems for a particular application.
4. Examine hydraulic circuits for an industrial application.
5. Assess the optimal components of pneumatic system.
6. Build a logic circuit for industrial problems.

MODULE I – FLUID POWER ELEMENTS (8 Lecture Hours)

Industrial Prime Movers, basic laws, applications, types of fluid power systems, fluid types and properties. Comparison of power systems, Fluid power symbols. fluid reservoir , Cylinders, Mechanics of cylinder loading, Pressure accumulators-types, DCV,FCV, relief valve, hydraulic servo systems, Cartridge valves, Hydraulic fuses, Temperature and pressure switches, Shock Absorbers , electromechanical devices like relays and solenoids.

MODULE II – HYDRAULIC PUMPS AND MOTORS (8 Lecture Hours)

Types – design and construction , gear pumps, vane pumps, piston pumps and pump performance, numerical problems, Hydraulic Motors –Types, theoretical torque , power and flow rate, performance and numerical problems.

MODULE III – DESIGN OF HYDRAULIC CIRCUITS (9 Lecture Hours)

Reciprocation, quick return, Speed control circuits, sequencing, synchronizing circuits, clamping and accumulator circuits, press circuits and hydro-pneumatic circuit.

MODULE IV – DESIGN OF PNEUMATIC CIRCUITS (8 Lecture Hours)

Basic elements -Compressor, Cylinders, DCV,FCV, other special valves, Boolean algebra, truth tables, reciprocation, quick return circuit, cascade circuits/ sequencing circuits like A+B+ A- B- , electro-pneumatic circuits.

MODULE V – INDUSTRIAL APPLICATIONS (8 Lecture Hours)

MPL control of Fluid power circuits, fluidic elements and fluidic sensors, Basic concepts of programmable logical control, Fail-safe Circuits, Intensifier circuits, Box-sorting System, Electrical Control of Regenerative Circuit, Hydro-pneumatic circuit.

MODULE VI – FAULT FINDING AND MAINTENANCE (4 Lecture Hours)

Trouble Shooting in Fluid Power Systems, Preventive Maintenance, Piping Design for Fluid Power Systems.

Reference books:

1. R.Srinivasan "Hydraulic and Pneumatic Controls" 2nd Edition ,Tata McGraw - Hill Education 2008.
2. Anthony Esposito," Fluid Power with Applications", Pearson Education Inc., Seventh Edition, 2014. ISBN 9780135136904.
3. John J Pippenger, Adrian Mitchell, Richard J Mitchell, "Fluid Power Maintenance Basics and Troubleshooting," Hardcover, Edition: 01, 1997.
4. M.K. Medhat, Dr.Khalil "Electro-Hydraulic Components and Systems: Hydraulic Systems Volume 2" Hardcover – Import, 1 Jan 2017.
5. S.R.Majumdar, "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw Hill, 2002.

18ME3042	TOTAL QUALITY MANAGEMENT	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Concepts, principles and applications of TQM.
2. Tools and techniques of TQM.
3. Control charts and process capability.

Course Outcomes: After completing the course the student will be able to

1. Apply the tools and techniques of TQM in manufacturing and service sectors.
2. Assess the barriers of TQM implementation.
3. Formulate and implement quality circles in their workplace.
4. Apply six sigma concepts in manufacturing and service sectors.
5. Apply TPM principles in manufacturing sectors.
6. Improve the processes by using control charts.

MODULE I **(8 Lecture Hours)**

Introduction, need for quality, evolution of quality; Definitions of quality, product quality and service quality; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. Barriers to TQM; Quality statements, customer focus, customer orientation & Satisfaction, customer complaints, customer retention; costs to quality.

MODULE II **(8 Lecture Hours)**

TQM principles; leadership, strategic quality planning; Quality councils- employee Involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection.

MODULE III **(8 Lecture Hours)**

Tools of Quality :The seven traditional tools of quality; New management tools; Six sigma- concepts, Methodology, applications to manufacturing, service sector including IT, Bench marking process; FMEA- stages, types.

MODULE IV **(7 Lecture Hours)**

TQM Techniques, control charts, process capability, concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM- concepts, improvement needs, performance measures.

MODULE V **(7 Lecture Hours)**

CONTROL CHARTS: Control for process capability: variable control charts- Attribute control charts- Process capability-Process capability index-Application of control

MODULE VI **(7 Lecture Hours)**

Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, Documentation, Quality auditing, QS 9000, ISO 14001 - concepts, requirements and benefits; TQM implementation in manufacturing and service sectors.

Reference Books:

1. Besterfield D.H. et al., Total Quality Management, 3rd ed., Pearson Education Asia, 2006.
2. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.
3. Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
4. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.
5. Kevin Otto and Kristin Wood, ‘Product Design’, Pearson Educational Inc. 2004.

18ME3043	INDUSTRIAL AUTOMATION AND MECHATRONICS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Basic principles of automation, tool transfer and implementation of automated flow line.
2. Design aspects and analysis of material handling system.
3. Principles of Mechatronics for design industrial and domestic applications.

Course Outcomes: After completing the course the student will be able to

1. Develop intelligent automated system and manufacturing data base system.
2. Implement the concepts of a productive system in automation.
3. Apply the knowledge of automated flow lines for industrial and other applications.
4. Design and analysis of material handling systems for automated assembly lines.
5. Select proper sensor and actuator for a given application.
6. Balance automated assembly lines.

MODULE I – PRODUCTION AND AUTOMATION STRATEGIES (8 Lecture Hours)
Plant Layout, production concepts and mathematical models, Automatic loading Systems-Automated flow lines, Methods of work flow - transport transfer mechanisms, buffer storage, Control functions, Automation for machining operations.

MODULE II – DESIGN AND FABRICATION CONSIDERATIONS (8 Lecture Hours)
Analysis of transfer lines without storage -partial automation automated flow lines with storage buffers implementing of automatic flow lines-Line balancing problems, Considerations in assemble line design-Manual assembly lines - line balancing problem.

MODULE III – FLEXIBLE MANUAL ASSEMBLY LINES (8 Lecture Hours)
Automated assembly systems, Analysis of multi station assembly-Manufacturing Cells, Automated Cells, Analysis of Single Station Cells, design and analysis of material handling system, conveyor system. Automated guided vehicle system-Automated storage and Retrieval systems, Transfer lines, Design for Automated Assembly, Partial Automation, Communication Systems in Manufacturing.

MODULE IV – OVERVIEW OF MECHATRONICS PRODUCTS (7 Lecture Hours)
Intelligent Machine vs Automatic Machine, Economic and social justification. Actuators and Motion Control. Control parameters and system objectives. Mechanical configurations. Popular control system configurations-S-curve, Motor/Load inertia matching, design with linear slides. Motion control Algorithms: significance of feed forward control loops, shortfalls.

MODULE V – FUNDAMENTAL CONCEPTS OF ADAPTIVE AND FUZZY CONTROL (7 Lecture Hours)
Fuzzy logic compensatory control of transformation and deformation non-Z linearities- Introduction to Microprocessor and programmable logic controllers and identification of system, System design Classification. Motion control aspects in Design.

MODULE VI – MANUFACTURING DATABASE (7 Lecture Hours)
Sensor Interfacing: Analog and Digital Sensors for Motion Measurement, Digital Transducers, Human - Machine and Machine - Machine Interfacing. Machine Vision: Feature and Pattern Recognition methods, concepts of perception and cognition in decision making.

References Books

1. Mikell P. Groover, “Automation, Production Systems and CIM”, Printice Hall of India, 2008.
2. Singh, “System Approach to Computer Integrated Design and Manufacturing”, John Wiley
3. 1996.
4. Michel B. Histand and David G. Alciatore, “Introduction to Mechatronics and Measurement Systems” Tata McGraw Hill, 2011.
5. C.W. De Silva, “Sensors and Actuators: Control system Instrumentation”, CRC Press, 1st Edition, 2011.

18ME3044	CONTROL OF CNC MACHINE TOOLS	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. CNC programming, hydraulic system
2. CNC interpolation, DDA integrator
3. CNC control loops and architecture

Course Outcomes: After completing the course the student will be able to

1. Design control systems for CNC machine tool
2. Understand the principles of motors and hydraulic system

3. Compare the interpolation methods in CNC control system
4. Recommend PID controllers, servo controller, Numerical control Kernel types
5. Select the components of CNC architecture
6. Propose the PLC programming Languages

MODULE I – INTRODUCTION TO CNC SYSTEMS AND PROGRAMMING (8 Lecture Hours)

Introduction to CNC systems, Coordinate systems of CNC machines, Economics. CNC programming-Interpolation, CNC programming - feed, tool and spindle functions (G-codes).

MODULE II – CNC DRIVES AND CONTROLLERS (8 Lecture Hours)

CNC drives Hydraulic systems, servo and stepping motors, response analysis, Feedback devices and counter.

MODULE III – CNC HARDWARE INTERPOLATORS (8 Lecture Hours)

CNC Interpolation – Hardware interpolators- DDA integrator, linear, circular, complete interpolators,

MODULE IV – CNC SOFTWARE INTERPOLATORS (7 Lecture Hours)

Software interpolators, Tustin method, NURBS and polynomial interpolators, Acceleration and deceleration control techniques.

MODULE V - CNC CONTROL LOOPS (7 Lecture Hours)

CNC control loops, PID control, servo controller, gain tuning, feed forward control, Mathematical analysis of control loops.

MODULE VI - CNC ARCHITECTURE (7 Lecture Hours)

CNC Architecture - Numerical control kernel- types, PLC, programming, languages, Human-Machine Interface functions, structure, Introduction to Open CNC architecture.

Reference books:

1. Suk-Hwan Suh and Ian Stroud, Gloud "Theory and Design of CNC Systems", Springer, 2008.
2. YoramKoren and Joseph Ben Uri, "Numerical Control of Machine Tools", Khanna Publishers, 2000.
3. YoramKoren, "Computer Control of Manufacturing Systems" McGraw-Hill, 1985.
4. Yusuf Altintas, "Manufacturing Automation Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design", Second edition, Cambridge University Press, 2012.

18ME3045	ENGINEERING PRODUCT DESIGN AND DEVELOPMENT STRATEGIES	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Modeling, simulation, material selection and GD & T.
2. Important practices followed during designing and developing a product in industries.
3. Product life cycle right from its conceptual stage to its development stage.

Course Outcomes: After completing the course the student will be able to

1. Apply the appropriate design process and modelling techniques to design components.
2. Categorize the models used in product design and use appropriately for product analysis.
3. Choose the right material selection process and calculate the economics of materials.
4. Design a product for sustainability, environment friendly considering human factors engineering.
5. Use GD & T principles for better product manufacturing.
6. Apply the principles of reliability, safety, robust design and design optimization.

MODULE I – NATURE AND SCOPE OF PRODUCT ENGINEERING (8 Lecture Hours)

Importance of product design, Design Constraints, Safety and reliability considerations, The Design process-A simplified approach, Consideration of a Good Design, Detail description of Design process (Morphology of Design), Technological Innovation and the design process; Product and Process cycle. Green Technology Application-Integrated CAD/CAM, Statistical process controls (SPC).

MODULE II – MODELING AND SIMULATION (8 Lecture Hours)

The role of Models in Engineering Design-Mathematical modeling, Similitude and scale modeling, Simulation, Finite-Difference method, Geometric modeling on the computer, Finite Element Analysis-Introduction to simulation modeling-Simulation programming software-Monte Carlo Simulation

MODULE III – MATERIAL SELECTION AND MATERIALS IN DESIGN (8 Lecture Hours)

Relation of Materials Selection to Design, Performance Characteristics of materials, The Materials Selection process – Design process and materials selection, Ashby charts, Material selection in Embodiment design, Economics of materials, Methods of material selection- Selection with Computer-Aided database, Weighted Property Index, Value analysis, Design examples- Materials systems, Material substitution; simple problems.

MODULE IV – DESIGN FOR SUSTAINABILITY AND ENVIRONMENT (7 Lecture Hours)

The Environmental Movement- Sustainability -Challenges of Sustainability for Business- End-Of-Life Product Transformations -Role of Material Selection in Design for Environment-Tools to Aid Design for the Environment and Sustainability- Influence of Space, Size, Weight, etc., on Form design, Aesthetics- Human factors Design-Industrial Ergonomic considerations.

MODULE V – GEOMETRIC DIMENSIONING AND TOLERANCING (7 Lecture Hours)

Introduction to Dimensioning-Dimensioning Characteristics and Definitions-Fundamental Dimensioning Rules-Dimensioning Symbols-Dimensioning Systems - Introduction to GD&T Symbols - Datums -Applying Material Condition and Material-Boundary Symbols--Limits of Size Application - Perfect Form Boundary -Applying Regardless of Feature Size and-Regardless of Material Boundary - Applying Maximum and Least Material Condition - Quality-Robust Design and optimization.

MODULE VI – RELIABILITY, SAFETY, ROBUST DESIGN AND OPTIMIZATION (7 Lecture Hours)

Introduction - Probabilistic Approach to Design - Reliability Theory - Design for Reliability (Problems) - Failure Mode and Effects Analysis (FMEA) - Defects and Failure Modes - Design for Safety – Concept of Total Quality - Quality Control and Assurance - Statistical Process Control- Process Capability - Taguchi Method - Robust Design - Optimization Methods - Design Optimization- Ergonomics in Product Design.

Reference Books:

1. Dieter. G. E, 'Engineering Design', 5th Ed. Tata McGraw Hill, 2010.
2. David A. Madsen, 'Engineering Drawing and Design', Delmar Thomson Learning Inc. 2002,
3. Jones J.C., 'Design Methods', Inderscience, 2008
4. Kevin Otto and Kristin Wood, 'Product Design', Pearson Educational Inc. 2004.
5. Karl T Ulrich, Steven D Eppinger, 'Product Design and Development', Irwin Homeward Boston Publishers, 2004.

18ME3046	**ADVANCED TOOL DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives: To impart knowledge on

1. Tool design and advanced cutting tool materials.
2. Design of cutting tools, forming tools and jigs.
3. Press tool design and fixtures for CNC machines.

Course Outcomes: After completing the course the student will be able to

1. Select appropriate materials for tool, jigs and fixtures.
2. Understand the requirements and challenges in the development of cutting tools.
3. Design Jigs and fixtures for conventional machines.
4. Develop Jigs and fixtures for CNC machines.
5. Design Dies and Press tools for conventional machines.
6. Develop Dies and Press tools for CNC machines.

MODULE I – INTRODUCTION TO TOOL DESIGN (7 Lecture Hours)

Introduction –Tool Engineering – Tool Classifications– Tool Design Objectives – Tool Design in manufacturing- Challenges and requirements- Standards in tool design-Tool drawings -Surface finish – Fits and Tolerances.

MODULE II – DESIGN OF CUTTING TOOLS (9 Lecture Hours)
Mechanics of Metal cutting –Oblique and orthogonal cutting- Chip formation and shear angle - Single-point cutting tools – Milling cutters – Hole making cutting tools- Broaching Tools - Design of Form relieved and profile relieved cutters-Design of gear and thread milling cutters.

MODULE III – DESIGN OF JIGS (8 Lecture Hours)
Introduction – Fixed Gages – Gage Tolerances –selection of material for Gages – Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – Chip formation in drilling – General considerations in the design of drill jigs – Drill bushings – Methods of construction –Thrust and Turning Moments in drilling - Drill jigs and modern manufacturing.

MODULE IV – DESIGN OF FIXTURES AND PRESS TOOLS (7 Lecture Hours)
Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures – Modular Fixtures – Cutting Force Calculations. Types of Dies –Method of Die operation–Clearance and cutting force calculations- Blanking and Piercing die design – Pilots – Strippers and pressure pads- Presswork materials – Strip layout – Short-run tooling for Piercing – Bending dies – Forming dies – Drawing dies-Design and drafting.

MODULE V – TOOL DESIGN FOR CNC MACHINE TOOL (8 Lecture Hours)
Introduction –Tooling requirements for Numerical control systems – Fixture design for CNC machine tools- Sub plate and tombstone fixtures-Universal fixtures– Cutting tools– Tool holding methods– Automatic tool changers and tool positioners – Tool presetting– General explanation of the Brown and Sharp machine.

MODULE VI – TOOL MATERIALS (7 Lecture Hours)
Tooling Materials- Ferrous and Non-ferrous Tooling Materials- Carbides, Ceramics and Diamond – Non-metallic tool materials. Designing with relation to heat treatment.

Reference books:

1. C. Donaldson, G. H.Lecain and V. C.Gold , Tool Design, Tata McGraw- Hill, 2007.
2. E.G.Hoffman," Jig and Fixture Design", Thomson Asia Pvt Ltd, Singapore, 2004.
3. Prakash Hiralal Joshi, "Tooling data", Wheeler Publishing, 2000.
4. Beckwith Thomas G, "Mechanical Measurements", Pearson Education, 2008.
5. Venkataraman K., "Design of Jigs, Fixtures and Presstools", TMH, 2005.

		L	T	P	C
18ME3047	**INDUSTRIAL ROBOTICS**	**3**	**0**	**0**	**3**

Course Objectives: To impart knowledge on
1. Robot configurations.
2. Sensors and transducers.
3. Actuating systems and Robot programming skills.

Course Outcomes: After completing the course the student will be able to
1. Infer the robot history and configurations.
2. Assess various components of a robot and choose the control system.
3. Compute the kinematic equations and select an actuator for robot configurations.
4. Identify the suitable sensor for a particular robot application.
5. Write a robot Program for an industrial application.
6. Identify the robot application for a unique operation.

MODULE I – AUTOMATION AND ROBOTICS CONCEPTS (7 Lecture Hours)
Basic Concepts such as Definition, three laws, DOF, Misunderstood devices etc., Elements of Robotic Systems i.e. Robot anatomy, Classification, Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device, etc. Automation - Concept, Need, Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations, introduction to automation productivity.

MODULE II – ROBOT GRIPPERS AND SENSORS (7 Lecture Hours)
Types of Grippers, Design aspect for gripper, Force analysis for various basic gripper system. Sensors for Robots:- Characteristics of sensing devices, Selections of sensors, Classification and applications of sensors. Types of Sensors, Need for sensors and vision system in the working and control of a robot.
MODULE III – CONTROL SYSTEMS AND DRIVES (9 Lecture Hours)
Types of Drives, Actuators and its selection while designing a robot system. Types of transmission systems, Control Systems -Types of Controllers, Introduction to closed loop control Control Technologies in Automation:- Industrial Control Systems, Process Industries Verses Discrete-Manufacturing Industries, Continuous Verses Discrete Control, Computer Process and its Forms. Control System Components such as Sensors, Actuators and others.
MODULE IV – KINEMATICS AND DYNAMICS (6 Lecture Hours)
Transformation matrices and their arithmetic, link and joint description, Denavit–Hartenberg parameters, frame assignment to links, direct kinematics, kinematics redundancy, kinematics calibration, inverse kinematics, solvability, algebraic and geometrical methods. Velocities and Static forces in manipulators:-Jacobians, singularities, static forces, Jacobian in force domain. Dynamics:- Introduction to Dynamics , Trajectory generations.
MODULE V – MACHINE VISION AND PROGRAMMING LANGUAGES (7 Lecture Hours)
Vision System Devices, Image acquisition, Masking, Sampling and quantisation, Image Processing Techniques, Noise reduction methods, Edge detection, Segmentation. Robot Programming:- Methods of robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Introduction to various types such as RAIL and VAL II etc, Features of type and development of languages for recent robot systems.
MODULE VI – PLANT AUTOMATION AND ARTIFICIAL INTELLIGENCE (9 Lecture Hours)
Introduction, need for system Modeling, Building Mathematical Model of a manufacturing Plant, Modern Tools- Artificial neural networks in manufacturing automation, AI in manufacturing, Fuzzy decision and control, robots and application of robots for automation. Artificial Intelligence:- Introduction to Artificial Intelligence, AI techniques, Need and application of AI. Other Topics in Robotics:- Socio-Economic aspect of robotisation. Economical aspects for robot design, Safety for robot and associated mass, New Trends & recent updates in robotics.

Reference Books:

1. Mikell P. Grooveret. Al., Industrial Robotics: Technology, Programming and Applications, McGraw – Hill International, 1986.
2. Ibrahim Zeid, "CAD/CAM Theory and Practice", McGraw Hill, 2003.
3. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic Engineering - An Integrated Approach", Prentice Hall India, 2002Raymond A Higgins "Engineering Materials (Applied Physical Metallurgy) English Language book, society, 2003.
4. John J. Craig, "Introduction to Robotics: Mechanics and Control", by Pearson India, ISBN: 9788131718360, 8131718360. Edition: 3rd Edition, 2008.
5. Industrial Automation: W.P. David, John Wiley and Sons.

		L	T	P	C
18ME3048	**ADVANCED MACHINE DESIGN**	**3**	**0**	**0**	**3**

Course Objectives: To impart knowledge on
1. Applications and design of mechanical system elements.
2. Applying the design concept in product design and development.
3. Using standard data's for design of machine components.

Course Outcomes: After completing the course the student will be able to
1. Understand the design principles of mechanical systems.
2. Design the machine elements and systems.
3. Design the material handling equipment.
4. Learn about construction, working principle and design of the conveyor systems.
5. Select appropriate machine elements for mechanical systems.
6. Design and develop new products which can be used in mechanical systems.

MODULE I – MATERIAL HANDLING EQUIPMENTS (7 Lecture Hours)
Types, Selection and applications, Method for determining stresses-Terminology and ligament efficiency-application.
MODULE II – STRESSES IN PRESSURE VESSELS (8 Lecture Hours)
Stresses in a circular ring, cylinder-Membrane stress analysis of vessels shell components-Cylinder shells, to spherical heads, conical heads-Thermal stresses, Dis-continuity stresses in pressure vessels.
MODULE III– DESIGN OF PRESSURE VESSELS (8Lecture Hours)
Design of tall cylinder self-supporting process columns-Supports for short vertical vessels Stress concentration at a variable thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of reinforcement.
MODULE IV – DESIGN OF AUTOMOTIVE TRANSMISSION SYSTEM (7 Lecture Hours)
Clutches – power transmitted brake – Brakes: Shoe, band and cone types. Cams – Multispeed gear box - Design of arresting gear.
MODULE V – DESIGN OF HOISTING ELEMENTS (8 Lecture Hours)
Welded and roller chains-Hemp and wire ropes. –Design of ropes, pulleys, pulley system, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks crane grabs-lifting magnets-Grabbing Attachments.
MODULE VI – CONVEYORS (7 Lecture Hours)
Types-description-Design and applications of belt conveyors, apron conveyors and escalators, pneumatic conveyors, screw conveyors and vibratory conveyors.

Reference Books:

1. Richard G. Budynas, J. Keith Nisbett, “Shigley’s Mechanical Engineering Design”, McGraw Hill, 2016.
2. John.F.Harvey, “Theory & Design of Pressure Vessels”, “CBS Distributors”, 2014.
3. Rudenko.N, “Materials Handling Equipments”, Elnvee Publishers, 2011.
4. Prabhu. T.J., “Design of Transmission Elements”, Mani Offset, Chennai, 2000.
5. Henry.H.Bedner “Pressure Vessels”, Design Hand Book, CBS Publishers & Distributors, 1987.

18ME3049	ADVANCED STRENGTH OF MATERIALS	L	T	P	C
		3	0	0	3

Course Objective: To impart knowledge on
1. Understanding of advanced topics concerning the response of materials and structural elements to applied forces of deformation.
2. Material behaviour under various stress conditions.
3. Stresses in the material for various shape and loading conditions.

Course Outcomes: After completing the course the student will be able to
1. Apply concepts in stress, displacement, and transformations to 2d, and 3d solids under load.
2. Apply concepts in elasticity for calculating strength on components subjected to concentrated loads.
3. Determine strength, predict failure, and incorporate design considerations in shafts and beams.
4. Determine stresses in open and closed sections in torsion and bending of standard sections.
5. Apply stress functions, and calculate stresses in plates and shells, thick circular cylinders, and discs.
6. Apply and use energy methods to find force, stress, and displacement in simple structures.

MODULE I – ANALYSIS OF STRESS AND STRAIN (8 Lecture Hours)
Introduction-Definition and Components of Stress-internal Force-Resultant and Stress Relations- -Stress Transformation- Principal Stresses and Maximum In-Plane Shear Stress-Mohr’s Circle for Two-Dimensional Stress-Three-Dimensional Stress Transformation-Principal Stresses in Three Dimensions-Geometry of contact surfaces, method of computing contact stresses and deflection of bodies in point

contact. Deformation-Strain Defined-Equations of Compatibility-State of Strain at a Point-Measurement of Strain: Strain Rosettes.

MODULE II – PROBLEMS IN ELASTICITY (7 Lecture Hours)

Introduction-Plain Elastic Problems-Governing Equations- Conversion between plane stress and plane strain problems-Airy's Stress Function-Solution of Elasticity Problems-Thermal Stresses-Basic Relations in Polar Coordinates-Stresses Due to Concentrated Loads- Stress Distribution Near Concentrated Loads-Stress Concentration Factors.

MODULE III – FAILURE CRITERIA (8 Lecture Hours)

Introduction-Failure-Failure by Yielding-Failure by Fracture-Yield and Fracture Criteria-Maximum Shearing Stress Theory-Maximum Distortion Energy Theory-Octahedral Shearing Stress Theory-Comparison of Yielding Theories-Maximum Principal Stress Theory-Mohr's Theory-Coulomb-Mohr Theory-Fracture Mechanics-Fracture Toughness-Failure Criteria for Metal Fatigue-Impact or Dynamic Loads-Dynamic and Thermal Effects.

MODULE IV – TORSION OF PRISMATIC BARS (8 Lecture Hours)

Introduction-Elementary Theory of Torsion of -Stresses on Inclined Planes-General Solution of the Torsion Problem-Prandtl's Stress Function-Prandtl's Membrane Analogy-Torsion of Narrow Rectangular Cross Section-Torsion of Multiply Connected Thin Walled Sections-Fluid Flow Analogy and Stress Concentration-Torsion of Restrained Thin-Walled Members of Open Cross Section.

MODULE V – APPLICATIONS OF ENERGY METHODS (7 Lecture Hours)

Introduction-Work Done in Deformation-Strain Energy-Components of Strain Energy-Saint-Venant's Principle-Reciprocity Theorem-Castigliano's First Theorem-Complementary Energy Theorem-Castigliano's Second Theorem-Statically Indeterminate Systems-Principle of Virtual Work-Principle of Minimum Potential Energy-Rayleigh-Ritz Method.

MODULE V1 – UNSYMMETRICAL BENDING AND SHEAR CENTRE (7 Lecture Hours)

Concept of shear center in symmetrical and unsymmetrical bending, stress and deflections in beams subjected to unsymmetrical bending, shear center for thin wall beam cross section, open section with one axis of symmetry, general open section, and closed section.

Reference Books:

1. R. G. Budynas, "Advanced Strength and Applied Stress Analysis", 2nd Edition, McGraw Hill Education (India) Pvt ltd., 2013
2. L. S. Srinath, "Advanced Mechanics of Solids", 2nd Edition, TMH Publishing Co. Ltd., New Delhi, 2003.
3. Ferdinand P. Beer, E. Russell Johnston, John T. DeWolff and David F. Mazurek Mechanics of Materials, 5th ed. in SI Units, McGraw-Hill, 2009.
4. Boresi, Arthur P. and Schmidt, Richard J., Advanced Mechanics of Materials, 6th Ed., John Wiley & Sons, 2003.
5. Young, Warren C. and Budynas, Richard G., Roark's Formulas for Stress and Strain, 7th Ed., McGraw-Hill, 2002.

18ME3050	ENGINEERING FRACTURE MECHANICS	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Stress and strain field around a crack in a body for different fracture modes.
2. Factors governing crack growth, crack arrest and fatigue.
3. The applications of fracture mechanics.

Course Outcomes: After completing the course the student will be able to

1. Estimate stress and strain field around a crack.
2. Understand plastic material behavior around the crack tip.
3. Estimate the fracture toughness value of a material for various fracture modes.
4. Design of components that contain crack under static and fatigue load condition.
5. Provide solution to prevent crack growth and fatigue failures.
6. Analyze of fatigue crack propagation using empirical methods.

MODULE I – ELEMENTS OF SOLID MECHANICS (8 Lecture Hours)
The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation – limit analysis – Airy's function – field equation for stress intensity factor
MODULE II –STATIONARY CRACK UNDER STATIC LOADING (8 Lecture Hours)
Two dimensional elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation - plastic zone size – Dugdaale model – determination of J integral and its relation to crack opening displacement.
MODULE III – ENERGY BALANCE AND CRACK GROWTH (8 Lecture Hours)
Griffith analysis – stable and unstable crack growth – Dynamic energy balance – crack arrest mechanism –K1c test methods - R curves – determination of collapse load
MODULE IV – FATIGUE CRACK GROWTH (7 Lecture Hours)
Empirical relation describing crack growth law – life calculations for a given load amplitude –effects of changing the load spectrum -- rain flow method– external factors affecting the KIC values.- leak before break analysis.
MODULE V – TESTING METHODS FOR DETERMING CRACK GROWTH (7 Lecture Hours)
Test methods for determining critical energy, release rate, critical stress intensity factor, J-Integral.
MODULE VI – APPLICATIONS OF FRACTURE MECHANICS (7 Lecture Hours)
Crack Initiation under large scale yielding – thickness as a design parameter – mixed mode fractures - crack instability in thermal and residual stress fields - numerical methods

Reference Books:

1. Brook D, "Elementary engineering fracture mechanics", 2009.
2. Prashant Kumar, "Elements of Fracture Mechanics", Tata McGraw-Hill,2009
3. T.L. Anderson, "Fracture mechanics fundamentals and applications", CRC Press, 2005.
4. R.W. Hertzberg, "Deformation and Fracture Mechanics of Engineering Materials", Wiley, 2014
5. TribikramKundu, "Fundamentals of Fracture Mechanics", CRC, Press, 2012.

18ME3051	ADVANCED MECHANISM DESIGN	L 3	T 0	P 0	C 3

Course Objectives: To impart knowledge on
1. The fundamentals of a mechanism and machines.
2. Kinematics of a mechanism.
3. Forces in the joints and links of a mechanism and a robot.

Course Outcomes: After completing the course the student will be able to
1. Identify the type and find degree of freedom of a given mechanism.
2. Conduct kinematic analysis of a mechanism.
3. Apply the path curvature theories in the analysis of a mechanism.
4. Synthesis of a mechanism for a given application.
5. Investigate forces in the joints and links of a mechanism.
6. Employ the capabilities of a robot in design.

MODULE I – INTRODUCTION (8 Lecture Hours)
Review of fundamentals of kinematics- mobility analysis- formation of one degree of freedom. Multiloop kinematic chains, Network formula- Gross motion concepts. Kinematic Analysis: Position Analysis- Vector loop equations for four bar, slider crank, inverted slider crank, geared five bar and six bar linkages. Analytical methods for velocity and acceleration. Analysis - four bar linkage - Jerk analysis. Plane Complex mechanisms**.**
MODULE II – PATH CURVATURE THEORY (8 Lecture Hours)
Fixed and moving centroids, inflection points and inflection circle. Euler Savary equation, Bobilier's construction - Cubic of stationary curvature.
MODULE III – SYNTHESIS OF MECHANISMS (8 Lecture Hours)
Type synthesis- Number synthesis- Associated Linkage concept. Dimensional synthesis –function generation, path generation, motion generation, Graphical methods. Cognate linkage- coupler curve

synthesis, Design of six-bar mechanisms. Algebraic methods. Application of instant center in linkage design. Cam Mechanisms- determination of optimum size of Cams.

MODULE IV – DYNAMICS OF MECHANISMS (7 Lecture Hours)

Static force analysis with friction – inertia force analysis- combined static and inertia force analysis, shaking force, kinetostatic analysis. Introduction to force and moment balancing of linkages.

MODULE V – COUPLER CURVES (7 Lecture Hours)

Equation of coupler curve, Robert-Chebychev theorem, double points and symmetry.

MODULE VI – SPATIAL MECHANISM AND ROBOTICS (7 Lecture Hours)

Introduction, topology arrangements of robotics arms, Kinematic Analysis of spatial mechanism. Denavait- Hartenberg parameters, Forward and inverse kinematic of Robotic manipulators. Study of mechanism using simulation software packages.

Reference Books:

1. Uicker J.J., Pennock G.R., and Shigley J. E. "Theory of Mechines and Mechanism", Oxford International Student Edition, 3rd Editon 2009".
2. Robert L.Nortan ,"Design of Machinery',Tata McGraw Hill Edition, 2007.
3. R.W. Hertzberg, "Deformation and Fracture Mechanics of Engineering Materials", Wiley, 2014
4. Amitabha Ghosh and Ahsok Kumar Mallik, "Theory of mechanism and Machines", EWLP, Delhi, 1999.
5. David Myszka, "Machines and Mechanisms: Applied Kinematic Analysis", 4th Edition, Pearson, 2012.

18ME3052	TRIBOLOGY IN DESIGN	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Application of basic theories of friction, wear and lubrication.
2. Frictional behavior of commonly encountered sliding interfaces.
3. Various testing methods for tribological properties.

Course Outcomes: After completing the course the student will be able to

1. Apply concepts of friction mechanisms and analyze performance of design components based on relative motion.
2. Identify wear mechanism on macro-scale in metals.
3. Recombined lubrications based on the type of lubrication.
4. Outline the methods to improve surface engineering.
5. Generate performance reports of the lubrications using tribo testing methods.
6. Understand the fundamentals of tribology and associated parameters.

MODULE I – FRICTION (8 Lecture Hours)

Friction – Adhesion – Ploughing – Energy dissipation mechanisms Friction Characteristics of metals – Friction of non-metals. Friction of lamellar solids – friction of Ceramic materials and polymers – Rolling Friction – Source of Rolling Friction – Stick slip motion – Measurement of Friction.

MODULE II – WEAR (8 Lecture Hours)

Types of wear – Simple theory of Sliding Wear. Mechanism of sliding wear of metals – Abrasive wear – Materials for Adhesive and Abrasive wear situations – Corrosive wear – Surface Fatigue wear situations – Brittle Fracture – wear – Wear of Ceramics and Polymers – Wear Measurements.

MODULE III – LUBRICANTS, FILM LUBRICATION THEORY AND LUBRICATION TYPES (8 Lecture Hours)

Types and properties of – Hydrodynamic Lubrication – Elasto–hydrodynamic lubrication – Boundary Lubrication – Solid Lubrication– Hydrostatic Lubrication. Fluid film in simple shear – Viscous flow between very close parallel plates – Shear stress variation Reynolds Equation for film Lubrication – High speed unloaded journal bearings – Loaded journal bearings – Reaction torque on the bearings – Virtual Co–efficient of friction.

MODULE IV – SURFACE ENGINEERING AND MATERIALS FOR BEARINGS (8 Lecture Hours)
Topography of Engineering surfaces – Contact between surfaces – Sources of sliding Surface modifications – Thermo chemical processes – Surface coatings – Plating and anodizing – Fusion Processes – Vapour Phase processes – Materials for marginally lubricated and dry bearings.
MODULE V – DYNAMIC TRIBOLOGY AND TESTING METHODS (7 Lecture Hours)
Dynamic testing machines and test methods, dry sand–rubber wheel test.
MODULE VI – TRIBOLOGY TESTING METHODS (7 Lecture Hours)
Wet sand rubber wheel test, slurry abrasivity test, solid particle erosion test, pin–on–disk wear test, rolling wear test, drum wear test, drill wear test. Lubricants, testing methods - Four ball tribo test.

Reference books:

1. PrasantaSahoo, "Engineering Tribology", Prentice Hall of India, 2005.
2. Sushil Kumar Srivastava, "Tribology in Industries", S. Chand Publishers, 2005.
3. Stachowiak G. W. and Batchelor A. W., Engineering Tribology, 3rd Edition (Indian), Butterworth-Heinnmann (Elsevier), 2010
4. A. Cameron, "Basic Lubrication Theory", Longman, U.K., 2011.
5. B. Bhushan, "Principles and Application of Tribology", Wiley, 2013.

18ME3053	ROTOR DYNAMICS	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Rotor dynamics phenomena with the help of simple rotor models
2. Behavior of fluid film lubrication and rotor bearing system in rotor system
3. Performance of bearings under dynamic conditions

Course Outcomes: After completing the course the student will be able to
1. Apply the principles of rotor dynamics in design and analysis of mechanical components
2. Analyze the bearing behavior under dynamic conditions
3. Acquire knowledge in rotor balancing.
4. Measure vibration and conduct dynamic analysis in rotating machine elements
5. Model a rotating machine element theoretically
6. Study the effect of vibration in rotating machinery

MODULE 1 – INTRODUCTION (8 Lecture Hours)
Brief history of rotor dynamics - overview of rotor dynamics phenomena and Recent trends - development of rotor dynamics analysis tools - software for rotor dynamic analysis - different rotor models - Torsional vibrations in rotating machinery - Equation of motion - Problems in torsional vibration - single and multiple rotor system - Transfer Matrix Methods for Torsional Vibration.
MODULE II – INSTABILITY IN ROTATING MACHINES (8 Lecture Hours)
Oil whip and Oil whirl - stability analysis using linearized stiffness and damping coefficients - Instability due to stream whirl and seals - Theory of Balancing of Rotors - Rigid rotor classification - Balancing criteria - Balancing of rigid rotors -Balancing of flexible rotors - Balance criteria for flexible rotors
MODULE III – ROTOR MODELS (8 Lecture Hours)
Single DOF un damped rotor model for both free and forced vibration - single DOF damped rotor model - attenuation of vibration - Rankine rotor model - Jeffcott rotor model - simple rotor systems with Gyroscopic effects - synchronous motion, asynchronous rotational motion - Asynchronous General Motion - Gyroscopic Effects by the Dynamics Approach
MODULE IV – BEARING IN ROTORS (7 Lecture Hours)
Rolling element bearings - Hydrodynamic oil lubricated journal bearing - types of hydrodynamic bearing - Reynolds equation and its basic assumptions - Basic concepts and assumptions of fluid - film bearing models - Short and long hydrodynamic radial bearings - Dynamic characteristics of fluid - film bearings - Dynamic seals and its classifications.

MODULE V – ROTOR VIBRATION AND CRITICAL SPEEDS (7 Lecture Hours)
Rotor vibration and Rotor critical speeds - support stiffness on critical speeds - Stiffness and damping coefficients of journal bearings - computation and measurements of journal bearing coefficients - Mechanics of Hydro dynamic Instability

MODULE VI – SIGNAL PROCESSING AND CONDITION MONITORING IN ROTOR DYNAMICS (7 Lecture Hours)
Vibration generating mechanism - Condition monitoring - Noise spectrum - Signal processing in rotating machineries - Measurements in rotating machineries - Real time analysis & Knowledge based (data base) - Expert systems - Display of vibration measurement instruments - Signature Analysis of Common Rotor Faults - Signature Analysis of Common Rotor Faults.

Reference Books:

1. Rao J.S., 'Rotor Dynamics', New Age International, New Delhi, 2012.
2. Genta G., 'Dynamics of Rotating Systems', Springer, New York, 2005.
3. Muszynska A., 'Rotor dynamics', Series: Dekker Mechanical Engineering, Vol. 188, CRC Press, 2005.
4. Robert B.M., 'Rotating Machinery: Practical Solutions to Unbalance and Misalignment', CRC Press, 2003.
5. Rao J.S., 'Vibratory Condition Monitoring of Machines', Narosa Publishing House, New Delhi, 2000.

18ME3054	OPTIMIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. The need and origin of the optimization methods.
2. The various applications of optimization methods used in engineering.
3. Optimization of various components

Course Outcomes: After completing the course the student will be able to

1. Outline the importance of optimization of industrial process management.
2. Apply basic concepts of mathematics to formulate an optimization problem
3. Analyze and appreciate variety of performance measures for various optimization problems
4. Select engineering minima/maxima problems into optimization framework
5. Develop an efficient computational procedures to solve optimization problems.
6. Developing skill for formulating and solving the engineering optimization problems

MODULE I – INTRODUCTION TO OPERATION RESEARCH (8 Lecture Hours)
Operation Research approach, scientific methods, introduction to models and modeling techniques, general methods for Operation Research models, methodology and advantages of Operation Research, history of Operation Research.

MODULE II – LINEAR PROGRAMMING (8 Lecture Hours)
Introduction to Linear Programming and formulation of Linear Programming problems, Graphical solution method, alternative or multiple optimal solutions, Unbounded solutions, Infeasible solutions, Maximization – Simplex Algorithm, Minimization – Simplex Algorithm using Big-M method, Two phase method, Duality in linear programming, Integer linear programming.

MODULE III – TRANSPORTATION & ASSIGNMENT PROBLEM (7 Lecture Hours)
Introduction to Transportation problems, various methods of Transportation problem, Variations in Transportation problem, introduction to Assignment problems, variations in Assignment problems.

MODULE IV – NETWORK ANALYSIS (7 Lecture Hours)
Network definition and Network diagram, probability in PERT analysis, project time cost trade off, introduction to resource smoothing and allocation.

MODULE V – SEQUENCING (7 Lecture Hours)
Introduction, processing N jobs through two machines, processing N jobs through three machines, processing N jobs through m machines. Introduction to inventory control, deterministic inventory model, EOQ model with quantity discount.

MODULEVI – QUEUING MODELS **(8 Lecture Hours)**

Concepts relating to queuing systems, basic elements of queuing model, role of Poison & exponential distribution, concepts of birth and death process. Replacement of items, subject to deterioration of items subject to random failure group vs. individual replacement policies. Introduction & steps of simulation method, distribution functions and random number generation.

Reference Books:

1. K Sharma, Operations Research Theory and Applications, MacMillan India Ltd. 2016
2. N D Vohra, Quantitative Techniques in management, Tata McGraw Hill, 2011.
3. Handy A Taha, Operations Research – An Introduction, Prentice Hall of India, New Delhi, 2008.
4. Hillier F S and Lieberman G J, Operations Research, Holden Day Inc., San Francisco, 2009.
5. Payne T A, Quantitative Techniques for Management: A Practical Approach, Reston Publishing Co. Inc., Virginia, 2012.

18ME3055	CONDITION BASED MONITORING	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Health monitoring and condition monitoring of structures and machines.
2. Basics of signal processing and various types of signals.
3. Basics of Vibration Systems, vibration analysis and condition monitoring.

Course Outcomes: After completing the course the student will be able to

1. Explain the aim and the basics of CM
2. Appreciate and understand the basic idea behind vibration-based structural health
3. Monitor the vibration-based condition monitoring, and to know the general stages of CM.
4. Apply some basic techniques for analysis of random and periodic signals
5. Identify the basic instrumentation used for machinery and structural vibration-based monitoring
6. Aware of some basic faults in rotating machinery, their manifestation and methods for detection and recognition.

MODULE I – HEALTH MONITORING **(8 Lecture Hours)**

The basic idea of health monitoring and condition monitoring of structures and machines. Some basic techniques.

MODULE II – SIGNAL PROCESSING **(8 Lecture Hours)**

Basics of signal processing: Study of periodic and random signals, probability distribution, statistical properties, auto and cross correlation and power spectral density functions of commonly found systems, spectral analysis

MODULE III – FOURIER TRANSFORM **(8 Lecture Hours)**

Fourier transform: the basic idea of Fourier transform, interpretation and application to real signals. Response of linear systems to stationary random signals: FRFs, resonant frequencies, modes of vibration.

Module IV – VIBRATION-BASED MONITORING **(7 Lecture Hours)**

Introduction to vibration-based monitoring, Machinery condition monitoring by vibration analysis: Use and selection of measurements, analysis procedures and instruments.

MODULE V – APPLICATIONS OF CONDITION MONITORING **(7 Lecture Hours)**

Typical applications of condition monitoring using vibration analysis to rotating machines.

MODULE VI – SPECIAL TYPES OF HEALTH MONITORING TECHNIQUES (7 Lecture Hours)

Special types of health monitoring techniques, acoustic emission, oil debris and temperature analysis, Applications.

Reference Books

1. M.Adams, rotating machinery analysis - from analysis to troubleshooting, Marcel Dekker, New York, 01, ISBN 0-8247-0258-1.

2. Cornelius Scheffer Paresh Girdhar, Practical Machinery Vibration Analysis and Predictive Maintenance, Newnes, 1st Edition, 04, Paperback ISBN: 9780750662758

18ME3056	MULTI-BODY DYNAMICS	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. Equation of motion for the bodies
2. Differential equations for multi-body dynamics
3. Intellectual skill to incorporate in the project and presentation

Course Outcomes: After completing the course the student will be able to

1. Derive equations of motion for interconnected bodies in multi-body systems with three dimensional motion.
2. Implement and analyze methods of formulating equations of motion for interconnected bodies.
3. Write programs to solve constrained differential equations for analyzing multi-body systems.
4. Simulate and analyze all types of static and dynamic behaviors of the multi-body systems including the kineto-static analysis.
5. Lead team projects in academic research or the industry that require modeling and simulation of multi-body systems.
6. Demonstrate an improved technical writing and presentation skills.

MODULE I – INTRODUCTION (8 Lecture Hours)

The method of constraints for planar kinematic analysis. Revolute, prismatic, gear and cam pairs are considered together with other 2 degrees-of-freedom types of constraints.

MODULE II – BASIC PRINCIPLES FOR ANALYSIS OF MULYI-BODY SYSTEMS (8 Lecture Hours)

The automatic assembly of the systems of equations for position, velocity and acceleration analysis. Iterative solution of systems of nonlinear equations. Geometry of masses. The principle of virtual work and Lagrange's equations.

MODULE III – DYNAMICS OF PLANAR SYSTEMS (8 Lecture Hours)

Dynamics of planar systems. Systematic computation and assembly of mass matrix. Computation of planar generalized forces for external forces and for actuator-spring-damper element. Simple applications of inverse and forward dynamic analysis. Numerical integration of first-order initial value problems. The method of Baumgartner for the solution of mixed differential-algebraic equations of motion. The use of coordinates partitioning, QR and SVD decomposition for the orthogonalization of constraints.

MODULE IV – KINEMATICS OF RIGID BODIES IN SPACE (7 Lecture Hours)

Reference frames for the location of a body in space. Euler angles and Euler parameters. Formula of Rodrigues. Screw motion in space. Velocity, acceleration and angular velocity. Relationship between the angular velocity vector and the time derivatives of Euler parameters

MODULE V – KINEMATIC ANALYSIS OF SPATIAL SYSTEM (7 Lecture Hours)

Basic kinematic constraints. Joint definition frames. The constraints required for the description in space of common kinematic pairs (revolute, prismatic, cylindrical, and spherical). Equations of motion of constrained spatial systems.

MODULE VI – COMPUTATION OF FORCES (7 Lecture Hours)

Computation of spatial generalized forces for external forces and for actuator-spring-damper element. Computation of reaction forces from Lagrange's multi- pliers.

Reference Books:

1. De Jalo n, J.C., Bayo, E., Kinematic and Dynamic Simulation of Multibody Systems, Springer-Verlag, 2004.
2. Schielen, W. ed., Multibody Systems Handbook, Springer-Verlag, Berlin, 2001.
3. Huston, R.L., Multibody Dynamics, Butterworth-Heinemann, 2009.
4. Haug, E.J., Computer-Aided Kinematics and Dynamics of Mechanical Systems-Basic Methods, Allyn and Bacon, 2003.

5. Roberson, R.E., Schwertassek, R., Dynamics of Multibody Systems, Springer-Verlag, Berlin, 2009.

18ME3057	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		2	0	0	2

Course Objectives: To impart knowledge on
1. Principles of academic and scientific research
2. Literature Review and Research ethics
3. Principles and practices of IPR

Course Outcomes: After completing the course the student will be able to
1. Understand research problem formulation.
2. Review the relevant literature
3. Analyze research related information
4. Follow research ethics
5. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
6. Understand that when IPR would take such important place in growth of individuals & nation,

MODULE I – INTRODUCTION (7 Lecture Hours)
Meaning of research problem, Sources of research problem, Criteria. Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

MODULE II – LITERATURE REVIEW (7 Lecture Hours)
Effective literature studies approaches, analysis Plagiarism, Research ethics and Research principles

MODULE III – TECHNICAL WRITING (7 Lecture Hours)
Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and
Assessment by a review committee

MODULE IV – IPR (8 Lecture Hours)
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

MODULE V – PATENTS (8 Lecture Hours)
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

MODULE VI – NEW DEVELOPMENTS IN IPR (8 Lecture Hours)
Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Reference Books:
1. Stuart Melville and Wayne Goddard,"Research methodology: an introduction for science& engineering students"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.

18ME3058	BUSINESS ANALYTICS	L	T	P	C
		3	0	0	3

Course objectives: To impart knowledge on
1. Understand the role of business analytics and analyze data using statistical techniques.
2. Formulate and solve business problems using decision-making tools.
3. Manage business process using analytical and management tools.

Course Outcomes: After completing the course the student will be able to

1. Understand the concept of business analytics.
2. Model and solve business problems using regression analysis.
3. Apply technical skills in predicative and prescriptive modeling.
4. Understand the forecasting techniques, Monte Carlo simulation and risk analysis
5. Analyze and solve business problems using decision-making tools
6. Understand recent trends in Embedded and collaborative business intelligence.

MODULE I – BUSINESS ANALYTICS (8 Lecture Hours)
Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

MODULE II – TRENDINESS AND REGRESSION ANALYSIS (7 Lecture Hours)
Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

MODULE III – VARIOUS TECHNIQUES IN BUSINESS ANALYTICS (7 Lecture Hours)
Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

MODULE IV – FORECASTING TECHNIQUES, MONTE CARLO SIMULATION AND RISK ANALYSIS (8 Lecture Hours)
Forecasting Techniques, Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

MODULE V – DECISION ANALYSIS (8 Lecture Hours)
Formulating Decision Problems, Decision Strategies with the Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

MODULE VI – RECENT TRENDS (8 Lecture Hours)
Recent trends in Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

Reference Books:

1. 1.Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Business analytics Principles, Concepts, and Applications, Pearson FT Press, 2015.
2. James Evans, Business Analytics, persons Education, 2016.

18ME3059	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on

1. Recognition, investigation, analysis, and control of hazards.
2. Management's role in safety and assess the importance
3. Multiple hazards associated with welding

Course Outcomes: After completing the course the student will be able to

1. Apply the basic concepts and scope of engineering safety.
2. Implement the standards of professional conduct that are published by professional safety organizations andcertification bodies.
3. Illustrate the importance of safety of employees while working with machineries
4. Express Safety in terms of Risk and to recognize unacceptable/inappropriate levels of Risk

5. Identify hazards arising from runaway reactions, explosions and fires
6. Suggest the various methods to prevent the hazards working with machineries

MODULE I – SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES (7 Lecture Hours)
General safety rules, Occupational Safety and Health act of USA– OSHAS 18000 – ISO 14000 – Benefits and Elements principles, maintenance, Inspections of manufacturing machines, hazards, Risks. Applications of ergonomic principles in the shop floor.
MODULE II – PRINCIPLES OF MACHINE GUARDING: GUARDING DURING MAINTENANCE (8 Lecture Hours)
Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding of hazards – point of operation protective devices.
MODULE III – SAFETY IN WELDING AND GAS CUTTING (8 Lecture Hours)
Gas welding and oxygen cutting, resistances welding, arc welding and cutting, personal protective equipment, training, safety precautions during welding.
MODULE IV – SAFETY IN COLD FORMING AND HOT WORKING OF METALS (7 Lecture Hours)
Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism.
MODULE V – SAFETY IN FINISHING (7 Lecture Hours) Heat treatment operations, electro plating, paint shops, sand and shot blasting industries.
MODULE VI - INSPECTION AND TESTING (8 Lecture Hours) Safety in inspection and testing, dynamic balancing, hydro testing. Applicable standards in Industrial safety management.

Reference books:

1. Philip E. Hagan, John Franklin Montgomery, James T. O'Reilly "Accident Prevention Manual" NSC, Chicago, 2009.
2. Charles D. Reese, "Occupational Health and Safety Management", CRC Press, 2015.
3. John Davies, Alastair Ross, Brendan Wallace, Safety Management: A Qualitative Systems Approach, CRC Press, 2003.
4. Accident Prevention Manual, National Safety Council (NSC), Chicago, 1982. 2. Occupational safety Manual, BHEL, Trichy, 1988.
5. John V. Grimaldi and Rollin H. Simonds, Safety Management, All India Travelers Book Seller, New Delhi, 1989.
6. N.V. Krishnan, Safety in Industry, JaicoPublishery House, 1996.
7. Indian Boiler Acts and Regulations, Government of India, 2007.

18ME3060	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. Linear Programming techniques.
2. Job sequencing problems, Transportation and assignment problems.
3. Inventory models, PERT/CPM and Queuing theory.

Course Outcomes: After completing the course the student will be able to
1. Correlate this subject knowledge with the engineering problems.
2. Construct flexible appropriate mathematical model to represent physical problem
3. Schedule their engineering projects by using network analysis
4. Analyze the transportation problem and optimize the resources and output
5. Apply their knowledge in solving their engineering queuing problems.
6. Develop their skills in decision making analysis by allocation of resources

MODULE I – LINEAR PROGRAMMING PROBLEM (9 Lecture Hours)
Formulation of LPP – Graphical Method – Simplex Method –Artificial variable technique and two phase simplex method. Duality – Dual and simplex method – Dual Simplex Method – Sequencing: Job sequencing – n jobs through two machines and three machines

MODULE II – TRANSPORTATION PROBLEM (9 Lecture Hours)
Transportation Model, finding initial basic feasible solutions using least cost method, Vogells's approximation method and North–West corner method, moving towards optimality through MODI method, Resolving degeneracy in transportation.
MODULE III – ASSIGNMENT PROBLEM (8 Lecture Hours)
Solution of an Assignment problem, Multiple Solution, Hungarian Algorithm, Maximization in Assignment Model, Impossible Assignment.
MODULE IV – NETWORK ANALYSIS (9 Lecture Hours)
Network diagram – probability of achieving completion date – crash time –cost analysis – PERT & CPM-Forward and backward scheduling.
MODULE V – INVENTORY MODELS (9 Lecture Hours)
Economic order quantity models-purchase models with and without shortage, production models with and without shortage-ABC analysis-Two Bin system.
MODULE VI – QUEUING MODELS (9 Lecture Hours)
Structure of queuing models-Attributes and components of queuing models-application of queuing models- Kendall's Notation -Single service channel with finite and infinite queue size - Single service channel with finite and infinite population size

Reference books:

1. S. Bhaskar, "Operations Research", Anuradha Agencies, Chennai 2013
2. Natarajan A.M., Balasubramani P., Thamilarasi A., "Operations Research", Pearson Education, 1st Edition, 2014.
3. HamdyTaha A., "Operations Research", 6th Edition Prentice – Hall of India Private Limited, New Delhi, 2010.
4. KantiSwarup, Manmohan, Gupta P.K., "Operations Research" Sultan Chand & Sons., 14th Edition 2014.
5. Srinivasan G., "Operations Research", Prentice – Hall of India Private Limited, New Delhi, 2010.

18ME3061	COST MANAGEMENT OF ENGINEERING PROJECTS	L	T	P	C
		3	0	0	3

Course Objectives: To impart knowledge on
1. The concept of cost management process and projects
2. Project cost and materials.
3. Budgetary Control and quantitative techniques for cost management.

Course Outcomes: After completing the course the student will be able to
1. Identify various costs.
2. Understand the elements of engineering project.
3. Analyze and control project cost.
4. Understand various cost management techniques.
5. Analyze and control Budget.
6. Apply quantitative techniques for cost management.

MODULE I – INTRODUCTION TO STRATEGIC COST MANAGEMENT PROCESS (8 Lecture Hours)
Cost concepts in decision-making; relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.
MODULE II – ENGINEERING PROJECT (7 Lecture Hours)
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts, Types and contents. Project execution, Bar charts and Network diagram, Project commissioning.

MODULE III – PROJECT COST CONTROL (8 Lecture Hours)
Mechanical and process Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Standard Costing and Variance Analysis, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing, Costing of service sector.
MODULE IV – COST MANAGEMENT TECHNIQUES (7 Lecture Hours)
Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis.
MODULE V – BUDGETARY CONTROL (7 Lecture Hours)
Budgetary Control, Flexible Budgets, Performance budgets, Zero-based budgets, Measurement of Divisional profitability pricing decisions including transfer pricing.
MODULE VI – QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT (8 Lecture Hours)
Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Text Books:

1. Charles T. Horngren, George Foster, Srikant M. Datar, Madhav V. Rajan, Chris M. Ittner, Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2008.
2. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, Prentice Hall, 2003.

Reference Books:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 2005.
2. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007.

18ME3062	COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

Objectives: To impart knowledge on
1. Composite materials and their applications.
2. Fabrication, analysis, and design of composite materials and structures.
3. Prediction of the mechanical response of multi layered materials and structures.

Course Outcomes: After completing the course the student will be able to
1. Predict elastic properties of composites and
2. Predict mechanical properties of fiber reinforced composite materials.
3. Design a composite laminate for a given load condition.
4. Describe fundamental fabrication processes for polymer matrix composites.
5. Analyze the stresses using laminated plate theories.
6. Compare and contrast different processes of manufacture of polymer composites.

MODULE I – INTRODUCTION COMPOSITES (7 Lecture Hours)
Definition – need- General Characteristics, applications, Fibers- Glass, Carbon, Ceramic and Aramid fibers. Matrices- polymer, Graphite, Ceramic and Metal Matrices- Characteristics of fibers and matrices. Smart Materials- type and Characteristics
MODULE II – MECHANICS AND PERFORMANCE (7 Lecture Hours)
Characteristics of fiber-reinforced lamina-laminates-interlaminar stresses – Static Mechanical properties- Fatigue and Impact properties- Environmental Effects - Fracture behaviour and Damage Tolerance.
MODULE III – POLYMER MATRIX COMPOSITES (8 Lecture Hours)
PMC processes - Hand lay up processes – Spray up processes – Compression moulding – Reinforced reaction injection moulding - Resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fibre reinforced plastics (FRP), Glass fibre reinforced plastics (GRP).
MODULE IV – METAL MATRIX COMPOSITES (8 Lecture Hours)

Characteristics of MMC, Various types of Metal matrix composites Alloy vs. MMC, Advantages of MMC, Limitations of MMC, Metal Matrix composite , Reinforcements – particles – fibres. Effect of reinforcement - Volume fraction – Rule of mixtures. Processing of MMC – Powder metallurgy process - diffusion bonding – stir casting – squeeze casting.

MODULE V – ANALYSIS (8 Lecture Hours)

Stress analysis of laminated Composite beams, plates, shells- vibration and stability analysis – reliability of composites- equivalent orthographic/layered Finite Elements- finite element method of analysis of composites- analysis of sandwich structures.

MODULE VI – DESIGN AND TESTING (7 Lecture Hours)

Characterization of composite products – laminate design consideration- bolted and bonded joints design examples- non-destructive testing- failure mode Predictions.

Reference Books:

1. Mallick, P.K., "Fiber- Reinforced composites: Materials, Manufacturing and Design" Maneel Dekker inc. 2004.
2. Agarwal, B.D., and Broutman L.J., " Analysis and Performance of fiber composites", John Wiley and Sons, New York, 2011.
3. Halpin, J. C., "Primer on Composite Materials, Analysis" Techomic Publishing Co., 2009.
4. Mallick, P.K. and Newman, S., " Composite Materials Technology: Processes and Properties", Hansen Publisher, Munish, 2012.
5. Williams D, Callister, "Material Science and Engineering" John Wiley & Sons Inc., 2015.

18ME3063	WASTE TO ENERGY	L T P C 3 0 0 3

Course Objectives: To impart knowledge on

1. List the various biomass energy sources and their conversion processes.
2. Develop a small scale gasifier and biogas plant.
3. Determine the power generation from biomass waste.

Course Outcomes: After completing the course the student will be able to

1. Explain the working principle of biomass conversion processes.
2. Estimate the liquid fuel production from pyrolysis process.
3. Analyze the composition of synthesis gas using gas chromatography.
4. Design a community type biogas plant.
5. Design and develop a biogas stove.
6. Determine the amount of power generation from I C engines using alcohol fuels.

MODULE I – INTRODUCTION TO ENERGY FROM WASTE (7 Lecture Hours)

Classification of waste as fuel – agro based, forest residue, industrial waste – municipal solid waste – conversion devices – incinerators, gasifiers, and digesters- biomass resources and their classification, biomass energy programme in India, Urban waste to energy conversion.

MODULE II – BIOMASS PYROLYSIS (7 Lecture Hours)

Pyrolysis – slow pyrolysis, flash pyrolysis and fast pyrolysis – Manufacture of charcoal – methods - yields and application – manufacture of pyrolytic oils and gases, properties of pyrolysis oil and composition of pyrolysis gases- application.

MODULE III – BIOMASS GASIFICATION (8 Lecture Hours)

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

MODULE IV – BIOMASS COMBUSTION (8 Lecture Hours)

Biomass stoves – improved chullahs, types, some exotic designs, fixed bed combustors, Types, inclined grate combustors, fluidized bed combustors, design, construction and operation - biomass combustors-operation, fuel, efficiency and maintenance.

MODULE V – BIOGAS (8 Lecture Hours)

Properties of biogas - biogas plant technology and status - bio energy system - design and constructional features - biomass conversion processes - thermo chemical conversion processes - direct combustion -

biomass gasification - pyrolysis and liquefaction - biochemical conversion processes - anaerobic digestion- types of biogas Plants – applications- maintenance problem.

MODULE VI – ALCOHOL PRODUCTION FROM BIOMASS (7 Lecture Hours)

Ethanol production from wood by acid hydrolysis- ethanol from sugar cane-fermentation systems- methanol production- properties of liquid fuel- bio diesel production- performance of alcohol in I.C engines.

Reference Books:

1. G.D.Ral, Non-conventional energy sources, Khanna publishers, 5th edition, 2011
2. Desai, Ashok V., Non Conventional Energy, Wiley Eastern Ltd., 2010.
3. K. C. and Mahdi, S. S., Biogas Technology - A Practical Hand Book - Khandelwal, Vol. I and II, Tata McGraw Hill Publishing Co. Ltd., 2013.
4. Challal, D. S., Food, Feed and Fuel from Biomass, IBH Publishing Co. Pvt. Ltd., 2001.
5. C. Y. WereKo-Brobby and E. B. Hagan, Biomass Conversion and Technology, John Wiley & Sons, 2006.

18ME3064	DISASTER MANAGEMENT	L	T	P	C
		2	0	0	2

Course objectives: To impart knowledge on

1. Critical understanding of key concepts in disaster risk reduction and humanitarian response
2. Disaster risk reduction and humanitarian response policy and practice from multiple perspectives
3. Understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations

Course Outcomes: After completing the course the student will be able to

1. Understand Definitions and Terminologies used in Disaster Management
2. Apply Disaster Concepts to Management
3. Analyzing Relationship between Development and Disasters
4. Classify Categories of Disasters and
5. Understand the Challenges posed by Disasters
6. Enumerate the responsibilities to society

MODULE I – INTRODUCTION (7 Lecture Hours)

Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

MODULE II – REPERCUSSIONS OF DISASTERS AND HAZARDS (8 Lecture Hours)

Economic Damage, Loss of Humanand Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

MODULE III – DISASTER PRONE AREAS IN INDIA (7 Lecture Hours)

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides and Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

MODULE IV – DISASTER PREPAREDNESS AND MANAGEMENT (8 Lecture Hours)

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

MODULE V – RISK ASSESSMENT (8 Lecture Hours)

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global andNational Disaster Risk Situation. Techniques of Risk Assessment, Global Co- Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

MODULE VI – DISASTER MITIGATION (7 Lecture Hours)

Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs Of Disaster Mitigation in India.

Reference Books:
1. R. Nishith, Singh AK, Disaster Management in India: Challenges and Strategies, New Royal book Company, 2007.
2. Sahni, Pardeep Et. Al., Disaster Mitigation: Experiences and Reflections, Prentice Hall of India, New Delhi, 2001.
3. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep &Deep Publication Pvt. Ltd., New Delhi, 2007.
4. Singh B.K., Handbook of Disaster Management: Techniques & Guidelines, Rajat Publication, 2008
5. Ghosh G.K., Disaster Management, APH Publishing Corporation, 2006.

18ME3065	CONSTITUTION OF INDIA	L	T	P	C
		2	0	0	2

Course objectives: To impart knowledge on
1. Basic information about Indian constitution.
2. Identification of individual role and ethical responsibility towards society.
3. Human rights and its implications

Course Outcomes: After completing the course the student will be able to
1. Have general knowledge and legal literacy and thereby to take up competitive examinations
2. Understand state and central policies, fundamental duties
3. Understand Electoral Process, special provisions
4. Understand powers and functions of Municipalities, Panchayats and Co-operative Societies
5. Understand Engineering ethics and responsibilities of Engineers.
6. Have an awareness about basic human rights in India

MODULE I – INTRODUCTION (6 Lecture Hours)
Introduction to the Constitution of India, The Making of the Constitution and Salient features of the Constitution. Preamble to the Indian Constitution Fundamental Rights & its limitations
MODULE II – DUTIES OF PRIME MINISTER, PRESIDENT AND SUPREME COURT (6 Lecture Hours)
Directive Principles of State Policy & Relevance of Directive Principles State Policy Fundamental Duties. Union Executives – President, Prime Minister Parliament Supreme Court of India.
MODULE III – DUTIES OF GOVERNOR, CHIEF MINISTER HIGH COURT AND ELECTION COMMISSION (6 Lecture Hours)
State Executives – Governor Chief Minister, State Legislature High Court of State. Electoral Process in India, Amendment Procedures, 42^{nd}, 44^{th}, 74^{th}, 76^{th}, 86^{th}& 91^{st} Amendments.
MODULE IV – PROVISONS FOR SC/ST, WOMEN, CHILDREN AND BACKWARD CLASSES (7 Lecture Hours)
Special Provision for SC & ST Special Provision for Women, Children & Backward Classes Emergency Provisions. Human Rights –Meaning and Definitions, Legislation Specific Themes in Human Rights- Working of National Human Rights Commission in India .
MODULE V – ETHICS AND RESPONSIBILITY OF ENGINEERS (6 Lecture Hours)
Scope & Aims of Engineering Ethics, Responsibility of Engineers, Impediments to Responsibility, Risks, Safety and liability of Engineers, Honesty, Integrity & Reliability in Engineering
MODULE VI – POWERS AND FUNCTIONS OF MUNICIPALITIES, PANCHAYATS AND SOCITIES (6 Lecture Hours)
Powers and functions of Municipalities, Panchayats and Co - Operative Societies

Reference Books:
1. Durga Das Basu, Introduction to the Constitution on India, Prentice Hall of India, 2001.
2. Charles E. Harieset, al, Engineering Ethics, Thompson Asia, 2003.
3. M.V.Pylee, An Introduction to Constitution of India, Vikas Publishing, 2002.
4. M.Govindarajan, S.Natarajan, V.S.Senthilkumar, (2004), Engineering Ethics, Prentice Hall of

India, 2004.
5. Brij Kishore Sharma,(2011), Introduction to the Constitution of India" , Prentice Hall of India, 2011.

18ME3066	PEDAGOGY STUDIES	L 2	T 0	P 0	C 2

Course Objectives: To impart knowledge on
1. Understanding the meaning, philosophies and theories of education.
2. Identify critical evidence gaps to guide the development.
3. Summarize existing evidence on the review topic to inform programme design and policy making undertaken by agencies and researchers.

Course Outcomes: After completing the course the student will be able to
1. Demonstrate knowledge of major theories and values of education in relation to class room management and social life.
2. Analyze the implications of thoughts and theories of education on teaching, learning processes, curriculum, class room management and social changes.
3. Outline how can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy.
4. Demonstrate skills in curriculum management and implementation
5. Evaluate how philosophy, thoughts and theories of education affect learning processes.
6. Explain what pedagogical practices are being used by teachers in formal and informal classrooms in developing countries

MODULE I – INTRODUCTION AND METHODOLOGY (7 Lecture Hours)

Aims and rationale- policy background- conceptual framework and terminology- meaning of education- theories of learning, curriculum and teacher education- conceptual framework- research questions- overview of methodology and searching.

MODLUE II – THEMATIC OVERVIEW (7 Lecture Hours)

Pedagogical practices- used by teachers in formal and informal classrooms in developing countries- curriculum and teacher education- critical pedagogy and standards- pedagogy and models of teacher knowledge.

MODULE III – EFFECTIVENESS OF PEDAGOGICAL PRACTICES(8 Lecture Hours)

Methodology for the in depth stage, quality assessment of included studies, teacher education - curriculum and guidance materials - best support effective pedagogy- theory of change- strength and nature of the body of evidence for effective pedagogical practices.- pedagogic theory and pedagogical approaches.- teachers attitudes and beliefs and pedagogic strategies.

MODULE IV – PROFESSIONAL DEVELOPMENT (8 Lecture Hours)

Alignment with classroom practices and follow-up support- peer support - support from the head teacher and the community- curriculum and assessment- barriers to learning- limited resources and large class sizes.

MODULE V – RESEARCH GAPS AND FUTURE DIRECTIONS (8 Lecture Hours)

Research design - contexts - pedagogy - teacher education- dissemination and research impact- great teachers- examples- parents as primary educators- education and technology- future visions- moral education.

MODULE VI – PEDAGOGY APPROACHES (7 Lecture Hours)

Educational philosophy and theory- pedagogy approaches- equality and diversity- learning principles to guide pedagogy- constructivist pedagogy- critical pedagogy-pedagogic theory- pedagogic strategies- teaching generation next

Reference Books:

1. Ackers J, Hardman F, Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261, 2001
2. Agrawal M, Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379, 2004

3. Akyeampong K, Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID, 2003
4. Akyeampong K, Lussier K, Pryor J, Westbrook J Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282, 2013
6. Alexander RJ, Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell, 2001.

LIST OF COURSES

Sl. No	Course Code	Name of the Course	Credits
1	17ME1001	Basic Mechanical Engineering	3:0:0
2	17ME1002	Engineering Drawing	0:0:2
3	17ME1003	Workshop Practice	0:0:2
4	17ME2001	Engineering Mechanics	3:0:0
5	17ME2002	Material Science and Engineering	3:0:0
6	17ME2003	Metrology and Measurement Systems	3:0:0
7	17ME2004	Engineering Thermodynamics	3:0:0
8	17ME2005	Mechanics of Solids	3:1:0
9	17ME2006	Manufacturing Processes	3:0:0
10	17ME2007	Metrology Laboratory	0:0:1
11	17ME2008	Metallurgy Laboratory	0:0:1
12	17ME2009	Foundry, Smithy, Welding and Sheet Metal Laboratory	0:0:2
13	17ME2010	Machining Processes	3:0:0
14	17ME2011	Thermal Engineering I	3:0:0
15	17ME2012	Kinematics of Machinery	3:1:0
16	17ME2013	Fluid Mechanics and Machinery	3:1:0
17	17ME2014	Machining Laboratory	0:0:2
18	17ME2015	Fluid Mechanics and Strength of Materials Laboratory	0:0:2
19	17ME2016	Machine Drawing	0:0:2
20	17ME2017	Computer Aided Design and Manufacturing	3:0:0
21	17ME2018	Thermal Engineering II	3:0:0
22	17ME2019	Dynamics of Machinery	3:1:0
23	17ME2020	Design of Machine Elements	3:1:0
24	17ME2021	Computer Aided Engineering Laboratory	0:0:2
25	17ME2022	Thermal Engineering Laboratory	0:0:2
26	17ME2023	Dynamics Laboratory	0:0:2
27	17ME2024	Heat and Mass Transfer	3:0:0
28	17ME2025	Resource Management	3:0:0
29	17ME2026	Fluid Power Control Engineering	3:0:0
30	17ME2027	Design of Mechanical Transmission Systems	3:0:0
31	17ME2028	Heat Transfer Laboratory	0:0:2
32	17ME2029	CAM Laboratory	0:0:2
33	17ME2030	Fluid Power Control and Mechatronics Laboratory	0:0:2
34	17ME2031	Finite Element Analysis	3:0:0
35	17ME2032	Principles of Mechanical Vibrations	3:0:0
36	17ME2033	Product Design and Development Strategies	3:0:0
37	17ME2034	Composite Materials	3:0:0
38	17ME2035	Design for Manufacture	3:0:0
39	17ME2036	Tribology	3:0:0
40	17ME2037	Design of Jigs, Fixtures and Press Tools	3:0:0
41	17ME2038	Industrial Engineering and Management	3:0:0
42	17ME2039	Rapid Prototyping and Tooling	3:0:0

43	17ME2040	Metal Cutting Theory and Practice	3:0:0
44	17ME2041	Welding Technology	3:0:0
45	17ME2042	Foundry Technology	3:0:0
46	17ME2043	Computational Fluid Dynamics	3:0:0
47	17ME2044	Renewable Energy Sources	3:0:0
48	17ME2045	Advanced Internal Combustion Engines	3:0:0
49	17ME2046	Refrigeration and Air Conditioning	3:0:0
50	17ME2047	Biomass Energy Systems	3:0:0
51	17ME2048	Alternative Fuels for I.C Engines	3:0:0
52	17ME2049	Modern Vehicle Technology	3:0:0
53	17ME2050	Power Plant Engineering	3:0:0
54	17ME2051	Turbomachinery	3:0:0
55	17ME2052	Design of Heat Exchangers	3:0:0
56	17ME2053	Mechatronics	3:0:0
57	17ME2054	Industrial Safety Engineering	3:0:0
58	17ME2055	Basic Automobile Engineering	3:0:0
59	17ME2056	Industrial Robotics	3:0:0
60	17ME2057	Heat Engines and Fluid Machinery	3:1:0
61	17ME2058	Fundamentals of Thermal and Fluid Sciences	3:0:0
62	17ME2059	Machine Design	3:0:0
63	17ME2060	Heat Power Engineering	2:0:1
64	17ME2061	CAD / CAM and Computer Graphics	0:0:2
65	17ME3001	Finite Element Methods in Engineering	3:0:0
66	17ME3002	Computer Applications in Design	3:0:0
67	17ME3003	Advanced Mechanical Vibrations	3:0:0
68	17ME3004	Advanced Strength of Materials	3:0:0
69	17ME3005	Engineering Materials and Applications	3:0:0
70	17ME3006	Advanced Mechanism Design	3:0:0
71	17ME3007	Experimental Stress Analysis	3:0:0
72	17ME3008	Engineering Product Design and Development Strategies	3:0:0
73	17ME3009	Engineering Fracture Mechanics	3:0:0
74	17ME3010	Design of Mechanical System Elements	3:0:0
75	17ME3011	Industrial Tribology	3:0:0
76	17ME3012	Quality Concepts in Design	3:0:0
77	17ME3013	Rotor Dynamics	3:0:0
78	17ME3014	Design for Manufacturing and Assembly	3:0:0
79	17ME3015	Modal Analysis of Mechanical Systems	3:0:0
80	17ME3016	Advanced Manufacturing Processes	3:0:0
81	17ME3017	Control of CNC Machine tools	3:0:0
82	17ME3018	Theory of metal cutting	3:0:0
83	17ME3019	Computer Integrated Manufacturing Systems	3:0:0
84	17ME3020	Advanced Metrology and Measurement Systems	3:0:0
85	17ME3021	Industrial Robotics	3:0:0
86	17ME3022	Advanced Tool Design	3:0:0
87	17ME3023	Design of Fluid Power Systems	3:0:0
88	17ME3024	Manufacturing System and Simulation	3:0:0
89	17ME3025	Advanced Thermodynamics	3:0:0
90	17ME3026	Advanced Heat Transfer	3:0:0
91	17ME3027	Advanced Fluid Mechanics	3:0:0
92	17ME3028	Design of Thermal Power Equipment	3:0:0

93	17ME3029	Combustion in Engines	3:0:0
94	17ME3030	Energy Conservation and Management	3:0:0
95	17ME3031	Advanced Instrumentation in Thermal Engineering	3:0:0
96	17ME3032	Advanced Refrigeration and Air-Conditioning Systems	3:0:0
97	17ME3033	Design and Analysis of Heat Exchangers	3:0:0
98	17ME3034	Biomass Energy	3:0:0
99	17ME3035	Advanced Turbomachinery	3:0:0
100	17ME3036	Two Phase Flow and Heat Transfer	3:0:0
101	17ME3037	Solar Energy Utilization	3:0:0
102	17ME3038	Nuclear Power Engineering	3:0:0
103	17ME3039	Vibration Laboratory	0:0:1
104	17ME3040	Advanced Computer Aided Engineering Laboratory	0:0:2
105	17ME3041	CAD/CAM Laboratory	0:0:2
106	17ME3042	Advanced Heat Transfer Laboratory	0:0:1
107	17ME3043	Automation and Robotics Lab	0:0:1
108	17ME3044	Advanced Computational Fluid Dynamics Laboratory	0:0:2

17ME1001 BASIC MECHANICAL ENGINEERING

Credits: 3:0:0

Course Objectives:
To impart knowledge

- To provide knowledge about IC Engines, External Combustion Engines, Boilers.
- To understand about power plants, metal forming, metal joining, machining process
- To learn the application of CAD, CAM, MEMS and CIM.

Course Outcomes:
Ability to

- Describe the working principle of Engines and Turbines.
- Classify Boilers and identify different types of engines.
- Distinguish conventional and non- conventional power plants.
- Examine various types of engineering materials.
- Select different types of metal forming and joining processes.
- Analyze metal machining processes.

Unit I - ENGINE, BOILERS AND REFRIGERATION: Working of petrol and Diesel Engine – Difference between two stroke and four stroke engines. Principles of fire tube and water tube boilers – Cochran boiler – Babcock & Wilcox boiler, Working principle of Impulse turbine reaction turbine, Refrigeration and air conditioning- working principle of refrigeration and air conditioning.

Unit II - POWER PLANTS: Conventional power plants: Hydro, Thermal, Nuclear power plants – Diesel and Gas Turbine power plants. Non-conventional power plants: Solar, wind and tidal power plants – Geothermal power plant – Ocean Thermal Energy conversion power plant.

Unit III - ENGINEERING MATERIALS: Engineering materials**:** classification of materials –properties of metals – Alloy steels – Nonferrous metals and alloys. Introduction to plastics and composites.

Unit IV - MANUFACTURING PROCESSES AND RECENT ADVANCES: Introduction: Metal casting process: patterns –molding processes – melting of cast iron. Metal forming process: Introduction – Forging – Rolling – Extrusion – Drawing operations. Metal joining Process: Introduction - welding – arc welding - gas welding. Metal machining: Lathe – Drilling machine – Milling machine.

Unit V - INTRODUCTION TO CAD, CAM, MEMS AND CIM: Introduction - Computer Aided Design – Computer Aided Manufacturing – Computer Integrated Manufacturing – Micro Electro Mechanical Systems (MEMS).

Text Books:

1. G. Shunmagam, S. Ravindran, "Basic Mechanical Engineering", Tata McGraw Hill, 2011.

2. K. Venugopal, V. Prabhuraja, "Basic Mechanical Engineering", Anuradha Agencies, 2014.

Reference Books:

1. I.E. Paul Degarmo, J.T. Black, Ronald A. Kosher, "Material and Processes in Manufacturing", 8th Edition, John Wiley and Sons. 2003.
2. S.R.J. Shantha Kumar, "Basic Mechanical Engineering", HiTech Publications, 2001.
3. Williams D. Callister "Material Science and Engineering", John Wiley and Sons. 2013.

17ME1002 ENGINEERING DRAWING

Credits: 0:0:2

Course Objectives:

To impart knowledge on:

- Visualization of objects and projection.
- Dimensioning, conventions and standards related to working drawings.
- Application of various line types, arcs and methods to draw using AutoCAD.

Course Outcomes:

Ability to

- Visualize the objects from their drawings.
- Illustrate graphically the details of engineering components using conventions and standards.
- Apply the theory of projection to represent the front and top views of points, lines and solids.
- Construct drawings using various line types, arcs, and circles using CAD software.
- Prepare drawings using modify, draw, layers and properties tool bars to draw orthographic views.
- Develop 2D models using modify, draw and properties tool bars to draw isometric views.

List of experiments

1. Geometrical constructions
   i) Introduction and use of drawing instruments & Lettering practice.
   ii) Construction of polygons using
      a. Semicircle and Bi-section of given side method
      b. Inscribing polygon in a circle method
      c. Special Method for Hexagon
   iii) Dimensioning practice of lines, circles, arcs using aligned and chain dimensioning systems.
2. First and third angle projections. Conversion of pictorial views into orthographic views (in first angle projection) of simple machine elements like V- block and bearing block.
3. Projection of points in different quadrants.
4. Projection of lines in first quadrant
   a. Parallel to both planes.
   b. Inclined to one plane and parallel to other.
   c. Parallel to one plane and perpendicular to other plane.
5. Projection of solids
6. Projections of prism, pyramid, cylinder and cone - axis parallel to one plane and perpendicular to the other plane, Parallel to both planes.
7. Isometric projection, Isometric views of basic solids - prism, pyramid, cylinder and cone.

Computer aided drafting:

8. Snap, Grid, Limits, OSNAP, line types and weights, text, pdf file creation and plotting.
9. Modifying Commands: Erase, trim, array, lengthen, break, mirror, offset, move, copy etc.
10. Methods of Drawing lines, arcs and circles and applications.
11. Dimensioning, hatching methods to show different materials, title block and layers.
12. Isometric view of primitive solids and combination of primitive solids.

Text books:

1. Leo Dev Wins. K., 'Engineering Drawing', Pearson India Education, 2nd Edition, 2016.
2. Basant Agrawal, C.M. Agrawal, 'Engineering Drawing', Tata McGraw Hill Private Ltd., 2010.

Reference books:

1. Shyam Tickoo, 'AUTOCAD 2015' Pearson Publications, 2015.
2. Bhatt N.D., "Elementary Engineering Drawing", 26th Edition Chartor Publishing House, Anand, 2009.
3. Venugopal K. "Engineering Graphics", 9th Edn. (Revised), New Age International Publishers, 2009.

4. Shah, M. B., Engineering Drawing, Pearson Education India, 2^{nd} Edition 2009.

17ME1003 WORKSHOP PRACTICE

Credits: 0:0:2

Course Objectives:
To impart knowledge on
- Fitting joints, carpentry joints and plumbing practices.
- Wiring of tube lights and lights used in stair case
- Assembly of PC and installation of operating system in PC

Course Outcomes:
Ability to
- Apply the practical skills in assembly work.
- Assemble mechanical devices and equipment by applying fitting practices
- Apply carpentry and fitting joints, to fabricate useful products
- Design and develop electronic and electrical circuits towards real time works and their project work.
- Identify and install the appropriate Operating System (OS) to the computes.
- Devise suitable procedural protocol to troubleshoot the functioning of the computer

List of Experiments:
1. Making of rectangular planning in carpentry
2. Making of middle lap joint in carpentry
3. Making of Square filing in Fitting
4. Making of V joint in Fitting
5. Assembly of pipes, valves and other fittings in Plumbing
6. Drilling holes & welding of Mild Steel plates
7. Assembly practice of Mono block pump
8. Assembly and dismantling of personal computer
9. Installation of Operating System (OS) in computer.
10. Design suitable electrical circuits for different applications
11. Measure the performance of various electrical devices

Text books:
1. S. Bawa, Workshop practices, Tata McGraw Hill, 2014
2. S. Suyambazhagan, Engineering practices, Prentice Hall India, 2012

Reference books:
1. K.C. John, Mechanical Workshop Practices, PHI, 2010
2. T. Jeyaboovan, Engineering practices, Vikash Publishers, 2010
3. P. Kanniah, KL. Narayana, Workshop Manual, SciTech Publishers, 2010
4. V. Rameshbabu, Engineering Workshop practice, VRB Publishers Pvt. Ltd, 2010
5. GHF Nayler, Dictionary of Mechanical Engineering, Jaico Publishing House, 2011

17ME2001 ENGINEERING MECHANICS

Credits: 3:0:0

Course Objectives:
To impart knowledge on
- Forces acting on particle and rigid bodies.
- Free body diagrams for solving problems with structural members.
- Geometrical properties of surfaces and solids
- Concepts of kinematics, kinetics of particle and rigid bodies

Course Outcomes:
Ability to
- Resolve the components of force and understand equilibrium of bodies
- Formulate free body diagram and calculate the forces in space.
- Determine the limiting conditions of friction

- Analyze the rectilinear and curvilinear motion using Newton's second law
- Apply the work energy method to determine motion of particle
- Apply impulse momentum principle to determine motion of rigid bodies.

Unit I - STATICS OF PARTICLE: Force – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Resolution and components of forces – Resultant of concurrent forces, Equilibrium of a two force and three force body – Forces in space – Equilibrium of a particle in space – Equilibrium of rigid bodies: Free body diagram. Support Reactions – Beams – Types of loads, Analysis of roof trusses by method of joints and method of sections. Moment of a force about a point – Varignon's theorem – Moment of a couple – Resolution of a given force in to force and couple system.
Unit II - STATICS OF RIGID BODIES: Centre of gravity and Centroid of composite plane figure – Moment of inertia – Parallel axis and Perpendicular axis theorem – Moment of inertia of composite planes – Mass moment of inertia of simple solid and composite bodies.
Friction: Frictional force – Limiting friction – Coefficient of friction and angle of friction – Impending friction – Basic concepts – Problems on body on a rough inclined plane, Ladder friction, Wedge friction, Rolling resistance.
Unit III - KINEMATICS OF PARTICLES: Rectilinear motion – Displacements, Velocity and acceleration, variable acceleration, their relationship – Relative motion, Curvilinear motion – Tangential and Normal components, velocity and acceleration of a particle – Projectile of body. Newton's second law of motion – D-Alembert's principle – Motion of a lift – Motion on an inclined surface – Motion on connected bodies.
Unit IV - KINETICS OF PARTICLE: Work Energy method – Kinetic energy of particle – Applications of principle of work and energy – Conservation of energy – Impulse and momentum method - Motion of connected bodies. Impact of elastic bodies: Types of impact – Method of analysis – Problems. Virtual work method.
Unit V - DYNAMICS OF RIGID BODIES: Translation – Rotation about a fixed axis – Equations defining the rotation of a rigid body about a fixed axis – General plane motion. Equations of motion for a rigid body – Angular momentum of a rigid body in plane motion. Principle of Work and Energy for a rigid body – Work of forces acting on a rigid body – Kinetic energy of a rigid body in plane motion.

Text Books:

1. N.H Dubey, "Engineering Mechanics – Statics and Dynamics", McGraw-Hill Education (India) Private Limited, 2016.
2. Rajasekaran S, Sankarasubramanian G., "Fundamentals of Engineering Mechanics", Vikas Publishing House Pvt. Ltd., 2007

Reference Books

1. Ferdinand P. Beer and E. Russell Johnston Jr. "Vectors Mechanics of Engineers", Vol. 1 Statics and Vol. 2 Dynamics, McGraw-Hill International Edition, 2014.
2. Palanichamy M.S., Nagan S., "Engineering Mechanics – Statics and Dynamics", Tata McGraw-Hill, 2004
3. Hibbeler R.C., "Engineering Mechanics", Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., 2014
4. Irving H. Shames, "Engineering Mechanics – Statics and Dynamics", 4^{th} Edition – Pearson Education Asia Pvt. Ltd., 2005.
5. N. Kottiswaran, "Engineering Mechanics", Sri Balaji Publications Edition – 2010
6. J.L.Meriam and L.G. Kraige,"Engineering Mechanics-Statics",John Wiley & sons, Inc, 2006

17ME2002 MATERIAL SCIENCE AND ENGINEERING

Credits: 3: 0: 0

Course Objectives:
To impart knowledge on

- To impart knowledge of the properties and applications of various engineering materials.
- To expose testing methods and procedures to find the mechanical properties of engineering materials
- To acquire knowledge on construction of phase diagrams and also the importance of iron-iron carbide phase diagram and different heat treatment

Course Outcomes:
Ability to

- Identify crystal structures of common engineering materials.

- Understand the principle of various microscopes.
- Identify the various behavior of materials and defects.
- Analyze failures and predict service behavior of materials for various applications
- Interpret and determine the right compositions of metals.
- Select the heat treatment process based on the metals.

Unit I - CRYSTALLOGRAPHY: Classifications of materials- metals, Ceramics, Composites, Polymer – properties of engineering materials – Structure of solid metals –BCC, FCC and HCP structures, atomic packing factor, polymorphism- Miller indices. Metallographic analysis- Optical microscope, SEM, TEM.
Unit II - MECHANICAL BEHAVIOR: Defects in crystals -point defects line defect edge and screw dislocations – propagation of dislocation - Frank Read source – surface imperfections - diffusion - mechanisms of diffusion - Fick's Laws of diffusion – plastic , deformation- slip and twinning – recovery re-crystallization and grain growth.- strengthening mechanisms strain hardening precipitation hardening.
Unit III - FAILURE OF MATERIALS: Fracture – ductile and brittle fracture - Griffith's theory of crack propagation protection against fracture-Creep- mechanisms of creep – creep resistant materials. Fatigue failure, SN curve- prevention of fatigue, failure.
Unit IV - PHASE DIAGRAMS: Solid solution, Phases- phase diagrams- Gibbs phase rule- cooling curves, types of Equilibrium diagrams, lever rule –Iron –Iron Carbide equilibrium diagram
Unit V - HEAT TREATMENT OF STEEL & NON FERROUS ALLOYS: Annealing normalizing - spheroidising- hardening, tempering – Hardenability, Case hardening of steels- carburizing- nitriding, induction hardening- flame hardening, Age hardening of Aluminium alloys

Text Books:

1. V. Raghavan., "Material Science and Engineering", Prentice Hall of India Pvt. Ltd, New Delhi, 2009.
2. Williams D. Callister "Material Science and Engineering" John Wiley and sons inc. 2014.

Reference Books

1. Reza Abbaschian, Lara Abbaschian, Robert E. Reed-Hill, "Physical Metallurgy Principles", Cengage Learning, 2013.
2. Raymond A Higgins "Engineering Materials (Applied Physical Metallurgy) English Language book, society, 2003.
3. Khanna O.P., "A text book of Materials Science and Metallurgy" DhanpatRai and Sons Delhi, 2014.
4. Sydney H. Avner, "Introduction to Physical Metallurgy", 2nd edition McGraw Hill Book Company, 2008.
5. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials: Properties and Selection", Pearson Education India, 2016.

17ME2003 METROLOGY AND MEASUREMENT SYSTEMS

Credits: 3:0:0

Course objectives:
To impart knowledge on

- To acquaint the concepts of Measurements.
- To impart knowledge on various Metrological equipment available to measure the dimension of the components.
- To identify procedures for the measurement of the dimension of the components.

Course Outcomes:
Ability to

- Differentiate accuracy, precision, and some additional terminology.
- Employ measuring instruments for linear and angle measurement.
- Use effective methods of measuring straightness, flatness, screw threads and gear teeth
- Recommend suitable techniques to measure temperature and flow
- Demonstrate the use of advanced measurement techniques.
- Demonstrate handling of various metrological equipment to measure the dimension of the components.

Unit I : GENERAL CONCEPTS OF MEASUREMENT: Definition-Standards of measurement-Errors in measurement-Accuracy, precision, sensitivity and readability - calibration of instruments, simple problems to find least count, selection and care of instruments.
Unit II - LINEAR AND ANGULAR MEASUREMENTS: Length standard-Line and end standard - Slip gauges, micrometers, Verniers, dial gauges comparators: various types-principle and applications, angular measuring instruments-bevel protractor, levels, sine bar and sine center, simple problems for finding taper angle using sine bar and sine center, angle Dekkor - autocollimator.
Unit III - FORM MEASUREMENT: Straightness, flatness, surface texture-various measuring instruments-run out and concentricity, Tool maker's microscope. Various elements of threads - 2 wire and 3 wire methods, simple problems in screw threads for calculating effective diameter -gear elements - Parkinson gear tester, Measurement of gear pitch, Gear rolling test, Gear tooth Vernier Caliper
Unit IV - MEASUREMENT OF FLOW AND TEMPERATURE: Flow measurement: Venturimeter, Orifice meter, rotameter, pitot tube – Temperature: bimetallic strip, thermocouples, electrical resistance thermometer
Unit V - ADVANCES IN METROLOGY: Coordinate measuring machine- Constructional features, types, applications, Introduction to Interferometer, optical and LASER interferometers-applications.

Text books:

1. R.K. Jain, "Engineering Metrology", New Delhi, 3rd Edition, Khanna Publication, 2012.
2. T.G. Beckwith and Marangoni, "Mechanical Measurements", Addison Wesley, 2007.

Reference books:

1. M. Mahajan, "A Text Book of Engineering Metrology", New Delhi, 4th Edition, DhanpatRai, 2009
2. I.C. Gupta, "A Text Book of Engineering Metrology", New Delhi, 4th Edition, DhanpatRai, 2009.
3. S. Bhaskar, "Engineering Metrology and Measurements", Anuradha Publication, 1ED Reprinted 2012.
4. R.K. Rajput, "Engineering Metrology and Instrumentation", S.K. Kataria & Sons, 5th Edition Reprint 2014
5. Ernest O Doeblin, "Measurement systems", McGraw Hill Publishers, 6th Edition, 2011.

17ME2004 ENGINEERING THERMODYNAMICS

(Use of standard thermodynamic tables, Mollier diagram and Psychrometric chart are permitted.)
Credits: 3:0:0

Course Objectives:
To impart Knowledge on
- The basic principles of thermodynamics via real-world engineering examples, to show students how thermodynamics is applied in engineering practice.
- The First Law of Thermodynamics (principle of conservation of energy) and its application to a wide variety of systems.
- The implications of the second law of thermodynamics and limitations placed by the second law on the performance of thermodynamic systems.

Course Outcomes:
Ability to
- Understand the basic concepts in thermodynamics and its application in different fields.
- Apply the first law of thermodynamics for closed and open systems to solve simple engineering problems
- Evaluate the feasibility of a thermodynamic cycle using the second law of thermodynamics for typical engineering problems.
- Determine steam quality using steam tables and Mollier chart.
- Apply the gas laws to solve problems related to ideal gases and mixtures.
- Apply psychrometric chart to perform moist air process calculations.

Unit I - BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS: Concept of continuum, microscopic and macroscopic approach, thermodynamic systems – closed, open, isolated, control volume. Thermodynamic properties and equilibrium state of a system, state diagram, path and process, quasi-static process, work, modes of work, zeroth law of thermodynamics – concept of temperature and heat. Concept of ideal and real gases. First law of thermodynamics – application to closed and open systems, internal energy, specific heat capacities C_v and C_p, enthalpy, steady flow process with reference to various thermal equipment.

Unit II - SECOND LAW OF THERMODYNAMICS: Kelvin's and Clausius statements of second law. Reversibility and irreversibility. Carnot cycle, reversed Carnot cycle, efficiency, COP, Carnot theorem. Thermodynamic temperature scale, Clausius inequality, concept of entropy, entropy of ideal gas, principle of increase of entropy, absolute entropy, availability.
Unit III - PROPERTIES OF PURE SUBSTANCES: Thermodynamic properties of pure substances in solid liquid and vapour phases, phase rule P-V, P-T, T-V, T-S, H-S diagrams, PVT surfaces, thermodynamic properties of steam. Calculations of work done and heat transfer in non-flow and flow processes -simple problem.
Unit IV - GAS MIXTURES: Properties of ideal and real gases, equation of state, Avagadro's law, Dalton's law of partial pressure ,Gay Lussac's law, Graham's law of diffusion, kinetic theory of gases, Vander Wall's equation of states, compressibility, compressibility chart.
Unit V - PSYCHROMETRY : Psychrometry and psychrometric charts, property calculations of air vapour mixtures. Psychrometric process – Sensible heat exchange processes. Latent heat exchange processes. Adiabatic mixing, evaporative cooling, problems.

Text Books:

1. P.K. Nag, "Engineering Thermodynamics", Tata McGraw-Hill, 2013.
2. Yunus Cengel, "Thermodynamics", Tata McGraw-Hill, 2014

Reference Books:

1. J.P. Holman, "Thermodynamics", 4th Edition, McGraw Hill, 2002
2. T. Roy Choudhury, "Basic Engineering Thermodynamics", Tata McGraw-Hill, 2000
3. Vanwylen and Sontag, "Classical Thermodynamics", Wiley Eastern, 1999
4. R.K. Rajput, "A Textbook of Engineering Thermodynamics", Laxmi Publications, 2016.

17ME2005 MECHANICS OF SOLIDS

Credits: 3:1:0
Prerequisites: Engineering Mechanics [17ME2001]

Course Objectives:
To impart knowledge on

- Material behaviour under various stress and strain conditions.
- Bending moment and shear force of determinate beams
- Stresses under torsion and bending loads
- Concepts of deflection and theories of failure

Course Outcomes:
Ability to

- Demonstrate the concept of stress and strain in solids
- Establish the relation between material properties.
- Analyze the structure for shear force and bending moment for design
- Analyze the behavior of structures subjected to bending and torsion conditions
- Interpret failure of mechanical components using theories of failure.
- Determine the deflection of beams and stability of columns

Unit I - SIMPLE STRESS AND STRAIN: Stresses and strain due to axial force – Hooke's law, factor of safety, stepped bars – Uniformly varying sections – Stresses in composite bars due to axial force and temperature – Strain energy due to axial force, stresses due to sudden loads and impact – Lateral strain: Poisson's ratio – Change in volume – Shear stress – Shear strain – Relationship between elastic constants , Cauchy stress tensor – Hoop and longitudinal stress in thin cylindrical and spherical shells subjected to internal pressure – Changes in dimensions and volume.
Unit II - SHEAR FORCE AND BENDING MOMENT: Relationship between loading – Shear force and bending moment – Shear force and bending moment diagrams for cantilever, simply supported and overhanging beams subjected to concentrated loads and uniformly distributed loads only – Maximum bending moment and point of contra flexure.
Unit III - BENDING STRESSES: Theory of simple bending and assumptions – Simple bending equation - Calculation of normal stresses due to flexure application. Leaf Springs – Strain Energy Due to Bending - Moment Torsion: Theory of torsion and assumptions – Torsion equation – Stresses and Deformation in Solid Circular and

Hollow Shafts –Stepped Shafts – Composite Shaft – Stress due to combined bending and Torsion – Strain energy due to Torsion - Deformations and Stresses in Helical Springs.

Unit IV - PRINCIPAL STRESSES and Theories of Elastic Failure: State of stress at a point, normal and tangential stresses on inclined planes – Principal stresses and their planes – Plane of maximum shear - Mohr's circle of stresses. Theories Of Elastic Failure: Maximum principal stress theory – Maximum shear stress theory – Maximum principal strain theory – Strain energy theory – Mohr's theory. Application of theories of failure

Unit V - DEFLECTION OF BEAMS: Deflection in statically determinate beams – Macaulay's method for prismatic members – Area moment method for stepped beams with concentrated loads. Maxwell's reciprocal and Castigliano's Theorems. Long columns: Buckling of long columns due to axial load – Euler's and Rankine's formulae for columns of different end conditions.

Text Books:

1. R.K. Bansal, "Strength of Materials", Laxmi Publications (P) Ltd., 2017
2. R.K. Rajput, "Strength of Materials", Chand Publications (P) Ltd., 2007

Reference Books:

1. Ferdinand P. Beer, E. Russell Johnston Jr., John T. Dewolf, "Mechanics of Materials", Tata McGraw-Hill, 2014.
2. S. Ramamurtham, S., "Strength of Materials", DhanpatRai Publishing Co., New Delhi, 2011.
3. R.C. Hibbeler, "Mechanics of Materials", Pearson, Tenth edition, 2016.

17ME2006 MANUFACTURING PROCESSES

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- The principle, procedure and applications of Casting
- The working principle and applications of Bulk forming and Sheet Metal
- Welding and Powder metallurgy processes

Course Outcomes:

Ability to

- Identify casting process to produce complex parts
- Suggest primary manufacturing process for the mass production of components
- Develop products with superior Mechanical properties using Bulk forming processes
- Perform various sheet metal operations on metal sheets
- Join multiple parts to form working assemblies using welding
- Provide exceptional properties using powder metallurgy

Unit I - CASTING PROCESSES: Sand mould castings – Types – Moulding machines – Moulding sand composition – Properties – Testing of sand properties – Pattern types – allowances – colour scheme – Core types – core print. Elements of gating system – gating system design – Pouring time – gating ratio – Risering design: Chvorinov rule – Caine's Method – Casting defects, Inspection of casting. Special Casting Processes: Shell Moulding, investment casting, die casting, centrifugal casting and continuous casting.

Unit II - BULK FORMING PROCESSES: Hot working and cold working-rolling-rolling load and power – rolling mill – defects in rolled parts. Forging – open die and close die forging operations – Forging force calculations – Forging machines – Extrusion – extrusion ratio – Hot extrusion – Cold extrusion – Extrusion force calculations – Defects – Wire, rod and tube drawing – degree of drawing operations – Drawing force and power, Processing of Plastics – Injection Moulding.

Unit III - SHEET FORMING PROCESSES: punching and blanking – stripping force – punching force calculations – Clearance and shear on punch and die – Drawing – calculation of blank diameter - number of draws – Bending – allowances – bending force – stretch forming, spinning, embossing, coining – Types of sheet metal dies.

Unit IV - WELDING PROCESSES: Welding joints – welding positions – terminologies – Filler and Flux materials – Electrodes – Coating and specifications – Gas metal arc welding, TIG welding – Submerged arc welding – Principles of Resistance welding – Electro slag welding – Thermit welding – Electron beam welding – Friction welding – welding design – heat input and melting efficiency – Weld defects.

Unit V - POWDER METALLURGY: Powder metallurgy: production of metal powder – method –particle size, distribution and size – blending – compaction of metal powder – equipment – isostatic pressing and other compacting and shaping processes – sintering – Secondary and finishing processes – impregnation - infiltration.

Text books:

1. P.N. Rao, "Manufacturing Technology Foundry, Forming and Welding", Tata McGraw-Hill, New Delhi, 2013.
2. S. Kalpakjian, "Manufacturing Engineering and Technology", Pearson Education India Edition, 2014.

Reference books:

1. Roy. A. Lindberg, "Processes and Materials of Manufacture", PHI / Pearson Education, 2006
2. Nagpal G.R. "Metal Forming Processes", Khanna Publishers, New Delhi, 2000
3. Heine, Richard, Carl R Loper and Philip Rosenthal, 'Principles of Metal Casting', Tata McGraw Hill Publishing Ltd., 2001.

17ME2007 METROLOGY LABORATORY

Credits: 0:0:1

Course Objectives:

To impart knowledge on

- Working principles of linear and angular measuring instruments.
- The measurement of linear and angular dimensions of work piece specimens using measuring instruments
- The methods of form measurements

Course Outcomes:

Ability to

- Carry out- measurements using linear measuring instruments.
- Demonstrate measurements using angular measuring instruments.
- Calibrate linear and angular measuring instruments.
- Construct process control charts for quality control
- Inspect screw threads for different forms of errors.
- Suggest suitable measuring instruments for various engineering applications.

List of experiments:

1. Calibration of vernier height gauge using slip gauges and to draw the calibration graph.
2. Measurement of angle of the V blocks by using bevel protractor.
3. Measurement of taper angle using sine bar and sine centre along with slip gauges.
4. Measurement of circularity of the given shaft by using bench centre method and V block method and to draw the polar graph.
5. Calibration of micrometer and vernier caliper by using slip gauges and to draw the calibration graph.
6. Establishing the control charts ($\bar{X}$, R chart) for the given sample workpieces.
7. Measurement of major diameter, minor diameter, pitch and thread angle measurement of the screw thread by using profile projector.
8. Measurement of major diameter, minor diameter, pitch and thread angle measurements of a small screw thread using Tool maker's microscope.

17ME2008 METALLURGY LABORATORY

Credits: 0:0:1

Course Objectives:

- Gain practical experience with the microstructure and performance of materials.
- Demonstrate to use optical microscope for analysis of materials.
- Impart knowledge to obtain properties of foundry sand

Course Outcomes:

Ability to

- Demonstrate the working principle of optical microscope
- Prepare samples for metallurgical studies following appropriate metallographic procedure and extract metallographic images.

- Determine the strength of foundry sand
- Analyse various phases of Iron Carbon alloy
- Select heat treated alloys for various applications.
- Identify the microstructures of different types of steels, aluminum and copper.

List of Experiments:

1. Study of Metallurgical microscope and Micro hardness Tester, UTM and Pin On Disc Wear tester
2. Determination of strength and permeability of foundry sand
3. Identification of Cast Iron specimen (a) Grey Cast Iron(b) Spheroidal Graphite Iron (c) Malleable Cast Iron
4. Identification of Low-,medium-,and High-Carbon steels
5. Identification of Heat Treated steels: (a) Annealed (b) Normalised (c) Hardened (d) Tempered steels and Case Hardened Steel
6. Identification of brasses and bronzes and aluminum
7. Heat treatment practice-Hardening and tempering
8. Sieve Analysis

17ME2009 FOUNDRY, SMITHY, WELDING AND SHEET METAL LABORATORY

Credits: 0:0:2

Course Objectives:
To impart knowledge on

- Hand tools used in the foundry, welding, smithy and sheet metal laboratories
- Process planning and procedures to develop models in foundry and smithy laboratories
- Sequence of operations adopted in welding and sheet metal laboratories to fabricate various Joints and models

Course Outcomes:
Ability to

- Use appropriate hand tools in the foundry, welding, smithy and sheet metal laboratories
- Apply standard operating procedures to develop models in foundry and smithy laboratories.
- Appraise the use of various equipments such as open furnace and closed furnaces in forging and casting.
- Design and fabricate the various objects in sheet metal using hand tools.
- Assess the capabilities and limitations of these production processes towards manufacturing
- Translate the acquired knowledge and skill to other real time engineering projects.

Exercises:

1. Preparation of green sand mould for a single piece pattern
2. Preparation of green sand mould for split pattern
3. Preparation of green sand mould for split pattern with additional core preparation
4. Making of butt joint by arc welding process
5. Making of lap joint by arc welding process
6. Making of T joint by arc welding process
7. Conversion of round rod into square rod by smithy forging operation
8. Preparation of L bend from square rod by smithy forging operation
9. Preparation of J bends from square rod by smithy forging operation.
10. Making of Rectangular tray by sheet metal operation
11. Making of Hopper by sheet metal operation

17ME2010 MACHINING PROCESSES

Credits: 3:0:0
Prerequisite: Manufacturing Processes [17ME2006]

Course Objectives:
To impart knowledge on

- The principles and applications of Metal cutting Theory

- Construction and working principles of Lathe, Milling, Reciprocating Machine tools, Hole making and Gear cutting operations
- Non-conventional Machining Processes in industry & Research

Course Outcomes:

Ability to

- select the machining processes suitable for machining a component
- generate the process sequences for machining in machine tools to reduce the lead time
- analyse and choose the optimized machining parameters
- select cutting tools for the identified machining sequences
- justify the abrasive machining process based on the surface finish requirements
- implement the non-conventional machining processes for machining hard materials.

Unit I - THEORY OF METAL CUTTING: Mechanics of chip formation, Types of chip – chip curl and chip breaker- orthogonal Vs. Oblique cutting – Merchant circle – shear plane angle according to Merchant – Temperature in metal cutting – Tool life and tool wear – cutting tool materials – cutting fluids.

Unit II - TURNING AND RECIPROCATING MACHINE TOOLS: Centre Lathe – Constructional features – specifications – work holding devices – Turning parameters – cutting tools – geometry. Turning operations – taper turning methods, thread cutting methods, special attachments, machining time and power estimation capstan and turret lathes. Shaper, planer, slotter.

Unit III - MILLING, HOLE MAKING AND GEAR CUTTING: Milling – types of milling machine, milling cutters, milling operations, Dividing head-simple, compound and angular indexing, Drilling, reaming, boring, tapping, machining time calculations Broaching machines: broach construction – push, pull, surface and continuous broaching machines. Gear cutting: forming, generations, shaping, planning and hobbing.

Unit IV - ABRASIVE PROCESSES: Grinding wheel – designation and selection, types of grinding machines – Cylindrical grinding, surface grinding, centerless grinding, honing, lapping, super finishing, polishing and buffing.

Unit V - NON-CONVENTIONAL MACHINING PROCESSES: Need for Unconventional processes - Electrical discharge machining (EDM) – Dielectric fluid – electrode – wire EDM –Electrochemical Machining (ECM) – Electrochemical Grinding (ECG), Ultrasonic Machining (USM) – Abrasive Jet Machining (AJM) – Laser Beam Machining (LBM) – Plasma Arc Machining (PAM).

Text books:

1. P.N Rao "Manufacturing Technology", Metal Cutting and Machine Tools, Tata McGraw- Hill, New Delhi, 2013.
2. S. Kalpakjian, "Manufacturing Engineering and Technology", Pearson Education India Edition, 2014.

Reference books:

1. Roy A. Lindberg, "Process and Materials of Manufacture", PHI / Pearson Education, 4th Edition, 2006.
2. HMT – "Production Technology", Tata McGraw Hill, 2001.
3. S.K. Hajra Choudhray, S.K. Bose, 'Elements of Workshop Technology, Vol. II, Machine Tools', Media Promoters & Publishers (P) Ltd, 2008.

17ME2011 THERMAL ENGINEERING I

Credits: 3:0:0

Prerequisite: Engineering Thermodynamics [17ME2004]

Course Objectives:

To impart knowledge on

- Steam generators and nozzles, Steam turbines.
- Steam turbines and vapour power cycles.
- Air compressors and refrigeration systems.

Course Outcomes:

Ability to

- Estimate the performance of a steam generator
- Analyze the flow through steam nozzles
- Determine the efficiency of the impulse and reaction turbine using velocity triangles
- Describe vapour power cycles

- Calculate the efficiency of a reciprocating air compressor
- Evaluate Coefficient of performance of Refrigeration systems

Unit I - STEAM GENERATORS: Classification of boilers, boiler terms. Performance of steam generator - evaporative capacity, equivalent evaporation, factor of evaporation, boiler efficiency, heat losses in a boiler plant and heat balance calculations.
Unit II - STEAM NOZZLES: Steam nozzles, flow through nozzles - general relation for adiabatic flow - effect of friction - critical pressure ratio, super saturated flow.
Unit III - STEAM TURBINES: Steam turbines, advantages of turbines, Impulse and reaction turbine, Compounding-Pressure compounding, velocity compounding, pressure velocity compounding - velocity diagrams for simple and multi stage turbines. Vapour power cycles: Simple Rankine Cycle, Reheat Rankine cycle, Regenerative Rankine cycle.
Unit IV - AIR COMPRESSOR: Classification and working principle, work of compression with and without clearance. Volumetric, Isothermal and Isentropic efficiency of reciprocating air compressors, multistage compressor and inter-cooling, work of multistage compressor.
Unit V - REFRIGERATION CYCLES: Vapour compression refrigeration cycle, Super heating, sub-cooling and performance calculations. Working principle of vapour absorption system, Ammonia-water, lithium bromide-water systems (Description only), Comparison between vapour compression and absorption systems.

Text Books:
1. Kothandaraman, C.P, Domkundwar S., “Thermal Engineering”, DhanpatRai & Sons, 6^{th} edition, New Delhi, 2015.
2. Rajput. R.K ., “Thermal Engineering”, Laxmi Publications(P) Ltd., 9^{th} Edition, New Delhi, 2014

Reference Books:
1. Rudramoorthy, R., “Thermal Engineering”, Tata McGraw-Hill, New Delhi, 2010
2. Nag, P.K., “Engineering Thermodynamics”, Tata McGraw-Hill, New Delhi, 5^{th} Edition, 2014
3. Arora, C.P., “Refrigeration and Air conditioning”, Tata McGraw-Hill, New Delhi, 3^{rd} Edition, 2013.

17ME2012 KINEMATICS OF MACHINERY

Credits: 3:1:0

Course Objectives:
- To understand the basic components and layout of linkages in the assembly of a system / machine.
- To understand the principles in analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism.
- To understand the function gears and cams in mechanisms and machines.

Course Outcomes:
Ability to
- Find the relation between input and output of simple mechanisms.
- Apply mobility criterion to determine degrees of freedom of a mechanism.
- Determine position, velocity and acceleration of a link in a linkage.
- Employ gears and gear trains in machine design.
- Estimate the effects of friction on motion transmission and machine components.
- Design a cam profile for the given motion characteristics of a follower.

Unit I - BASICS OF MECHANISMS: Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, Mobility – Kutzbach criterion, Gruebler’s criterion – Grashof’s Law – Kinematic inversions of four-bar chain and slider crank chains – Limit positions – Mechanical advantage – Transmission Angle – Description of some common mechanisms – Quick return mechanisms, Straight line generators, Universal Joint – rocker mechanisms.
Unit II - KINEMATICS OF LINKAGE MECHANISMS: Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method– Velocity and acceleration polygons – Velocity analysis using instantaneous centres – kinematic analysis of simple mechanisms – Coincident points – Coriolis component of Acceleration – Introduction to linkage synthesis problem.

Unit III - KINEMATICS OF CAM MECHANISMS: Classification of cams and followers – Terminology and definitions – Displacement diagrams – Uniform velocity, parabolic, simple harmonic and cycloidal motions – Derivatives of follower motions – Layout of plate cam profiles – Specified contour cams – Circular arc and tangent cams – Pressure angle and undercutting – sizing of cams.
Unit IV - GEARS AND GEAR TRAINS: Law of toothed gearing – Involutes and cycloidal tooth profiles – Spur Gear terminology and definitions – Gear tooth action – contact ratio – Interference and undercutting. Helical, Bevel, Worm, Rack and Pinion gears [Basics only]. Gear trains – Speed ratio, train value – Parallel axis gear trains – Epicyclic Gear Trains.
Unit V - FRICTION IN MACHINE ELEMENTS: Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads –Bearings and lubrication – Friction clutches – Belt and rope drives – Friction in brakes- Band and Block brakes.

Text books:

1. Rattan, S.S, "Theory of Machines", 3rd Edition, Tata McGraw-Hill, 2014.
2. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.

Reference books:

1. Uicker J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", 3rd Edition, Oxford University Press, 2010.
2. Ghosh A. and Mallick A.K., "Theory of Mechanisms and Machines", Affiliated East-West Pvt. Ltd., New Delhi, 1988.
3. Rao J.S. and Dukkipati R.V., "Mechanisms and Machine Theory", Wiley-Eastern Ltd., New Delhi, 2006.
4. Khurmi, R.S., "Theory of Machines", 14th Edition, S Chand Publications, 2005 .

17ME2013 FLUID MECHANICS AND MACHINERY

Credits: 3:1:0
Pre-requisite: Engineering Mechanics [17ME2001]

Course Objectives:
To impart knowledge on

- Conservation of mass, momentum and energy in fluid flows.
- Internal flows and dimensional analysis
- To understand working of pumps and turbines.

Course Outcomes:
Ability to

- Recognize the important fluid properties.
- Determine forces acting on immersed bodies.
- Solve fluid flow problems using Conservation principles.
- Determine rate of flow and calculate flow losses through pipes.
- Analyze the relationship between different physical quantities of fluid flow.
- Evaluate the performance of pumps and turbines.

Unit I - FLUID PROPERTIES AND FLUID STATICS: Density – Specific weight - Specific gravity – Viscosity – Surface tension – Capillarity –Perfect gas – Compressibility – Vapour pressure. Fluid Statics: Pascal's law – Measurement of pressure – Manometers, Forces on submerged surfaces – plane and curved surfaces.
Unit II - EQUATIONS OF FLUID FLOW: Types of flow, Velocity and acceleration, Stream line – streak line – path line, velocity potential and Stream function. Differential Equations of continuity and momentum, Free and forced vortex flow, Euler's equation, Bernoulli's equation – Venturi meter – Orifice meter – Pitot tube.
Unit III - FLOW THROUGH CIRCULAR CONDUITS: Laminar flow through circular conduits –Boundary layer concepts – elementary turbulent flow, Loss of energy in pipes – Major and Minor energy losses – Hydraulic gradient line and Total energy line – Pipes in series and parallel, Dimensional analysis – Application of dimensionless parameters – Model analysis.
Unit IV - PUMPS: Impact of Jets: plane and curved – stationary and moving plates. Centrifugal pumps – operation – velocity triangles – performance curves – Cavitation – Multi staging – Selection of pumps. Reciprocating pumps – operating principles – slip – indicator diagram – separation – air vessels.

Unit V - TURBINES: Classification – working principles – Pelton wheel – Francis – Kaplan turbines – Velocity triangles – Similarity laws – Specific speed – Governing of turbines – Surge tanks. Miscellaneous pumps – Jet pump, Gear oil pump, Submersible pump.

Text Books:

1. P.N. Modi and S.M. Seth., "Hydraulics and Fluid Mechanics Including Hydraulics Machines", Standard Book House, 20th Edition, 2015.
2. R.K. Bansal., "A Textbook of Fluid Mechanics and Hydraulic Machines", Laxmi Publications, Revised 9th Edition, 2017.

Reference Books:

1. S.K. Som, G. Biswas and S. Chakraborty, "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw Hill, 3rd Edition, 2013.
2. R.K. Rajput., "A Text book of Fluid Mechanics and Hydraulic Machines", S. Chand, 6th Edition 2015.
3. V.L. Streeter, E.B. Wylie and K.W. Bedford., "Fluid Mechanics", Tata McGraw-Hill, 9th Edition, 2010.
4. Frank M. White., "Fluid Mechanics", Tata McGraw Hill, 8th Edition, 2016.
5. Fox and McDonald., "Introduction to Fluid Mechanics", Wiley India, 9th Edition, 2016.
6. Yunus A. Cengel and John M. Cimbala., "Fluid Mechanics: Fundamentals and Applications", Tata McGraw-Hill, 3rd Edition 2014.

17ME2014 MACHINING LABORATORY

Credits: 0:0:2
Co/Pre-requisite: Machining Processes [17ME2010]

Course Objectives:
To impart knowledge on

- Types of machine tools
- Metal cutting operations .
- Selection of tools for machining operations.

Course Outcomes:
Ability to

- Demonstrate skills to machine cylindrical components using Lathe
- Demonstrate skills to machine V-block, rectangular block and key way using shaping/milling/slotting machine.
- Demonstrate skills to cut spur gear using gear hobbing machine.
- Select appropriate cutting tools
- Interpret component drawings
- Compare the dimensions of the components using measuring instruments.

List of Experiments:

1. Step turning
2. Taper turning
3. Knurling and countersinking
4. Drilling and boring
5. External thread cutting
6. Tapping
7. Machining rectangular block using shaper
8. Machining V- block using shaper
9. Machining rectangular block using milling machine
10. Key way cutting
11. Cylindrical grinding
12. Spur gear cutting.

17ME2015 FLUID MECHANICS AND STRENGTH OF MATERIALS LABORATORY

Credits: 0:0:2

Course Objectives:
To impart knowledge on
- The calibration of Flow measurement devices and calculation of losses due to friction and pipe fittings
- The working of different types of Pumps and Turbines.
- The mechanical properties of materials and apply the theory of mechanics of solids for testing of beams and springs.

Course Outcomes:
Ability to
- Conduct flow measurements in pipes.
- Evaluate performance of pumps and turbines.
- Determine the head losses for internal flows.
- Prepare specimens according to standards.
- Determine mechanical properties of materials through tests.
- Analyze the deflections in beams and springs.

List of Experiments:
1. Determination of Darcy’s Friction Factor.
2. Calibration of Venturi Meter.
3. Calibration of orifice Meter.
4. Determination of Minor Losses in pipes
5. Performance of single stage Centrifugal Pump.
6. Load Test on Pelton Wheel.
7. Tension test on mild steel
8. Test on springs (open coiled springs)
9. Static bending test on wood
10. Deflection tests on cantilever beams
11. Charpy Impact tests
12. a) Double shear test on mild steel
    b) Rockwell Hardness test

17ME2016 MACHINE DRAWING

Credits 0:0:2

Course Objectives:
To impart knowledge on:
- Visualize and represent any matter/object with the help of drawings.
- Working drawings.
- Orthographic drawing of different machine parts.
- Developing assembly drawings.

Course Outcomes:
Ability to
- Understand drafting fundamentals and standards.
- Interpret drawings and extract required information.
- Prepare part drawings of threaded fasteners, keys and rivets.
- Create sectional views of machine components.
- Develop assembly drawings from part drawings.
- Analyze tolerances for the design of engineering components.

List of experiments
1. Conventional Representations of machine parts and symbols
2. Representation of limits, Fits and Tolerances
3. Basics of Geometric Dimensioning and Tolerancing
4. Representation of screw threads and threaded fasteners

5. Sectional views of machine components
6. Illustration of different types of keys and rivets
7. Assembly drawing of cotter Joints with sleeve
8. Assembly drawing of knuckle Joint
9. Assembly drawing of flanged Coupling [Protected Type]
10. Assembly drawing of universal Coupling
11. Assembly drawing of Plummer Block
12. Assembly drawing of machine Vice/screw Jack

Text books:

1. Gopalakrishnan, “Machine Drawing”, Subash Publishers, .Division of Production Engineering, 2007
2. Bhatt, N.D. “Machine Drawing”, Charotar Publishing House, Anand, 2012.

Reference books:

1. Siddheswar, N. P. Kanniah, and V.V.S. Sastry, “Machine Drawing”, Tata McGraw Hill, 2005
2. Bhatt N.D., “Elementary Engineering Drawing”, 26th Edition. Chartor Publishing House, Anand, 2009
3. Revised IS codes; 10711, 10713, 10714, 9609, 1165, 10712, 10715, 10716, 10717, 11663, 11668, 10968, 11669, 8043, 8000.
4. Ajeet Singh, “Machine Drawing”, Tata McGraw Hill Edition, 2012.

17ME2017 COMPUTER AIDED DESIGN AND MANUFACTURING

Credits: 3:0:0

Course Objectives:

- To impart knowledge on the various computer aided design tools for industrial applications
- To provide an overview on the graphical entities of CAD/CAM and computer numerical programming
- To make the students understand the application of computers in manufacturing sectors

Course Outcomes:

Ability to

- Outline the process of representing graphical entities in a CAD environment
- Construct the geometric model using different techniques to represent a product
- Interpret the geometric function of various elements of a CNC machine tool
- Program and operate the CNC Machines by identifying proper cutting tools
- Analyse the models for design solutions using FEM.
- Discuss the various computer aided tools implemented in various industrial applications

Unit I - Introduction to CAD/CAM:

CAD/CAM- Contents and tools – History of CAD/CAM Development, Product cycle of CAD/ CAM, Benefits of CAD/CAM, Product engineering – Rapid Prototyping – Sequential and Concurrent Engineering – CAD Standards – IGES, GKS and PDES.

Computer Graphics Display and Algorithms**:** Graphics Displays, DDA Algorithm – Bresenham’s Algorithm – Coordinate systems – Transformation of geometry – Translation, Rotation, Scaling, Reflection, Homogeneous Transformations – 2D and 3D Transformations – Concatenation – line drawing-Clipping and Hidden line removal algorithms – viewing transformations

Unit II - Geometric Modeling: Wireframe models and entities – Curve representation – parametric representation of analytic curves – circles and conics – Hermite curve – Bezier curve – B-spline curves – rational curves. Surface Modeling – Surface models and entities – Parametric representation of analytic surfaces – Plane surfaces – Synthetic surfaces – Bicubic Surface and Bezier surface and B-Spline surfaces. Solid Modeling – Models and Entities – Fundamentals of solid modelling – B-Rep, CSG and ASM.

Unit III - CNC Machine Tools: NC – NC Modes – NC Elements – NC Machine tools. CNC Hardware – Structure of CNC Machine tools – Spindle design – Drives – Actuation systems – Feedback Devices – Axes – Standards – CNC tooling – cutting tool materials – turning tool geometry – milling tooling system – tool presetting – ATC – work holding – cutting process parameter selection – CNC Machine tools – CNC Machining centres – CNC turning centres – High speed machine tools – machine control unit and support systems.

Unit IV - CNC Programming: Part Programming fundamentals – manual part programming – preparatory functions – miscellaneous functions – program number – tool compensation – canned cycles – cutter radius compensation – Advanced part programming – polar coordinates – parameters – looping and jumping – subroutines – Computer aided part programming – concepts of CAP – APT language and simple programs, Introduction to Computer Integrated Manufacturing (CIM)

Unit V - Finite Element Analysis: Basic concepts – General applicability of the method to structural analysis, heat transfer and fluid flow problems – Boundary Value Problems and Initial Value Problems – General Procedure of FEA – Element Types and its Characteristics – Boundary conditions – Convergence and Continuous criteria.

Text books:

1. Ibrahim Zeid, "CAD - CAM Theory and Practice", Tata McGraw Hill Publishing Co. Ltd., 2009.
2. Kunwoo Lee, "Principles of CAD/CAM/CAE Systems", Addison Wesley, 2005.

References Books:

1. Rao. S.S. "The Finite Element Method in Engineering", 2nd Edition, Pergamon Press, Oxford, 2009.
2. P.N. Rao, "CAD/CAM Principles and Applications", Tata McGraw Hill Publishing Co. Ltd., 2010.
3. Groover and Zimmers, "CAD/CAM: Computer Aided Design and Manufacturing" PHI, New Delhi, 2003.

17ME2018 THERMAL ENGINEERING II

(Use of standard thermodynamic tables, Mollier diagram, Psychometric chart and Refrigerant, property tables are permitted.)

Credits: 3:0:0

Prerequisite: Engineering Thermodynamics [17ME2004]

Course Objectives:

To impart knowledge on

- Internal combustion engines, gas power cycles and air conditioning.
- Isentropic flow, Fanno flow and Rayleigh flow
- Gas turbines and jet propulsion

Course Outcomes:

Ability to

- Evaluate the performance of internal combustion engine
- Estimate the efficiency of gas power cycles
- Determine cooling loads in air–conditioning systems
- Explain isentropic flow through variable area
- Describe Fanno flow and Rayleigh flow
- Analyze gas turbines cycles and compare the operational aspects of jet engines.

Unit I - INTERNAL COMBUSTION ENGINE: Classification of IC engines, IC engine components and functions. Valve timing diagram and port timing diagram. Comparison of two stroke and four stroke engines. Fuel supply systems, ignition systems, lubrication system, cooling system, knocking and detonation. Testing and performance of I.C. Engine.

Unit II - GAS POWER CYCLES: Otto cycle, Diesel cycle, Dual cycle, Brayton cycle, calculation of mean effective pressure and air standard efficiency.

Unit III - AIR–CONDITIONING: Introduction, Air–conditioning systems, Air–conditioning equipment, components and controls. Air distribution and cooling load estimation.

Unit IV - GAS DYNAMICS: Isentropic flow – Isentropic flow through variable area, Mach number variation, area ratio as a function of Mach number, impulse function, flow through nozzles and diffusers. Fanno flow and Rayleigh flow.

Unit V - GAS TURBINES AND JET PROPULSION: Classification of gas turbines, Constant pressure combustion gas turbine– open, closed cycle. Jet Propulsion – Turbo jet engine, Ram jet engine, Rocket Propulsion.

Text Books:

1. Kothandaraman, C.P, Domkundwar S., "Thermal Engineering", Dhanpat Rai & Sons, 6th Edition, New Delhi, 2011.
2. Rajput.R.K ., "Thermal Engineering", Laxmi Publications(P) Ltd., 9th Edition, New Delhi, 2013.

Reference Books:

1. Rudramoorthy R., "Thermal Engineering", Tata McGraw–Hill, New Delhi, 2010.

2. Mahesh M Rathore., “Thermal Engineering”, Tata McGraw Hill Education Private limited, New Delhi, 2010
3. S.M Yahya., “Fundamentals of Compressible Fluid Flow”, New Age International Publishers, 4th edition, New Delhi, 2012.
4. Arora C.P., “Refrigeration and Air Conditioning”, Tata McGraw–Hill, 3rd Edition, New Delhi, 2013.

17ME2019 DYNAMICS OF MACHINERY

Credits: 3:1:0

Course Objectives:
To impart knowledge on
- Turning moment diagrams employed in flywheel and forces involved in reciprocating engines.
- Balancing procedures for rotating and reciprocating engines.
- Fundamentals of free and forced vibrations.

Course Outcomes:
Ability to
- Demonstrate an understanding of turning moment diagrams in various applications.
- Demonstrate skills to design flywheel for an IC engine and punching press with the consideration of geometrical and economical constraints.
- Perform static and dynamic balancing of high speed rotary and reciprocating machines.
- Analyze free vibrations of machines, engines and structures.
- Analyze forced vibrations of machines, engines and structures.
- Calculate gyroscopic couple on various vehicles and apply concept of governors.

Unit I - DYNAMIC FORCE ANALYSIS: D’Alembert’s principle – Equivalent offset inertia force – Dynamic analysis of four bar mechanism – Dynamic Analysis of reciprocating engines – Piston effort, Crank effort, Turning moment on crankshaft, Inertia of connecting rod – Inertia force in reciprocating engines (Graphical method).Turning moment diagrams – Single and multi cylinder engines – Fluctuation of energy – Fly Wheels – Applications in engines and punching presses.

Unit II - BALANCING: Static and Dynamic balancing of rotating masses – Balancing of reciprocating masses – Balancing of locomotives – Partial balancing of reciprocating masses – Multi cylinder Inline and radial engines.

Unit III - VIBRATION – SINGLE DEGREE OF FREEDOM SYSTEMS: Introduction to vibration – Terminology – Classification of vibrations – Undamped and Damped free vibration of single degree of freedom systems – Viscous damping.

FORCED VIBRATION: Forced vibration – harmonic excitation – Magnification factor – Vibration isolation and Transmissibility.

Unit IV - TRANSVERSE AND TORSIONAL VIBRATION SYSTEMS: Transverse vibrations of shafts and beams – Rayleigh’s and Dunkerley’s method – Whirling of shafts. Torsional vibrations – Single rotor, two rotors and three rotors systems – Free vibration of geared systems.

Unit V - MECHANISM FOR CONTROL: Functions of Governors – Gravity controlled and Spring controlled governor characteristics. Stability – Hunting and Isochronisms. Effect of friction – Calculation of equilibrium speeds and ranges of speed of governors.Gyroscopic couple – Gyroscopic effects on the movement of air planes and ships – Stability of two wheel drive and four wheel drive – Gyroscope stabilization.

Text books:
1. Rattan, S.S, “Theory of Machines”, 4th Edition, Tata McGraw–Hill, 2014.
2. S. Balaguru, “Dynamics of Machinery”, 4th Edition, SCITECH Publications Pvt. Ltd., 2014

Reference books:
1. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw–Hill, 2009.
2. Uicker, J.J., Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”, 3rd Edition, Oxford University Press, 2010.
3. Ghosh. A and Mallick, A.K., “Theory of Mechanisms and Machines", Affiliated East–West Pvt. Ltd., New Delhi, 2006.
4. Rao J.S. and Dukkipati R.V., "Mechanisms and Machine Theory", Wiley–Eastern Ltd., New Delhi, 1992.

5. William T Thomson, Marie Dillon Dahleh and Chandramouli Padmanabhan, “Theory of Vibration with Applications”, 5th Edition, Pearson Education Publishers, 2008.
6. Khurmi R.S., “Theory of Machines”, 14th Edition, S. Chand Publications, 2005

17ME2020 DESIGN OF MACHINE ELEMENTS

(Use of approved data books are permitted)

Credits: 3:1:0
Prerequisites: Mechanics of Solids [17ME2005]

Course Objectives:
To impart knowledge on

- Design principles and basic design procedures.
- Using design data for the design of mechanical elements.
- Applying topics learned in Engineering Mechanics and Mechanics of Solids to actual machine elements.

Course Outcomes:
Ability to

- Understand the standard design procedure for Design of machine elements.
- Analyse stresses acting on components and determine the size based on theories of failure.
- Design machine components for a given load condition using design data hand books.
- Decide specifications as per standards given in design data and select standard components to improve interchangeability.
- Design and develop nonstandard machine components.
- Prepare a detail design layout and drawing of machine components.

Unit I - STRESSES IN MACHINE MEMBERS: Introduction to the design process, Factors influencing machine design, selection of materials based on physical and mechanical properties. Direct, bending, torsional and combined stress equations, Impact and shock loading. Criteria of failure, stress concentration factor, size factor and surface finish factor – Factor of safety, Theories of failures – simple problems.
Unit II - VARIABLE AND CYCLIC LOADS AND SPRINGS: Variable and cyclic loads – fatigue strength and fatigue limit – SN curve, combined cyclic stress, Soderberg and Goodman equations – Design of helical, leaf, disc and torsional springs under constant loads and varying loads.
Unit III - SHAFTS AND COUPLINGS: Design of solid and hollow shaft based on strength, rigidity and critical speed. Design of keys, keyways, Bolts and nut joints. Design of Rigid and Flexible couplings.
Unit IV - JOINTS: Design of bolted, riveted and welded joints – pressure vessels and structures, Threaded fasteners, Cotter joints, Knuckle joints and pipe joints.
Unit V - DESIGN OF ENGINE COMPONENTS: Design of piston, connecting rod, crankshaft, and flywheel.

Text books:
1. S.Md. Jalaludeen, “Machine Design”, Anuradha Publications, Chennai 2011.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett, “Mechanical Engineering Design”, 8th Edition, Tata McGraw–Hill, 2015.

Reference books:
1. Bhandari V, “Design of Machine Elements”, 4th Edition, Tata McGraw–Hill Book Co., 2016.
2. Sundarrajamoorthy T.V. and Shanmugam, ‘Machine Design’, Khanna Publishers, 2003.
3. Bernard Hamrock, “Fundamentals of Machine Elements”, McGrawHill, 2014.
4. Hall and Allen, “Machine Design”, Schaum Series, 2001.

Hand book:
1. Design Data – Data Book for Engineers, PSG College of Technology, Coimbatore, Kalaikathir Achchagam 2012.

17ME2021 COMPUTER AIDED ENGINEERING LABORATORY

Pre–requisites: Machine Drawing [17ME2016]

Credits: 0:0:2

Course Objectives:

To impart knowledge on

- Handling the 3D modelling softwares.
- Modelling products of industrial system.
- Analysis of structural and thermal engineering

Course Outcomes:

Ability to

- Recognize the applications of software in 3D modelling/analysis of Mechanical Engineering components
- Construct the 3D model using various commands like extrude, mirror, revolve etc
- Model 3D mechanical components like knuckle joint, plummer block using appropriate modelling/ assembling commands
- Build the 3–D model/ Assembly model and to create bill of materials.
- Identify the domain of the problem and select element, boundary condition, solvers for 2D problems
- Analyse the models for design solutions using software

List of Exercises:

Introduction to 3–D modeling software

1. 3D modeling using Extrude, Round, Mirror commands
2. 3D modeling using Revolve, Hole, shell, and pattern commands
3. Assembly of Knuckle Joint or Universal Joint/Plummer block or flange coupling/ Lathe Tailstock
4. Advanced modeling commands Sweep and Blend.
5. Drafting/Generation of bill of materials

Introduction to Simulation software

6. Force and Stress analysis of 2D Truss
7. Stress and deflection analysis in beams with different support conditions.
8. Analysis of Bicycle Frame
9. Static Analysis of Bracket or Corner Bracket
10. 2D Heat Conduction within a Solid
11. Thermal Analysis of 2D Chimney
12. Thermal Analysis of 3D Fin
13. Vibration analysis of spring–mass systems

17ME2022 THERMAL ENGINEERING LABORATORY

Co/Prerequisite: Thermal Engineering I [17ME2011]

Credits: 0:0:2

Course Objectives:

To impart knowledge on

- The performance characteristics of various thermal systems and internal combustion engines
- The design calculations of different thermal equipment
- The boiler operation and conduct a performance test on a steam turbine

Course Outcomes:

Ability to

- Evaluate the performance of refrigeration, heat pump and air–conditioning cycles
- Conduct a variety of experiments in internal combustion engines
- Estimate emission contents in the exhaust gases through emission test
- Analyze the efficiency and performance of two stage reciprocating air compressor
- Calculate & compare the performance parameters of air blower
- Determine the principle of various parameters in the performance of steam turbine

List of Experiments

1. Measurement of coefficient of performance in a vapour compression refrigeration cycle

2. Measurement of coefficient of performance in a heat pump apparatus
3. Determination of coefficient of performance in air–conditioning cycle
4. Measurement of performance parameters on air blower
5. Measurement of performance parameters on two stage reciprocating air compressor
6. Performance test and study on the steam turbine apparatus
7. Performance test on variable compression ratio, 4 stroke petrol engine
8. Performance test on four–stroke twin cylinder vertical Diesel engine
9. Heat balance test on four stroke single cylinder Diesel engine
10. Performance test on four stroke single cylinder Diesel engine
11. Heat balance test on four–stroke twin cylinder vertical Diesel engine
12. Retardation test on four stroke single cylinder vertical Diesel engine

17ME2023 DYNAMICS LABORATORY

Credits: 0:0:2

Course objectives:
To impart knowledge on

- Principle and operations of vibration based systems
- Measuring devices used for dynamic testing
- Forces in various equipment based on theoretical and experimental methods

Course outcomes:
Ability to

- Demonstrate the effect of unbalances resulting from rotary motions
- Study the effect of dynamics on vibrations in single and multi–degree of freedom system
- Understand the principle and mechanism used in governor /gyroscope
- Evaluate cutting forces using dynamometer
- Classify the systems of vibration and evaluate natural frequency using experimental & experimental methods
- Demonstrate the effect of forces in Differential Gear/ Centrifugal clutch/ four bar mechanism under dynamic conditions

List of experiments:

1. Longitudinal vibration for single degree of freedom
2. Torsional Vibration for single rotor system
3. Forced vibration in equivalent spring mass system
4. Whirling of shaft
5. Jump speed analysis of cam and follower
6. Transmissibility ratio in vibration table
7. Universal Governor apparatus
8. Dynamic balancing of single rotor system
9. Turn table apparatus
10. Forces in Lathe tool dynamometer/ Centrifugal clutch
11. Gyroscopic couple
12. Four bar mechanism–wiper setup

17ME2024 HEAT AND MASS TRANSFER

Prerequisite: Engineering Thermodynamics [17ME2004]
Credits: 3:0:0

Course Objectives:
To impart knowledge on

- Conduction, convection and radiation.
- Analytical and computational tools to investigate heat and mass transport phenomena.
- Designing heat transfer equipment with increased efficiency.

Course Outcomes:
Ability to

- Interpret conduction, convection and radiation heat transfer.
- Formulate and solve one and two dimensional conduction heat transfer problems.
- Determine values of the convection heat transfer coefficient by applying empirical correlations.
- Analyze and design heat exchangers.
- Apply mass transfer correlations to process–based problems.
- Evaluate radiation heat transfer between black, gray surfaces and the surroundings.

Unit I - CONDUCTION: Fourier's law of conduction, thermal conduction equation. Derivation in Cartesian, Cylindrical and Spherical coordinates. One dimensional steady state conduction in plane wall and composite wall. Thermal resistance concept. Electrical analogy. Overall heat transfer coefficients, critical thickness of insulation. Heat generation in plane wall, cylinder and sphere. Steady State conduction in two dimensions, conduction shape factor, numerical method of analysis. Unsteady state conduction – lumped heat capacity systems, significance of Biot and Fourier numbers, use of Heisler and Grober charts.
Unit II - CONVECTION: Concept of hydrodynamic and thermal boundary layers. Significance of non–dimensional numbers in convection. Dimensional analysis in free and forced convection. Forced Convection over a flat plate, flow through pipes. Free Convection from vertical, horizontal and inclined surfaces. Fins with different boundary conditions.
Unit III - HEAT EXCHANGERS Types of heat exchangers, overall heat transfer coefficients, LMTD and NTU methods, fouling factor, problems in heat exchangers, effectiveness.
Unit IV - RADIATION: Nature of thermal radiation, black body concepts, gray body, radiation shape factor, relation between shape factors, radiation heat transfer between two surfaces. Electrical analogy, Re–radiating surface, radiation shields.
Unit V - MASS TRANSFER: Fick's law of diffusion, equimolal counter diffusion, Convective mass transfer coefficient, non–dimensional number in mass transfer, evaporation process in the atmosphere.

Text Books:

1. R. C. Sachdeva, 'Heat and Mass Transfer', Wiley Eastern, 2017
2. J.P. Holman, 'Heat Transfer', SI Metric 10th Ed., McGraw Hill, ISE, 2011.

Reference Books:

1. P.K. Nag, "Heat Transfer", Tata McGraw Hill, New Delhi, 2011.
2. P.S. Ghoshdastidar, "Heat Transfer", Oxford, 2012,
3. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 2010
4. C.P. Kothandaraman, "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 2012.
5. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 2011.

17ME2025 RESOURCE MANAGEMENT

Credits: 3:0:0

Course Objectives:
To impart knowledge on

- Linear Programming techniques.
- Job sequencing problems, Transportation and assignment problems.
- Inventory models, PERT/CPM and Queuing theory.

Course Outcomes:
Ability to

- Correlate this subject knowledge with the engineering problems.
- Construct flexible appropriate mathematical model to represent physical problem
- Schedule their engineering projects by using network analysis
- Analyze the transportation problem and optimize the resources and output
- Apply their knowledge in solving their engineering queuing problems.
- Develop their skills in decision making analysis by allocation of resources

Unit I - LINEAR PROGRAMMING PROBLEM: Formulation of LPP – Graphical Method – Simplex Method – Artificial variable technique and two phase simplex method. Duality – Dual and simplex method – Dual Simplex Method – Sequencing: Job sequencing – n jobs through two machines and three machines

Unit II - TRANSPORTATION PROBLEM: Transportation Model, finding initial basic feasible solutions using least cost method, Vogells's approximation method and North–West corner method, moving towards optimality through MODI method, Resolving degeneracy in transportation

Unit III - ASSIGNMENT PROBLEM: Solution of an Assignment problem, Multiple Solution, Hungarian Algorithm, Maximization in Assignment Model, Impossible Assignment.

Unit IV - NETWORK ANALYSIS: Network diagram – probability of achieving completion date – crash time – cost analysis – PERT & CPM

Unit V - INVENTORY AND QUEUING MODELS: Economic order quantity models – techniques in inventory management – ABC analysis. Queuing problems with single server with finite and infinite population size, queuing problems with single server with finite and infinite queue size,

Text Books:

1. S. Bhaskar, "Operations Research", Anuradha Agencies, Chennai 2013
2. Natarajan A.M., Balasubramani P., Thamilarasi A., "Operations Research", Pearson Education, 1st Edition, 2014.

Reference books:

1. Hamdy Taha A., "Operations Research", 6th Edition Prentice – Hall of India Private Limited, New Delhi, 2010.
2. Kanti Swarup, Manmohan, Gupta P.K., "Operations Research" Sultan Chand & Sons., 14th Edition 2014.
3. Srinivasan G., "Operations Research", Prentice – Hall of India Private Limited, New Delhi, 2010.
4. Winston, "Operations Research, Applications and Algorithms" – Cengage Learning, 4th Edition, 2004.
5. S. Pannerselvam, "Operations Research", Prentice – Hall of India Private Limited, New Delhi, 2006.

17ME2026 FLUID POWER CONTROL ENGINEERING

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- The fundamental principles of fluid power systems
- The design and operation of hydraulic and pneumatic machines, components and systems
- Application in industrial automation

Course Outcomes:

Ability to

- Interpret the standard symbols and laws used in FPC Systems
- Infer the working principles of pumps and motors
- Identify the suitable elements of a fluid power systems for a particular application.
- Examine hydraulic circuits for an industrial application.
- Assess the optimal components of pneumatic system
- Build a logic circuit for an industrial problems.

Unit I - FLUID POWER SYSTEMS: Introduction, history, basic laws, applications, types of fluid power systems, fluid types and properties. Comparison of power systems, Fluid power symbols. Oil–Hydraulic Pumps – Types – design and construction, gear pumps, vane pumps, piston pumps and pump performance, numerical problems, Hydraulic Motors –Types, theoretical torque, power and flow rate, performance and numerical problems.

Unit II - ELEMENTS OF HYDRAULIC SYSTEMS: Fluid reservoir, Cylinders – construction, Mechanics of cylinder loading, Types, Selection, Pressure accumulators – types, directional control valves, restrictors, check valve, flow control valves relief valve, hydraulic servo systems, Cartridge valves, Hydraulic fuses, Temperature and pressure switches, Shock Absorbers, electromechanical devices like relays and solenoids.

Unit III - OIL–HYDRAULIC CIRCUITS: Reciprocation, quick return, Speed control circuits, sequencing, synchronizing circuits, clamping and accumulator circuits, press circuits and hydro –pneumatic circuit.

Unit IV - PNEUMATIC SYSTEMS AND CIRCUITS: Compressor – types, Air servicing Unit, Cylinders – construction, Types, Section, directional control valves, check valve, flow control valves, other special valves, Boolean algebra, truth tables, reciprocation, quick return circuit, cascade circuits / sequencing circuits like $A^+B^+ A^- B^-$, electro–pneumatic circuits,

Unit V - TYPICAL INDUSTRIAL APPLICATIONS: MPL control of Fluid power circuits, fluidic elements and fluidic sensors, Basic concepts of programmable logical control, Fail–safe Circuits, Intensifier circuits, Box–sorting System, Electrical Control of Regenerative Circuit, Hydro–pneumatic circuit. Fault finding and maintenance, Hydraulic and Pneumatic power packs.

Text Books:

1. R. Srinivasan "Hydraulic and Pneumatic Controls" 2nd Edition, Tata McGraw–Hill Education, 2008
2. Anthony Esposito, "Fluid Power with Applications", Pearson Education Inc., 7th Edition, 2014..

Reference books:

1. John J Pippenger, Adrian Mitchell, Richard J Mitchell, "Fluid Power Maintenance Basics and Troubleshooting", Hardcover, Edition: 01, 1997.
2. M.K. Medhat, Dr. Khalil "Electro–Hydraulic Components and Systems: Hydraulic Systems Volume 2" Hardcover – Import, 1 Jan 2017.
3. K. Shanmugasundaram, "Hydraulic and Pneumatic controls", Chand & Co., 2012.
4. S. Ilango, V. Soundararajan, "Introduction to Hydraulics and Pneumatics" Paperback, PHI Learning Pvt. Ltd., 2011.
5. S.R. Majumdar, "Oil Hydraulics Systems – Principles and Maintenance", Tata McGraw Hill, 2002

17ME2027 DESIGN OF MECHANICAL TRANSMISSION SYSTEMS

(Use of approved data books are permitted)

Prerequisite: Design of Machine Elements [14ME2020]

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Machine elements by specifying their type, geometry, material etc., and to integrate these elements to build a mechanical system.
- Usage of design data book to design standard machine elements like bearings, gears and other elements.
- Different mechanical transmission components and mechanisms.

Course Outcomes:

Ability to

- Select suitable principles and design flexible elements like Belt, rope, chain drives and bearings.
- Determine the dimensions and design the different types of gears using standard procedure.
- Estimate the layout and design gear boxes based on load and speed requirements.
- Design various types of cams, clutches and brakes for a given application.
- Analyze mechanical systems for machine elements from standard data books and catalogues for a required application.
- Know the applications of the various mechanical systems, materials used to make them and methods used.

Unit I - DESIGN OF FLEXIBLE ELEMENTS AND BEARINGS: Design of Flat belts and V belts, Design of Journal bearings – Sliding contact and Rolling contact.

Unit II - CHAIN AND ROPE DRIVES, SPUR GEARS AND HELICAL GEARS: Design and selection of Transmission chains and hoisting wire ropes, Design of gears – Spur gear, helical gear and Herring–bone gears, Skew gears.

Unit III - BEVEL AND WORM GEARS: Design of bevel gears – Straight and Spiral bevel types, Design of worm gears, Design of a Ratchet and pawl mechanism, Design of Geneva mechanism.

Unit IV - GEAR BOXES: Geometric progression, Standard step ratio, Ray diagram, Kinematics layout – Design of multi speed gear box for machine tool applications, Speed reducer unit and Stepped pulley.

Unit V - CAMS, CLUTCHES AND BRAKES: Design of cams – Contact stress and Torque calculation, Design of Power Screws, Design of plate clutches – Axial clutches and Cone clutches, Design of Internal and External shoe brakes.

Text books:

1. Md. Jallaudeen, "A Text book of Machine Design", Anuradha Publications 2006.
2. Prabhu. T.J , " Design of Transimission Elements", Mani Offset, Chennai, 2000.

Reference books:

1. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 8^{th} Edition, Tata McGraw–Hill, 2014.
2. Sundarajamoorthy T.V. and Shanmugam, "Machine Design", Khanna Publishers, 2003.
3. Sen G. C. & Bhattacharyya A, "Principles of Machine Tools", New Central Book Agency (P) Ltd., 2009.
4. Bhandari V, "Design of Machine Elements", 4^{th} Edition, Tata McGraw–Hill Book Co., 2016.
5. Bernard J. Hamrock, 'Fundamentals of Machine Elements', 3^{rd} Edition, McGraw–Hill Companies, 2014.
6. Hall A.S., Holowenko A.R. and Laughlin H.G., "Theory and Problems in Machine Design", Schaum's Series, 2000.

Hand book

1. Design Data – Data Book for Engineers, PSG College of Technology, Coimbatore, Kalaikathir Achchagam 2012.

17ME2028 HEAT TRANSFER LABORATORY

(Use of standard Heat and Mass Transfer data book is permitted)

Co/Prerequisite: Heat and Mass Transfer [17ME2024]
Credits: 0:0:2

Course Objectives:
To impart knowledge on

- The heat transfer characteristics of various heat transfer apparatus
- The design calculations of different modes of heat transfer
- Conducting the heat transfer experiments and practically learn how to find heat transfer coefficients

Course Outcomes:
Ability to

- Calculate and compare the thermal conductivity of different materials.
- Predict the convective heat transfer coefficient by free convection.
- Analyze the performance of forced convective heat transfer coefficient through pin–fin.
- Evaluate the performance of radiation through black and gray bodies.
- Analyze the performance parameters of parallel flow heat exchanger.
- Analyze the performance parameters of counter flow heat exchanger.

List of Experiments

1. Measurement of thermal conductivity through a composite wall.
2. Measurement of thermal conductivity in a lagged pipe.
3. Determination of thermal conductivity in a guarded plate.
4. Measurement of heat transfer coefficient in a vertical cylindrical rod by free convection.
5. Measurement of heat transfer coefficient in a flat plate by natural convection.
6. Determination of heat transfer coefficient in a fin–pin by free convection.
7. Determination of heat transfer coefficient in a fin–pin by forced convection.
8. Measurement of heat transfer coefficient in a forced convection apparatus.
9. Determination of emissivity of the given test surface.
10. Determination of Stefan–Boltzmann constant in radiation heat transfer.
11. Determination of heat transfer coefficient in a parallel flow heat exchangers.
12. Determination of heat transfer coefficient in a counter flow heat exchangers.

17ME2029 CAM LABORATORY

Credits: 0:0:2
Prerequisite: Machining Laboratory [17ME2014]

Course Objectives:
To impart knowledge on

- NC programming for CNC turning and milling operation and execution.
- Selection of tools for a machining operation.
- Simulation and verification of machining processes.

Course outcomes:
Ability to

- Know features and applications of CNC turning and machining centers.
- Understand the CNC control in modern manufacturing system.
- Prepare CNC Programming for different mechanical parts using G codes and M codes
- Implement the communication procedure for transmitting the CNC part program from an external computer to the control of the CNC machine tool.
- Generate automated tool paths for a given engineering component.
- Operate a modern industrial CNC machine tool for actual machining of simple and complex mechanical parts.

List of Experiments:

1. Step turning in CNC
2. Taper turning in CNC
3. Taper turning and thread cutting using multiple cutting cycles in CNC
4. Ball Turning in CNC
5. External thread cutting in a CNC Turning center
6. Drilling in a CNC drilling machine
7. Face milling and step milling in Machining center
8. Profile cut using linear and circular interpolation
9. Circular pocketing and slotting in CNC
10. Rectangular pocketing and slotting in CNC
11. Mirror using Subprogram and drilling using drilling cycles
12. Spiral cutting in a CNC 4–axis Trainer Mill
13. Integrating CAM with CNC Machines (demonstration only)

17ME2030 FLUID POWER CONTROL AND MECHATRONICS LABORATORY

Credits: 0:0:2

Course Objectives:
To impart knowledge on

- Application of fluid power symbols
- Designing a suitable hydraulic or pneumatic circuit
- Automating an Industrial application.

Course Outcomes:
Ability to

- Recognise the standard symbols used in fluid power circuits.
- Illustrate the working principles of valves
- Assess the suitable component for a particular application.
- Construct the hydraulic circuits for an industrial application.
- Build a pneumatic circuit and apply them to real life problems.
- Design and develop a plc controlled pneumatic circuit for industrial application.

List of Experiments:

1. Study of standard fluid power symbols
2. Development of basic pneumatic logic Circuits
3. Design of pneumatic speed control circuits

4. Application of time delay valve and pressure Sequence Valves in a pneumatic circuit.
5. Design of pneumatic circuit for material handling system
6. Design of electro–pneumatic circuit by using relay, limit switch and solenoids.
7. Design of Electro–pneumatic circuit for cascade system of sequence A+B+C+A–B–C–.
8. Construct hydraulic speed control circuits
9. Create electro–hydraulic circuit for continuous reciprocation of DAC using limit switches
10. Provide solution for an electro–hydraulic circuit using proximity sensors.
11. Design and develop PLC controlled pneumatic logic circuits
12. Simulation of PLC controlled pneumatic circuit for material handling unit

17ME2031 FINITE ELEMENT ANALYSIS

Credits: 3:0:0

Course Objective:

- To impart the knowledge to the students on the use of FEM to various Engineering Problems.
- To introduce the concepts of Mathematical Modeling of Engineering Problems
- To know the principles involved in discretization and finite element approach.

Course Outcomes:

Ability to

- recognise the use of FEM in various engineering problems and application
- outline the different formulation of field problems and governing equations for different models and problems
- Interpret the steps to find stiffness matrix and shape function for structural and thermal problems using suitable approaches.
- Demonstrate and categorise the 2D continuum and their various applications.
- Illustrate the axisymmetric continnum and find stress, temperature and velocity head based on the application.
- Analyse the various isoparametric 2D continuum elements in 1-D, 2-D and 3-D.

Unit I - INTRODUCTION: Historical background – Matrix approach – Application to the continuum – Discretisation – Matrix algebra –General field problems, Governing equations- Weighted Residual Method- Ritz method.

Unit II - ONE DIMENSIONAL PROBLEMS: Finite Element Modeling- FEM analysis of one dimensional problems- Coordinates and Shape functions- Derivation of Shape functions- discretization of domain, element equations and assembly, derivation of stiffness matrices and load vectors- Solution of problems from solid mechanics and heat transfer

Unit III - TWO DIMENSIONAL CONTINUUM: Second order equation involving a scalar variable function – Triangular and quadrilateral elements- Shape functions and element matrices and force vectors- Application to Field Problems - Thermal problems

Unit IV - AXI-SYMMETRIC CONTINUUM: Equations of elasticity- Plane stress, plane strain and axisymmetric problems- Element stiffness matrix- body forces- Temperature effects- Stress calculation- head and fluid flow problems, time dependent problems- Application to Cylinder under internal and external pressure.

Unit V - ISOPARAMETRIC ELEMENTS FOR 2-D CONTINUUM: Isoparametric formulation- Shape functions for isoparametric elements-, Lagrangean and serendipity elements- element stiffness matrix- formulation of element equations- Stress calculations- Numerical integration

Text Books:

1. Rao, S.S., “The Finite Element Method in Engineering”, 3rd Edition, Butterworth Heinemann, 2004
2. Logan, D.L., “A first course in Finite Element Method”, Thomson Asia Pvt. Ltd., 2002

Reference Books

1. Seshu, P, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.
2. Reddy. J.N., “An Introduction to the Finite Element Method”, 3rd Edition, Tata McGraw-Hill, 2005
3. Tirupathi, R.Chandrupatla and Ashok, D. Belegundu., "Introduction to Finite Elements in Engineering", Prentice Hall of India Private Limited., New Delhi, 2004.

4. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts and Applications of Finite Element Analysis”, 4th Edition, Wiley Student Edition, 2002.
5. Rajasekaran, S., "Finite Element Methods in Engineering Design", S.Chand& Co Ltd., NewDelhi, 2003.
6. Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons, 2013.

17ME2032 PRINCIPLES OF MECHANICAL VIBRATIONS

Credits: 3:0:0

Course Objectives:
To impart knowledge on

- Formulating mathematical model for vibration problems
- Analyzing the vibration behavior of mechanical systems subjected to loading
- Reduction of vibration and the equipments used for collecting response data.

Course Outcomes:
Ability to

- Classify the systems of vibration and formulate equations of motion for vibratory systems.
- Solve vibration problems with multiple degrees of freedom.
- Suggest methods to regulate vibration
- Perform vibration tests and acquire data from vibration measuring instruments.
- Present the theoretical and the experimental principles of mechanical vibrations to gain practical understanding in the field of vibration
- Recognize unwanted noise in machines and proficient with instrumentation used in noise control tests

Unit I - VIBRATION OF SINGLE DEGREE OF FREEDOM SYSTEM: Introduction – Equation of motion – Newton’s law, Energy methods – free vibration – forced vibration – damping models – Solutions of problems for one degree of freedom systems for transient and harmonic response – Vibration isolation and transmissibility.
Unit II - VIBRATION OF TWO AND MULTI DEGREE FREEDOM SYSTEMS: Equations of motion for Two Degree of freedom systems – generalized coordinates – dynamic vibration absorber – semi definite systems – Multi degree of freedom system
Unit III - NUMERICAL METHODS TO SOLVE VIBRATION PROBLEMS: Numerical methods in vibration problems to calculate natural frequencies – Matrix iteration technique – Stodola’s method, Holzer’s method .
Unit IV - ENGINEERING ACOUSTICS: Basic physical acoustics – acoustic levels and spectra – decibels, sound power, Sound pressure, power and intensity – Character of noise – Addition of two noise sources – Noise source identification. Noise radiation from vibrating bodies sound – properties of the various sources that create noise – Noise in machines and machine elements.
Unit V - EXPERIMENTAL METHODS IN VIBRATION, NOISE TESTING AND ANALYSIS: Vibration instruments – vibration exciters – measuring devices – analysis – vibration Tests – Free, forced environmental vibration tests – Modal and FFT analysis. Introduction to Acoustic Standards, Acoustic / Noise sensors, instrumentation, measurement and noise control instruments and noise propagation.

Text books:
1. Singiresu S. Rao, “Mechanical Vibrations”, Addison Wesley Longman, 2016.
2. Ambekar A.G., “Mechanical Vibrations and Noise Engineering”, Prentice Hall of India, New Delhi, 2006.

Reference books:
1. Benson H Tongue, “Principles of vibration, 2nd Edition, Oxford University Press, 2002.
2. Thomson W.T., “Theory of Vibration with Applications”, CBS Publishers and Distributers, New Delhi, 2014
3. Kelly, “Fundamentals of Mechanical Vibrations”, McGraw Hill Publications, 2000.
4. Rao V. Dukkipati, J. Srinivas, “Vibrations Problem Solving Companion”, Narosa Publishers, 2007.
5. Kewal Pujara. “Vibrations and Noise for Engineers”, Dhanpat Rai & Co, 4th Edition, 2007.

17ME2033 PRODUCT DESIGN AND DEVELOPMENT STRATEGIES

Credits: 3:0:0

Course Objectives:

To impart the knowledge on:

- The important practices followed during designing and developing a product in industry.
- The entire product life cycle right from its conceptual stage to its development stage.
- The concepts like modelling, simulation, material selection and GD&T, aesthetics.

Course Outcome:

Ability to

- Recognize the importance of product design and apply the design process in developing a product.
- Categorize various models in engineering design and select appropriate modeling and simulation techniques for analyzing a product.
- Choose the right material selection method and calculate the economics of a material for a new product.
- Distinguish between the functional and production design and use the right manufacturing method by considering the influence of size, shape and weight of the product.
- Use the Geometrical Dimensioning and Tolerancing rules and systems to select the desired fabrication method to produce the error free product.
- Design and Developing a product in industries by applying the aesthetic and ergonomic considerations

Unit I - NATURE AND SCOPE OF PRODUCT ENGINEERING: Importance of product design, Design Constraints, Safety and reliability considerations, The Design process – A simplified approach, Consideration of a Good Design, Detail description of Design process (Morphology of Design), Technological Innovation and the design process; Product and Process cycle.

Unit II - MODELING AND SIMULATION: The role of Models in Engineering Design – Mathematical modeling, Similitude and scale modeling, Simulation, Finite – Difference method, Monte Carlo method, Geometric modeling on the computer, Finite Element Analysis.

Unit III - MATERIAL SELECTION AND MATERIALS IN DESIGN: Relation of Materials Selection to Design, Performance Characteristics of materials, The Materials Selection process – Design process and materials selection, Ashby charts, Material selection in Embodiment design, Economics of materials, Methods of material selection – Selection with Computer – Aided database, Weighted Property Index, Value analysis, Design examples – Materials systems, Material substitution; simple problems.

Unit IV - FUNCTIONAL AND PRODUCTION DESIGN: Form design – Influence of basic design, Mechanical loading and material on Form design – Form design of Grey castings, Aluminum castings, Forging and Manufacture by machining methods. Influence of Space, Size, Weight, etc., on Form design, Aesthetic and Ergonomic considerations.

Unit V - DIMENSIONING AND TOLERANCING: Dimensioning systems, Dimensioning Rules, Geometric Tolerancing, Datum features, Functional production and Inspection datum, Tolerancing types, Tolerance analysis.

Text books:

1. Dieter. G. E and Linda Schmidt, “Engineering Design", 5th Edition, Tata McGraw Hill, 2010.
2. David A. Madsen, “Engineering Drawing and Design”, Delmar Thomson Learning Inc. 2016.

Reference books:

1. Kevin Otto and Kristin Wood, “Product Design”, Pearson Educational Inc. 2004.
2. Karl T Ulrich, Steven D Eppinger, “Product Design & Development”, Irwin Homeward Boston Publishers, 2016.
3. Robert Matousek, “Engineering Design – A Systematic Approach” Blackie and Son Ltd., London, 1972.

17ME2034 COMPOSITE MATERIALS

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Composite materials and their applications.
- Fabrication, analysis, and design of composite materials and structures.
- Prediction of the mechanical response of multi layered materials and structures.

Course Outcomes:

- Predict elastic properties of composites.
- Predict mechanical properties of fiber reinforced composite materials.
- Design a composite laminate for a given load condition.
- Describe fundamental fabrication processes for polymer matrix composites.
- Make stress analyses using laminated plate theories.
- Compare and contrast different processes of manufacture of polymer composites.

Unit I - STRESS STRAIN RELATION: Introduction – Advantages and application of composite materials, reinforcements and matrices – generalized Hooke's Law – Elastic constants for anisotropic, orthotropic, and isotropic materials.
Unit II - METHODS OF ANALYSIS: Micro mechanics – Mechanics of materials approach, elasticity approach to determine material properties – Macro Mechanics – Stress – strain relations with respect to natural axis, arbitrary axis – Determination of material properties. Experimental characterization of lamina.
Unit III - LAMINATED PLATES: Governing differential equation for a general laminate, angle ply and cross ply laminates. Failure criteria for composites.
Unit IV - SANDWICH CONSTRUCTIONS: Basic design concepts of sandwich construction – Materials used for sandwich construction – Failure modes of sandwich panels.
Unit V - FABRICATION PROCESS: Various Open and closed mould processes. Manufacture of fibers – Types of resins and properties and applications – Netting analysis.

Text books:

1. Calcote L R. "The Analysis of laminated Composite Structures", Von – Noastrand Reinhold Company, New York 1969.
2. Jones R.M., "Mechanics of Composite Materials", McGraw–Hill, Kogakusha Ltd., Tokyo, 1985.

Reference books:

1. Agarwal B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites", John Wiley and sons. Inc., New York, 2006.
2. Lubin G., "Handbook on Advanced Plastics and Fibre Glass", Von Nostrand Reinhold Co., New York, 1989.

17ME2035 DESIGN FOR MANUFACTURING

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- The design principles, the needs of product functionality, product design, and production planning and Product Assembly.
- Product quality by incorporate the reliability, safety functions and robustness of the product.
- Principles of the form design and GD&T for quality manufacturing

Course Outcomes:

Ability to

- Identify and apply the principles of DFM for an integrated design and manufacturing process.
- Select and suggest the materials and interrelations with the manufacturing processes to reduce the overall costs of the product.
- Distinguish between the manufacturing datum and functional datum and apply the principles during the designing and manufacturing.
- Design the components suitable for various manufacturing process such as machining, extrusion, thermo setting and electrical discharge machining.
- Categorize various design features required for better manufacturing output.
- Differentiate between economical and uneconomical design and modify using the principles of DFM, GD&T and Group technology

Unit I - INTRODUCTION: General Design principles for manufacturing – DFM principles and approach, guidelines, standardization – comparison of materials on cost basis, design for assembly, DFA index, poka – yoke, lean principles, six sigma concepts – Process capability –Simple problems.
Unit II - MATERIALS SELECTION: Selection of Materials for design Developments in Material technology – criteria for material selection – Material selection interrelationship with process selection process selection charts – Ashby charts.
Unit III - DATUM FEATURE: Feature tolerances – Geometric tolerances – assembly limits – Datum Features – Functional datum, Machining sequence, manufacturing datum, changing the datum. Problems and Examples. Design features to facilitate machining – drills – milling cutters –Design for machinability – Design for economy – Design for clampability – Design for Accessibility – Design for Assembly.
Unit IV - DESIGN CONSIDERATIONS: Design considerations for the manufacture of extruded, cold headed metal parts – Tube and section bends – powder metal parts – Thermo settings plastic parts – Reinforced – Plastic and Composite parts Machined Components – Design for the manufacture of Turned parts – drilled parts – milled parts, Planned, shaped and slotted parts – Ground parts – parts produced by Electrical discharge machining.
Unit V - DESIGN FEATURES: Principles of GD&T, ASME Y 14.5 standard – Examples for application of geometric tolerances – True Position Theory – Identification of uneconomical design Modifying the design – Group technology – Design for reliability and safety – Robust and quality design. Computer Application for DFMA.

Text Books:

1. George E. Dieter, Linda C. Schmidt “Engineering Design”, 5th Edition, Tata McGraw–Hill, 2012.
2. Geoffrey Boothroyd, Petre Dewhurst, Winston A Knight, “Product Design for Manufacture and Assembly”, CRC Press, Taylor & Francis Group, 2010.

Reference Books:

1. C. Poli, “Design for Manufacturing”, Butterworth–Heinemann, Reed Elsevier Group, 2001.
2. Swift K.G., “Knowledge based design for manufacture”, Kogan Page Ltd., 1987.
3. A.K. Chitale, R.C. Gupta, Product Design and Manufacturing Prentice Hall of India, 2007.
4. Robert Matousek, “Engineering Design – A Systematic Approach” Blackie and Son Ltd., London,1963.

17ME2036 TRIBOLOGY

Credits 3:0:0
Prerequisite: Design of Machine Elements [17ME2020]

Course Objectives:
To impart knowledge on

- Application of basic theories of friction, wear and lubrication.
- The frictional behavior of commonly encountered sliding interfaces.
- Various testing methods for tribological properties.

Course Outcomes:
Ability to

- Apply concepts of friction mechanisms and analyze performance of design components based on relative motion.
- Identify wear mechanisms on macro–scale in metals.
- Recombined lubrications based on the type of lubrication.
- Outline the methods to improve surface engineering
- Generate performance reports of the lubrications using tribo testing methods.
- Understand the fundamentals of tribology and associated parameters.

Unit I - FRICTION: Friction – Adhesion – Ploughing – Energy dissipation mechanisms Friction Characteristics of metals – Friction of non-metals. Friction of lamellar solids – friction of Ceramic materials and polymers – Rolling Friction – Source of Rolling Friction – Stick slip motion – Measurement of Friction.
Unit II - WEAR: Types of wear – Simple theory of Sliding Wear Mechanism of sliding wear of metals – Abrasive wear – Materials for Adhesive and Abrasive wear situations – Corrosive wear – Surface Fatigue wear situations – Brittle Fracture – wear – Wear of Ceramics and Polymers – Wear Measurements.
Unit III - LUBRICANTS, FILM LUBRICATION THEORY AND LUBRICATION TYPES: Types and properties of – Hydrodynamic Lubrication – Elasto–hydrodynamic lubrication – Boundary Lubrication – Solid

Lubrication– Hydrostatic Lubrication. Fluid film in simple shear – Viscous flow between very close parallel plates – Shear stress variation Reynolds Equation for film Lubrication – High speed unloaded journal bearings – Loaded journal bearings – Reaction torque on the bearings – Virtual Co–efficient of friction

Unit IV - SURFACE ENGINEERING AND MATERIALS FOR BEARINGS: Topography of Engineering surfaces – Contact between surfaces – Sources of sliding Surface modifications – Thermo chemical processes – Surface coatings – Plating and anodizing – Fusion Processes – Vapour Phase processes – Materials for marginally lubricated and dry bearings.

Unit V - MECHANICAL DYNAMIC TRIBOLOGY AND TESTING METHODS: Mechanical dynamic testing machines and test methods. dry sand–rubber wheel test, wet sand rubber wheel test, slurry abrasivity test, solid particle erosion test, pin–on–disk wear test, rolling wear test, drum wear test, drill wear test. Lubricants – Testing methods.

Text books:

1. Prasanta Sahoo, "Engineering Tribology", Prentice Hall of India, 2005.
2. Sushil Kumar Srivastava, "Tribology in Industries", S. Chand Publishers, 2005.

Reference books:

1. Engineering Tribology, G.W. Stachowiak and A.W. Batchelor, Butterworth–Heinemann. Engineering Tribology, P. Sahoo, PHI, New Delhi, 2006.
2. A. Cameron, "Basic Lubrication Theory", Longman, U.K., 1981.
3. M.J. Neale (Editor), "Tribology Handbook", Newnes. Butter worth, Heinemann, U.K., 1995.
4. "Principles and Application of Tribology", B. Bhushan, Wiley, 2013.
5. "Fundamentals of Tribology", S. K. Basu, S. N.Sengupatha and D. B.Ahuja, PHI., 2005

17ME2037 DESIGN OF JIGS, FIXTURES AND PRESS TOOLS

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- The principles of designing jigs, fixtures and press tools.
- The use of standard parts in design.
- Be proficient in the development of jigs and fixtures.

Course Outcomes:

Ability to

- Understand the principles of location, clamping and mechanical actuation.
- Develop jigs and fixtures for different operations.
- Adopt standard procedure for the design of Jigs, fixtures
- Analyze tolerances and specify appropriate tolerances for the design of jigs, fixtures and dies.
- Design and develop bending, forming and drawing dies.
- Apply recent developments in tool design.

Unit I - LOCATING AND CLAMPING PRINCIPLES: Objectives of tool design – Function and advantages of Jigs and fixtures – Basic elements – principles of location – Locating methods and devices – Redundant Location – Principles of clamping – Mechanical actuation – pneumatic and hydraulic actuation Standard parts – Drill bushes and Jig buttons – Tolerances and materials used.

Unit II - JIGS AND FIXTURES: Design and development of jigs and fixtures for given component – Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems – Quick change fixtures.

Unit III - PRESS WORKING TOOLS: Press Working Terminologies – operations – Types of presses – press accessories – Computation of press capacity – Strip layout – Material Utilization – Shearing action – Clearances – Press Work Materials – Center of pressure – Design of various elements of dies – Die Block – Punch holder, Die set, guide plates – Stops – Strippers – Pilots – Selection of Standard parts.

Unit IV - BENDING FORMING AND DRAWING DIES: Difference between bending, forming and drawing – Blank development for above operations – Types of Bending dies – Press capacity – Spring back – knockouts –

direct and indirect – pressure pads – Ejectors – Variables affecting Metal flow in drawing operations – draw die inserts – draw beads – ironing – Design and development of bending, forming and drawing dies.

Unit V - ADVANCED PRESS TOOLS: Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine Blanking dies – recent trends in tool design – computer aided sheet metal forming. Tools for high velocity forming, explosive forming and pressure die casting.

Text books:

1. Joshi P.H. "Jigs and Fixtures", 2nd Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2004.
2. Donaldson, Lecain and Goold, "Tool Design", 3rd Edition Tata McGraw Hill, 2012.

Reference books:

1. K. Venkataraman, "Design of Jigs Fixtures & Press Tools", Tata McGraw Hill, New Delhi, 2005.
2. Hoffman "Jigs and Fixture Design" – Thomson Delmar Learning, Singapore, 2004.
3. Design Data Hand Book, PSG College of Technology, Coimbatore, 2012.
4. V. Balachandran, "Design of Jigs, Fixtures and Press Tools", Notion Press; 1st Edition, 2015.

17ME2038 INDUSTRIAL ENGINEERING AND MANGEMENT

Pre requisite: Machining processes [17ME2010]

Credits 3:0:0

Course objectives:

To impart knowledge on

- Work study for the improvement of productivity.
- Planning and management of materials and operations in floor level and plan.
- Modern Industrial engineering approaches.

Course outcomes:

Ability to

- Apply work study techniques to improve working condition and productivity.
- Design an industrial system to optimize various factors of production.
- Analyze the past data for production planning and control.
- Identify suitable plant layout to minimize material handling and to improve productivity.
- Control quality of production using statistical process control and reliability tools.
- Appraise the impact of modern industrial engineering approaches in a global, economic, environmental, and social context.

Unit I - WORK STUDY AND PRODUCTIVITY: Introduction to industrial engineering – objectives and functional areas of Industrial engineering Method Study (Motion Study): Definition, objectives, micro motion study, therbligs, operation chart, flow process chart, man machine chart, SIMO chart. Time Study (Work measurement): uses of time study, procedure, standard time, performance rating, allowances, Methods of time study, Number of cycles to be timed. Productivity–Importance, Measurement of productivity, productivity indices, productivity improvement, Productivity bargaining

Unit II - PRODUCTION PLANNING AND CONTROL: Types of production – job, batch, mass and continuous production – Introduction to PPC, planning, Routing, scheduling, master schedule and subsidiary schedule, dispatching–functions, Follow up, control boards, idle machine time

Unit III - PLANT LAYOUT: Product layout, process layout, cellular manufacturing system, factors influencing layout. Factors governing flow pattern, travel chart, line balancing, work station design, tools and techniques for plant layout, advantages of scientific layout

Unit IV - QUALITY AND RELIABILITY ENGINEERING: Statistical process control–variable control chart X–R chart – X–S chart – attribute control chart – C,P,U and np charts–process capability analysis – over view of 6 sigma – life testing – reliability – reliability of series parallel and mixed configuration.

Unit V - MODERN MANAGEMENT: Business process reengineering–need, steps and process of reengineering .supply chain management (SCM) –objectives and strategies of SCM, Just in Time (JIT) manufacturing, basic elements and benefits of JIT, Kanban system, Implementation of JIT, Human Resource Management.

Text books:

1. Martand Telsang, "Industrial Engineering and Management", S. Chand, 2014
2. T.R. Banga and Sharma, "Industrial Engineering and Management", Khanna Publishers, 2010

Reference books:

1. M. Govindarajan and S. Natarajan, "Principles of Management", Prentice Hall of India Pvt. Ltd. New Delhi, 2007
2. George Kanawathi, "Introduction to Work Study", 4th revised Edition, ILO, 1996.
3. S. Chandran, "Organizational Behaviors", Vikas Publishing House Pvt., Ltd, 2014
4. David J. Sumanth, "Productivity Engineering and Management", Tata McGraw Hill,1999
5. Panneer selvam, "Production and Operations Management", PHI, 2013

17ME2039 RAPID PROTOTYPING AND TOOLING

Prerequisite: Machining Processes [17ME2010]
Credits: 3:0:0

Course Objectives:
To impart knowledge on

- methods, areas of usage, possibilities and limitations as well as environmental effects of the Rapid Prototyping
- the characteristics of the different materials those are used in Rapid Prototyping
- Rapid tooling and reverse engineering.

Course Outcomes:
Ability to

- Recognize and use techniques for processing of CAD models for RP
- Outline the importance of RP Technology in product development cycle
- Know the principles and use RP Technology
- Select appropriate tooling for RP process
- Apply RP for reverse engineering
- Implement RP techniques & Manufacturing to solve real time industrial problems

Unit I - INTRODUCTION: Need – History and Development of RP systems – classification of RP systems – RP process chain – Impact of Rapid Prototyping and Tooling on Product Development – Benefits, Applications. Digital prototyping – Virtual Prototyping
Unit II - LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS: Liquid based rapid prototyping systems – Photo – polymerization – Stereo–lithography Apparatus – Polyjet – Solid Creation System – Solid Object Ultraviolet – Laser Printer – Bioplotter – Rapid Freeze Prototyping – Solid Ground Curing – Microfabrication Technology – Solid based rapid prototyping systems – Fused deposition Modeling – Laminated object manufacturing – Multi – Jet Modeling System – Plastic Sheet Lamination – Invision LD Sheet Lamination – Paper Lamination Technology
Unit III - POWDER BASED RAPID PROTOTYPING SYSTEMS: Selective Laser Sintering – Three–Dimensional Printing – Laser Engineered Net Shaping – Electron Beam Melting – Laser Cusing – Selective Laser Melting – Selective Mask Sintering – Micro Sintering – Rapid casting Technology
Unit IV - RAPID TOOLING AND REVERSE ENGINEERING: Conventional Tooling Vs. Rapid Tooling – Classification – Indirect Rapid Tooling – Direct Rapid Tooling – Powder Metallurgy Tooling – Reverse Engineering using RP: Basic concept, Digitization techniques, Model Reconstruction, Data Processing for Rapid Prototyping, Reverse Engineering (RE) Methodologies and Techniques, Selection of RE systems, software, hardware, RE in product development
Unit V - RAPID PROTOTYPING APPLICATIONS: Application in Design – Application in Engineering – Application in Analysis and Planning – Application in Manufacturing and Tooling – Aerospace Industry – Automotive Industry – Jewellery Industry – Coin Industry – Geometric Information Systems application – Arts and Architecture – Medical and Bioengineering Applications

Text Books:

1. C.K. Chua, K.F. Leong., C.S. Lim., "Rapid Prototyping: Principles and Applications", World Scientific Publishing Co. Pvt. Ltd., 2010.
2. Peter D. Hilton, Paul F. Jacobs. "Rapid Tooling: Technologies and Industrial Applications", CRC Press, 2000.

Reference books:
1. Kenneth G. Cooper., “Rapid Prototyping Technology: Selection and Application”, Marcel Dekker, Inc., 2007.
2. Rafique Noorani, “Rapid Prototyping – Principles and Applications”, John Wiley and Sons Inc. New Jersey, 2005.
3. Liou W. Liou, Frank W. Liou, “Rapid Prototyping and Engineering Applications: A Tool box for Prototype Development”, CRC Press, 2007.
4. Paul F Jacobs, “Stereo Lithography and other RP and M Technologies”: SME, NY, 1996
5. Andreas Gebhardt, “Rapid Prototype”, Hanser Publishers, 2003.

17ME2040 METAL CUTTING THEORY AND PRACTICE

Prerequisites: Machining Processes [17ME2010]
Credits: 3:0:0

Course Objectives:
To impart knowledge on
- Types of cutting tools and their nomenclature.
- Measuring cutting force and cutting temperature.
- The mechanisms of tool wear and chatter.

Course Outcomes:
Ability to
- Understand the theories of metal cutting mechanics
- Distinguish the types of tool and their nomenclature
- Measure the cutting force and apply for design of tools
- Determine the cutting temperature and suggest coolants
- Identify the mechanisms of tool materials wear and design optimum parameters
- Design tools and machines considering chatter

Unit I - INTRODUCTION: Basic mechanism of chip formation – types of chips – Chip breaker –Orthogonal Vs Oblique cutting – force and velocity relationship and expression for shear plane angle in orthogonal cutting – Energy Consideration in machining – Modern theories in Mechanics of cutting – Review of Merchant and Lee Shaffer Theories, critical comparison.
Unit II - TOOL NOMENCLATURE AND CUTTING FORCES: Nomenclature of single point tool – Systems of tool Nomenclature and Conversion of rake angles – Nomenclature of multi point tools like drills, milling cutters and broaches. Forces in turning, drilling and milling – specific cutting pressure – measurement of cutting forces.
Unit III - THERMAL ASPECTS OF MACHINING: Thermodynamics of chip formation – Heat distributions in machining – Effects of various parameters on temperature – Method of temperature measurement in machining – Hot machining – cutting fluids. Mechanism of grinding – Various parameters affecting grinding process.
Unit IV - TOOL MATERIALS, TOOL LIFE AND TOOL WEAR: Essential requirements of tool materials – Developments in tool materials–ISO specifications for inserts and tool holders – Tool life– optimum tool life – Conventional and accelerated tool life tests – Concepts of machinability and machinability index – Economics of machining
Unit V - WEAR MECHANISMS AND CHATTER IN MACHINING: Reasons for failure of cutting tools and forms of wear–mechanisms of wear – chatter in machining – Factors effecting chatter in machining – types of chatters – Mechanism of chatter – Stability lobe diagram.

Text books:
1. B.L. Juneja and G.S Sekhon, “Fundamentals of Metal Cutting and Machine Tools", New Age International (P) Ltd., 2015.
2. G.R. Nagpal, “Tool Engineering and Design”, Khanna Publishers, 2014

Reference books:
1. David A. Stephenson, John S. Agapiou, “Metal Cutting Theory and Practice”, CRC Press, 2016.
2. G. K. Lal, "Introduction to Machining Science", New Age International (p) Ltd., 2015.
3. M.C. Shaw, “Metal cutting Principles", Oxford Clarendon Press, 2005.

4. D.G. Boothroyd and W.A. Knight, "Fundamentals of Machining and Machine Tools", Marcel Dekker, New York, 2005.
5. Bhattacharya, "Metal Cutting Theory and Practice", New Central Book Agency Pvt. Ltd., 1984.

17ME2041 WELDING TECHNOLOGY

Pre–requisite: Manufacturing Processes [17ME2006]
Credits: 3:0:0

Course Objectives:
To impart knowledge on
- Gas and arc welding processes, resistance welding processes, solid state welding processes
- Thermit welding, atomic hydrogen welding, electron beam welding, laser beam welding, friction stir welding
- Design of weld joints, weldability and testing of weldments.

Course Outcomes:
Ability to
- Summarize different welding processes and its applications.
- Suggest welding processes for metals.
- Realize the various applications, advantages and types of welding processes.
- Adapt different types of welding process for effective welding of structural components and complex shapes.
- Design welding joints & test of weldments.
- Relate the principles of metallurgy during the welding process.

Unit I - GAS AND ARC WELDING PROCESSES: Fundamental principles – Air Acetylene welding, Oxyacetylene welding, Carbon arc welding, Shielded metal arc welding, Submerged arc welding, TIG & MIG welding, Plasma arc welding and Electro slag welding processes – advantages, limitations and applications.
Unit II - RESISTANCE WELDING PROCESSES: Spot welding, Seam welding, Projection welding, Resistance Butt welding, Flash Butt welding, Percussion welding and High frequency resistance welding processes – advantages, limitations and applications.
Unit III - SOLID STATE WELDING PROCESSES: Cold welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction welding, Forge welding, Roll welding and Hot pressure welding processes – advantages, limitations and applications.
Unit IV - OTHER WELDING PROCESSES: Thermit welding, Atomic hydrogen welding, Electron beam welding, Laser Beam welding, Friction stir welding, Under Water welding, Welding automation in aerospace, nuclear and surface transport vehicles.
Unit V - DESIGN OF WELD JOINTS, WELDABILITY AND TESTING OF WELDMENTS: Various weld joint designs – Weldability of Aluminium, Copper, and Stainless steels. Destructive and non–destructive testing of weldments.

Text books:
1. R.S Parmer., “Welding Engineering and Technology”, 1st Edition, Khanna Publishers, New Delhi, 2008.
2. R.L Little, “Welding and Welding Technology”, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 34th Reprint, 2008.

Reference books:
1. M.M. Schwartz, “Metals Joining Manual”, McGraw Hill Books, 1979.
2. R.F. Tylecote, “The Solid Phase Welding of Metals”, Edward Arnold Publishers Ltd. London, 1968.
3. AWS – Welding Hand Book. “Welding Process” 8th Edition. Vol. 2. 1991
4. S.V Nadkarni. “Modern Arc Welding Technology”, 1st Edition, Oxford IBH Publishers, 2005.
5. Christopher Davis. “Laser Welding – Practical Guide”, Jaico Publishing House, 1994.
6. A.C. Davis, “The Science and Practice of Welding”, Cambridge University Press, Cambridge, 1993.

17ME2042 FOUNDRY TECHNOLOGY

Pre–requisite: Manufacturing processes [17ME2006]
Credits: 3:0:0

Course Objectives:
To impart Knowledge on:

- The process of solidification of pure metals and alloys.
- Sand molding and permanent die molding.
- Design of molds, casting defects, inspection and testing of castings and modernization of foundries.

Course outcomes:
Ability to:

- Understand the technology, variables and complexity involved in producing a casting.
- Select the furnace for a casting problem and design the pattern.
- Identify the type of sand for molds and cores for a molding process.
- Distinguish the special molding processes and when their use is acceptable.
- Understand the casting of ferrous and non–ferrous alloys
- Inspect and detect casting defects.

Unit I - MOULDING AND CASTING PROCESSES: Introduction to Moulding and casting process, Steps involved in casting process, Advantages and limitation of foundry process, Application of casting process, Pattern, types of Pattern, Pattern Allowances, Pattern Material, Pattern Making, Cores and core print, Core boxes and core making

Unit II - MANUAL MOULDING PROCESS: Moulding equipments and tools, Moulding sand ingredients and properties, Influences of ingredients on properties on moulding sand, sand preparation and control, sand testing, Machine molding, types of machines, applications, Core Blowers, Core Shooters.

Unit III - SAND CASTING PROCESS: Sand Casting Process, Permanent Mold process, Centrifugal Casting, Investment Casting, Shell Moulding, CO_2 Moulding and continuous castings, Squeeze Casting, Electro slag casting process, Vacuum process, Full mold process, Magnetic Molding process.

Unit IV - FOUNDRY FURNACE: Introduction foundry furnace, Selection of furnace, Crucible, Oil fired Furnace, Electric Furnace – resistance furnace, Induction Furnace, Cupola furnace, non ferrous melting furnace, Pouring equipments, Inspection of casting, Destructive and non destructive test, casting defects, Casting defects – occurrence and causes.

Unit V - GATING SYSTEM, FOUNDRY LAYOUT AND AUTOMATION: Introduction to Gating system, Function of gating system, Types of gating system, Gating Ratio – simple problems, Function of Riser, types of riser, riser design problems, Foundry layout and Automation.

Text books:

1. P.L. Jain "Principles of Foundry Technology",(Fifth edition) Tata McGraw–Hill, 2014.
2. M Lal, and O.P Khanna "A Text Book of Foundry Technology" Dhanpat Rai and Sons, New Delhi 2011.

References Books:

1. Richard W Heine, Carl R Loper, Philip C Rosenthal "Principles of Metal Casting" Tata McGraw–Hill Publishing Company Ltd, 2008.
2. R.B Gupta "Foundry Engineering", Satyaprakashan Publisher, 2002.
3. T.R. Banga and R.L. Agarwal "Foundry Engineering", Khanna Publishers, 2005.

17ME2043 COMPUTATIONAL FLUID DYNAMICS

Pre–requisite: Fluid Mechanics and Machinery [17ME2013]
Credits: 3:0:0

Course Objectives:
To impart knowledge on

- The governing equations of fluid dynamics.
- Appropriate discretization method for the given formulation
- The solution methodologies of discretized equations for turbulence and combustion models.

Course Outcomes:
Ability to

- Formulate governing equations for a given flow problem.
- Select appropriate discretization method for the given formulation.
- Interpret and discretize the governing equation.
- Select an appropriate solver for the discretized equations.
- Interpret the solutions obtained from the solver.
- Prepare results in the form of graphs and tables.

Unit I - GOVERNING EQUATIONS AND BOUNDARY CONDITIONS: Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Physical boundary conditions – Time averaged equations for Turbulent flow – Turbulence –Kinetic – Energy Equations – mathematical behavior of PDEs on CFD: Elliptic, Parabolic and Hyperbolic equations.
Unit II - INTRODUCTION TO FD AND FVM: Methods of Deriving the Discretization Equations – Taylor Series formulation – Finite difference method – Control volume Formulation – Solution methodologies: Direct and iterative methods, Relaxation method, Alternating Direction Implicit method.
Unit III - DISCRETIZATION OF HEAT CONDUCTION: Finite difference and finite volume formulation of steady/transient one–dimensional conduction equation, Source term linearization, Incorporating boundary conditions, Finite volume formulations for two and three dimensional conduction problems.
Unit IV - DISCRETIZATION OF CONVECTION AND DIFFUSION: Finite volume formulation of steady one–dimensional convection and Diffusion problems, Central, upwind, hybrid and power–law schemes – Discretization equations for two dimensional convection and diffusion.
Unit V - CALCULATION OF FLOW FIELD: Representation of the pressure – Gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and velocity corrections – Pressure – Correction equation, SIMPLE algorithm and its variants. Turbulence models: mixing length model, Two equation (k–E) models.

Text Books:

1. D.A. Anderson, J.C. Tannehill and R.H. Pletcher, "Computational Fluid Mechanics and Heat Transfer", Hemispher Publishing Corporation, Taylor & Francis Group, New York, 1984.
2. H.K. Versteeg & W. Malalasakera, "An Introduction to Computational Fluid Dynamics – The Finite Volume Method", Addison Wesley Longman Limited, England, 2007.

Reference books:

1. S.V. Patankar, "Numerical Heat Transfer and Fluid Flow", Heimisphere Publishing Corporation, Taylor Francis Group, New York, 1980.
2. M.T. Gerritsma & B. Koren, "Introduction to Computational Fluid Dynamics", 2008.
3. M.N. Ozisik, "Heat Transfer – A Basic Approach", McGraw Hill, New York, 1985.
4. H. Schlichting., "Boundary Layer Theory", 7th Edition, McGraw Hill, New York, 1979
5. K. Muralidhar and T. Sundarajan, "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.
6. T.K. Bose, "Numerical Fluid Dynamics", Narosa Publishing House, 1997.

17ME2044 RENEWABLE ENERGY SOURCES

Credits: 3:0:0

Course Objectives:
To impart knowledge on

- Types renewable energy sources.
- The working principle and power generation techniques of renewable energy systems.
- The application and environmental aspects of renewable energy systems.

Course Outcomes:
Ability to

- Identify the various renewable energy sources.
- Summarize the application of solar energy systems.
- Develop a small size gasifier.

- Design a wind mill for water pumping application.
- Explain the method of electricity production from water.
- Develop a fuel cell.

Unit I - NON–CONVENTIONAL ENERGY SOURCES: Introduction, non–conventional energy systems, world energy features, non–conventional energy sources and their availability, prospectus of renewable energy sources, advantages and disadvantages of renewable energy sources, history of energy consumption pattern.
Unit II - SOLAR ENERGY SYSTEMS: Solar radiation, solar radiation measurements, flat plate collectors, solar air heaters, concentrating collectors, solar water heating, solar space heating, solar refrigeration, solar photo voltaic cells, solar cooking, solar chimney, calculation of collector efficiency, outlet temperature of fluid.
Unit III - BIOMASS ENERGY SYSTEMS: Biomass resources, biomass conversion technologies, thermo chemical conversion of biomass – pyrolysis, gasification, direct combustion, liquefaction. Gasifier – classification of biomass gasifiers, gasifier engine systems, application of gasifier. Ethanol production from biomass, biogas plants, calculation of volume of biogas digester, gas holder volume, volume of biogas generated.
Unit IV - WIND ENERGY SYSTEMS: The power in the wind, forces on the blades and thrust on turbines, wind energy conversion, site selection considerations, basic components of wind energy conversion systems, classification of wind energy conversion systems, wind energy collectors, performance of wind energy machines, application of wind energy, environmental impacts. Determination of power available in the wind.
Unit V - OTHER RENEWABLE ENERGY SOURCES: Ocean thermal energy conversion – calculation of power output from turbine. Tidal energy – determination of power available in the tidal energy, types. Wave energy conversion devices, small, mini, micro hydro systems. Geothermal energy – calculation of hot water temperature and pressure. Hydrogen energy, fuel cells, magneto hydro dynamic systems, nuclear fusion energy.

Text books:

1. G.D Rai, “Non–conventional Energy Sources”, 5th Edition, Khanna Publishers, Delhi, 2011
2. S.P. Sukhatme, “Solar Energy– Principles of Thermal Collection and Storage”, Tata McGraw Hill Publishing Co. New Delhi, 2008.

Reference books:

1. Desire Le Gouriers, “Wind Power Plants”, Theory and Design, Pregmon Press, 2014
2. Srivastava, Shukla and Jha, “Technology and Application of Biogas” Jain Brothers, New Delhi, 2000
3. N.H.Ravindranath, Hall D.O., “Biomass, Energy and Environment”, Reprinted Edition, Oxford University Press, Oxford, 2002.
4. O.P. Chawla, “Advances in biogas technology”, Publications and Information Division, Indian Council of Agricultural Research, New Delhi, 2009.
5. K.M, Mital, “Biogas Systems: Principles and Applications”, 1st Edition, New Age International Private Ltd, New Delhi, 2009.

17ME2045 ADVANCED INTERNAL COMBUSTION ENGINES

Prerequisite: Thermal Engineering I [17ME2011]
Credits: 3:0:0

Course Objectives:
To impart knowledge on
- SI and CI Engines
- Engine exhausts emission control and alternate fuels
- Introduce the recent developments in IC Engines

Course Outcomes:
Ability to
- Classify different types of internal combustion engines.
- Analyze performance of spark ignition and compression ignition engines.
- Predict concentrations of primary exhaust pollutants
- Evaluate alternative fuels for Internal Combustion engines.
- Perform basic calculations relating to the performance and emissions of automobile engines.
- Adapt emission control norms for engine design.

Unit I - SPARK IGNITION ENGINES: Mixture requirements – Fuel injection systems – Monopoint, Multipoint & Direct injection -Stages of combustion – Normal and Abnormal combustion, Spark Knock, Factors affecting knock, Combustion chambers
Unit II - COMPRESSION IGNITION ENGINES: Diesel Fuel Injection Systems - Stages of combustion – Knocking – Factors affecting knock – Direct and Indirect injection systems – Combustion chambers – Fuel Spray behaviour – Spray structure and spray penetration – Air motion - Introduction to Turbo charging..
Unit III - POLLUTANT FORMATION AND CONTROL: Pollutant – Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters, Selective Catalytic Reduction and Particulate Traps – Methods of measurement – Emission norms.
Unit IV - ALTERNATIVE FUELS: Alcohol, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel – Properties, Suitability, Merits and Demerits – Engine Modifications.
Unit V - RECENT TRENDS: Air assisted Combustion, Homogeneous charge compression ignition engines – Variable Geometry turbochargers – Common Rail Direct Injection Systems –Multi point fuel injection system– Hybrid Electric Vehicles – Onboard Diagnostics.

Text Books:

1. Mathur. R.B. and R.P. Sharma, “Internal Combustion Engines”, Dhanpat Rai & Sons 2010.
2. Ramalingam. K.K., “Internal Combustion Engine Fundamentals”, Scitech Publications, 2011.

Reference Books

1. Colin, Ferguson. R., “Internal Combustion Engines”, John Wiley and Sons, 2015.
2. Edward. F. Obert., “Internal Combustion Engines”, Inter–Science Publishers, 1973
3. Ganesan. V., “Internal Combustion Engines”, Tata McGraw Hill, New Delhi, 2012

17ME2046 REFRIGERATION AND AIR CONDITIONING

Pre–requisite: Thermal Engineering II [17ME2018]
Credits: 3:0:0

Course Objectives:
To impart knowledge on

- Working principle of refrigeration and air–conditioning cycle
- Fundamentals of psychrometry and cooling load components
- Applications of refrigeration and air–conditioning

Course Outcome:
Ability to

- Identify various refrigeration and air–conditioning cycles
- Estimate the performance of various refrigeration and air–conditioning cycles
- Demonstrate different types of refrigerants
- Analyze psychometrics processes
- Evaluate the space cooling load
- Choose the refrigeration and air–conditioning systems for relevant applications

Unit I - REFRIGERATION AND AIRCONDITIONING SYSTEMS: Review of thermodynamic principles – refrigeration. Air refrigeration – Bell–Coleman cycle performance calculations. Aircraft refrigeration system. Vapour compression refrigeration cycle – multistage multiple evaporator systems – cascade system – COP comparison. Vapour absorption refrigeration system. Ammonia water and Lithium Bromide water systems.
Unit II - REFRIGERATION AND AIRCONDITIONING EQUIPMENT: Compressors – working principles of reciprocating and rotary. Condensers, evaporators – types. Refrigerants – properties – selection of refrigerants. Air conditioning equipment – air cleaning and air filters – humidifiers – dehumidifiers – air washers – cooling tower and spray ponds
Unit III - PSYCHROMETRY AND COMFORT CHART: Review of fundamental properties of psychometric – use of psychometric charts – psychometric processes – Grand and Room Sensible Heat Factors – by pass factor – requirements of comfort air conditioning – comfort charts –factors governing optimum effective temperature

Unit IV - COOLING LOAD ESTMATION: Types of load – design of space cooling load – Heat transmission through building. Solar radiation – infiltration – internal heat sources (sensible and latent) – outside air and fresh air load – estimation of total load – design of air conditioning cycles
Unit V - APPLICATIONS: Applications to refrigeration systems – ice plant – food storage plants – milk –chilling plants – refrigerated cargo ships – Domestic, commercial and industrial systems – central air conditioning systems – applications: car, train, industry, stores, and public buildings.

Text Books:

1. Arora C.P., "Refrigeration and Air Conditioning", TMH, New Delhi, 2008
2. W.F. Stoecker and Jones, "Refrigeration and Air Conditioning", TMH, New Delhi, 2003

Reference Books:

1. Manohar Prasad, "Refrigeration and Air Conditioning", Wiley Eastern Ltd Division of Mechanical Engineering 259, 2011.
2. Jordon and Prister, "Refrigeration and Air Conditioning", Prentice Hall of India PVT Ltd., New Delhi, 1999
3. Raj J. Dossat, "Principles of Refrigeration", SI Version, Wiley Eastern Ltd., 2002.

17ME2047 BIOMASS ENERGY SYSTEMS

Credits: 3:0:0

Course Objectives:
To impart knowledge on

- Types of biomass resources and biomass conversion processes
- Construction of a small size gasifier and biogas plant
- The alcohol production methods from biomass

Course Outcomes:
Ability to

- Classify the thermo chemical conversion process of biomass
- Design a community biogas plant
- Select a biogas plant for the given application
- Develop a small size biomass gasifier
- Explain the application of bio–fuels
- Demonstrate the power generation techniques using biomass waste

Unit I - ENERGY FROM BIOMASS: Biomass resources – energy plantation, advantages of energy plantation, plants proposed for energy plantation, photosynthesis. Biomass conversion technologies – thermo chemical conversion – direct combustion, pyrolysis, liquefaction, gasification. Biochemical conversion – anaerobic digestion, fermentation. Biodegradability.
Unit II - BIOGAS GENERATION: Classification of biogas plants – floating drum plant, fixed dome type plant, continuous and batch type plant, community biogas plants. Biogas generation – biogas from plant wastes, materials used for biogas generation, additives, factors affecting bio–digestion. Estimation of volume of biogas generation, digester volume, gas holder volume.
Unit III - DIGESTER DESIGN: Design based on methane production rate, design based on end user requirements, scaling of biogas plants, digester sizing, problems related to biogas plants, starting a biogas plant, filling a digester for starting, fuel properties of biogas, selection of site for a biogas plant. Utilization of biogas – modification of SI and CI engine, biogas use in stationary power plants, mobile power plants, use of biogas in refrigerators, gas turbines. Purification, scrubbing, compression and storage of biogas, biogas burners.
Unit IV - GASIFIER: Gasification process – gasification of wood. Wood gas purification and shift conversion, gasification equipment, use of wood gas in engines, classification of biomass gasifiers – fixed bed gasifier, fluidized bed gasifier. Applications of gasifier. Estimation of power generation from gasifier engine system.
Unit V - ELECTRICITY PRODUCTION FROM BIOMASS WASTES: Ethanol production from wood and sugar cane, methanol production, electricity production from municipal solid wastes, animal wastes, plant residues, pulp and paper industry wastes, distillery waste.

Text Books:

1. G.D. Rai, "Non Conventional Energy Sources", 8th reprint, Khanna Publishers, 2013
2. B.T. Nijaguna, "Biogas Technology", 1st Edition, New Age International Private Ltd, New Delhi, 2012.

Reference Books:

1. N.H. Ravindranath, D.O. Hall, "Biomass, Energy and Environment", Reprinted Edition, Oxford University Press, Oxford, 2011.
2. O.P. Chawla, "Advances in Biogas Technology", Publications and Information Division, Indian Council of Agricultural Research, New Delhi, 2013.
3. K.M. Mital, "Biogas Systems: Principles and Applications", 1st Edition, New Age International Private Ltd, New Delhi, 2012.

17ME2048 ALTERNATIVE FUELS FOR IC ENGINES

Prerequisite: Thermal Engineering II [17ME2018]
Credits: 3:0:0

Course objectives:
To impart knowledge on

- The concepts of energy and its sources.
- The production &performance characteristics of alternative fuels.
- Emission control with alternate fuels.

Course Outcomes:
Ability to

- Describe the refining process of petroleum.
- Identify the various alternative fuel options available for conventional fuels and their performance and emission characteristics.
- Outline the production method of various alternative fuels.
- Analyze the performance and Emissions of alternate fuels.
- Apply emission control norms and alternate fuels used in IC engines.
- Design electric and hybrid vehicles.

Unit I - FUELS AND ITS PROPERTIES: Introduction, Structure of petroleum, Refining process, Products of refining process, Fuels for spark Ignition, Knock rating of SI engine fuels, Diesel fuels and Numerical, Properties of Petroleum products, lubricant and grading of lubricants, Specific gravity, Density, Molecular weight, Vapour Pressure, Viscosity, Flash point, Fire point, Cloud Point, Pour point, Freezing Point, Smoke Point and Char value, Aniline point, Octane number, performance number, Cetane number, Emulsification, Oxidation Stability, Acid value/Number, Distillation Range & sulphur content.
Unit II - ALTERNATIVE FUELS FOR IC ENGINES: Need for alternate fuels such as Ethanol, Methanol, LPG, CNG, Hydrogen, Bio gas and producer gas and the method of manufacturing Single fuel engines. Properties of alternate fuels use of alternative fuels in SI engines, Engine modification required performance in emission and emission characteristics of alternative fuels in SI mode of operation v/s Gasoline operation.
Unit III - DUAL FUEL ENGINE: Need and advantages, the working Principle, Combustion in duel fuel engines, Factors affecting combustion in dual fuel engine, use of alcohols, LPG, CNG, Hydrogen, Bio gas and producer gas in CI engine in dual fuel mode, Engine modification required, performance and emission characteristics of alternative fuels (mentioned above) in dual fuel mode of operation v/s diesel operation.
Unit IV - BIO AND SYNTHETIC FUELS: Biodiesels and ethanol, Need of biofuels, Properties of biodiesels v/s diesel, ethanol Vs petrol Performance and emission characteristics of biodiesel v/s diesel and ethanol Vs petrol operation. New fuels like BTL and DME, their availability and properties, use in IC engines.
Unit V - AVAILABILITY AND FUELS FOR HYBRID VEHICLES: Suitability & Future prospects of these gaseous fuels in Indian context. Environmental Pollution with Convection and alternative fuels, Pollution control methods and packages. Electric and Hybrid vehicles: types, batteries, applications.

Text books:

1. S.S. Thipse, "Alternative Fuels", Jaico Publications, 2010.
2. R.P. Sharma and M.L. Mathur: "A course in Internal Combustion Engines", D. Rai & Sons, 2016.

Reference books:

1. John B. Heywood, "Internal Combustion Engines Fundamentals", McGraw Hill International Edition, 2011.
2. O.P. Gupta "Elements of Fuels, Furnaces and Refractories", Khanna Publishers, 2016.
3. V.M. Domkundawar "Internal Combustion Engines", Dhanpat Rai & Co., 2014.

17ME2049 MODERN VEHICLE TECHNOLOGY

Credits: 3:0:0

Course objectives:

To impart knowledge on

- Principles of engines used for automobiles and different systems.
- The various transmission and drive line units of automobiles.
- The importance of sensors and fuel injection systems.

Course Outcomes:

Ability to

- Identify the importance and functions of vehicle chassis, components of IC Engines and cooling systems.
- Describe the types of steering and suspension systems.
- Demonstrate the functions of clutch and braking systems.
- Recognize and select drives for transmission.
- Summarize the working principles of sensors and actuators.
- Express the functions and components of fuel injection and ignition systems.

Unit I - INDRODUTION: Types of automobiles: Engine location – chassis layout – construction types, engine cylinder arrangements – Piston rings – Cylinder liners – Valves and Actuating mechanisms – Inlet and Exhaust manifolds. Self–driving car. Review of Fuel, Cooling and Lubrication systems.

Unit II - STEERING AND SUSPENSION: Steering system: Principle of steering – Centre point steering – Steering linkages – Steering geometry and Wheel alignment – Power steering. Wheels and tyres: Types and places of use – tyre construction, specification – tyre wear and causes – wheel balancing. Suspension system – need, types – independent suspension – coil and leaf springs – suspension systems for multi–axle vehicles.

Unit III - CLUTCH AND BRAKES: Clutches – need, types – Single and Multiple Disc Clutches, Diaphragm Clutch, Centrifugal Clutch, Overrunning Clutch, Fluid Coupling, Torque Converters. Brakes: Need, Types – Mechanical, Hydraulic and Pneumatic Brakes – disc and drum types, their relative merits – details of components– Power brake, Antiskid brake, Antilock Braking System (ABS) & its operation.

Unit IV - AUTOMOTIVE TRANSMISSION: Gear box: Need, types of gear transmission – sliding mesh, constant mesh and synchromesh gearboxes; Gearshift mechanisms; Epicyclic transmission. Universal joint – constant velocity joint – propeller shaft – Hotchkiss drive – Torque tube drive; Front and Rear axles: Types – stub axle; Differential: need and types; Four wheel drive.

Unit V - SENSORS AND ENGINE ELECTRONICS: Types of Sensors; Sensors for Speed, Throttle Position, Exhaust Oxygen Level, Manifold Pressure, Crankshaft Position, Coolant Temperature, Exhaust Temperature, Air–mass flow for engine application. Solenoids, Stepper–Motors, & Relay. Multi point fuel injection (MPFI), Gasoline Direct Injection (GDI); Common Rail Direct Injection (CRDI); Variable Timing Ignition (VTI), Engine Mapping; On–board Diagnostics; Electronically controlled Automatic Transmission System.

Text books:

1. Ramalingam K.K., 'Automobile Engineering' SciTech Publications Pvt. Ltd., 2011.
2. Kirpal Singh," Automobile Engineering" vol. 1 and vol. 2, Standard Publishers, 2011.

Reference books:

1. Robert Bosch, "Automotive Hand Book", SAE 9th Edition, 2014.
2. Bechhold, "Understanding Automotive Electronics", SAE, 1998.
3. Newton. K, Steeds.W, Garret T.K. and Butterworth. "Motor Vehicle", IE, 2000.

17ME2050 POWER PLANT ENGINEERING

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- The concepts of various sources of power generation and engineering analysis of power plants.
- The economics of power plants and methods of optimum utilization of electrical energy.
- The environmental effects of power plants.

Course Outcomes:

Ability to

- Analyze performance and determine efficiency of a modified Rankine cycle steam power plant.
- Compare and contrast various air–preheating, combustion, condensing and cooling systems for modern thermal power plants.
- Analyze the performance of gas turbines with reheat, regeneration cycles and compute the efficiency of gas turbines.
- Recognize environmental impact of electric power production on air quality, climate change, water, and land.
- Recognize various methods and the significance of power generation from nuclear and renewable energy sources.
- Compute factors affecting economics of power distribution and conduct energy audit.

Unit I - POWER CYCLES: Simple Rankine Cycle, modified Rankine cycle – Re heating – Regeneration, analysis, pressure and temperature limits. Binary vapour cycle and combined cycle.

Unit II - STEAM POWER PLANT: various components, layout, Modern high pressure boilers – sub critical and super critical – Stoker type and Pulverized type combustion systems. Economizer and Air pre heater. Ash handling and dust collectors. Draught systems. Water treatment. Condensers and cooling towers.

Unit III - NUCLEAR POWER PLANT: Basic nuclear physics and nuclear reactions related to nuclear reactors, nuclear reactor materials, types of reactors, radiation shielding, waste disposal.

Gas Turbine Power Plant: components and layouts. Open and closed cycle plants – combined gas turbines and steam power plants.

Unit IV - DIESEL ENGINE POWER PLANT: components and lay–outs, selection of engine type. Environmental hazards of various power plants.

Hydro–Electric Power Plant: runoff, storage and pumped storage type – draft tube. Lay–out and selection of water turbine.

Unit V - ECONOMICS OF POWER PLANT: Load curve – definition – fixed and operating costs – comparison of economics of different types of power plants.

Unconventional Power Plants: Solar, Wind, Ocean thermal Tidal, Wave and Geothermal power plants. MHD concepts of energy conversion and energy audit.

Text books:

1. Domkundwar, "Power Plant Engineering", Dhanpat Rai & Sons, 2005
2. Nag P.K., "Power Plant Engineering", TMC, 2002.

Reference books:

1. Wakil, M.M.E.L, "Power Plant Technology", McGraw Hill, 2002.
2. Roy Eckart and Joel Weisman., "Modern Power Plant Engineering", PHI, 1999.
3. Rajput R.K., "Power Plant Engineering", Laxmi Publications (P) Ltd., 2016.

17ME2051 TURBOMACHINERY

Pre–requisite: Fluid Mechanics and Machinery [17ME2013]

Credits: 3:0:0

Course objectives:

To impart knowledge on

- Classification of turbo machines
- Types of pump, compressor, fan, and turbine

- Efficiencies and performance of turbo machines

Course outcomes:

Ability to

- Define the terminology used in turbo machines
- Compare the performance of types of fans and blowers
- Illustrate the selection of fans and blowers for different applications
- Analyze the performance centrifugal compressor
- Evaluate the .performance of axial flow compressor
- Develop axial and radial flow turbines for various applications

Unit I - PRINCIPLES: Energy transfer between fluid and rotor, classification of fluid machinery, dimensionless parameters, specific speed, applications, stage velocity triangles, work and efficiency for compressors and turbines.
Unit II - CENTRIFUGAL FANS AND BLOWERS: Types, stage and design parameters, flow analysis in impeller blades, volute and diffusers, losses, characteristics curves and selection, fan drives and fan noise.
Unit III - CENTRIFUGAL COMPRESSOR: Construction details, types, impeller flow losses, slip factor, diffuser analysis, losses and performance curves.
Unit IV - AXIAL FLOW COMPRESSOR: Stage velocity triangles, enthalpy–entropy diagrams, stage losses and efficiency, work done factor, simple stage design problems and performance characteristics.
Unit V - AXIAL AND RADIAL FLOW TURBINES: Stage velocity diagrams, reaction stages, losses and coefficients blade design principles, testing and performance characteristics.

Text Books:

1. S.M. Yahya, “Turbines, Compressors and Fans”, Tata McGraw Hill, 2010
2. Seppo A Korpela, “Principles of Turbomachinery” John Wiley & Sons, 2011

Reference Books

1. D.G. Stephard, “Principles of Turbo Machines”, Macmillan Co., 2004
2. Lee. “Theory and Design of Steam and Gas Turbine”, McGraw Hill, 2004
3. William J Kerten, “Steam Turbine Theory and Practice”, CBS Publisher and Distributors, 2011
4. Cohen Rogers, Saravana Muttoo, “Gas Turbine Theory”, Long Man, 2005
5. Bathe WN., “Fundamentals of Gas Turbines”, Willey & Sons, 2004.

17ME2052 DESIGN OF HEAT EXCHANGERS

Prerequisite: Heat and Mass transfer [17ME2024]
Credits: 3:0:0

Course Objectives:
To impart knowledge on

- various types of heat exchangers
- thermal analysis of heat exchangers
- the sizing and rating of the heat exchangers for various applications.

Course outcomes:

Ability to

- understand the working principle of different types of heat exchangers
- Design various types of heat exchangers
- Identify applications of heat exchangers
- Apply correlations for reducing errors in the design of heat exchangers
- Predict performance parameters of heat exchangers
- Design evaporator, condenser and cooling towers

Unit I - Introduction and classification of heat exchangers: Parallel flow, counter flow and cross flow; shell and tube and plate type; single pass and multi pass.
Unit II - Heat transfer correlations: Overall heat transfer coefficient, fouling factors, pressure drop calculations.
Unit III - Design of heat exchangers: LMTD and effectiveness NTU methods, sizing of finned tube heat exchangers, thickness calculations, tube sheet design using TEMA formula.

Unit IV - Compact and Plate Heat Exchangers: types, merits and demerits, design of compact heat exchangers, plate heat exchangers, performance influencing parameters, limitations.
Unit V - Design of evaporator and condensers: cooling tower - performance characteristics

Text Books:
1. Sadik Kakac, Hongtan Liu, Anchasa Pramuanjaroenkij, "Heat Exchangers Selection, Rating and Thermal Design", CRC Press, Third Edition, 2012.
2. Shah, R. K., Dušan P. Sekulić," Fundamentals of heat exchanger design", John Wiley & Sons, 2003.

Reference Books:
1. John E. Hesselgreaves, "Compact heat exchangers: selection, design, and operation", Elsevier science Ltd, 2001.
2. T. Kuppan, "Heat exchanger design hand book", New York: Marcel Dekker, 2009.
3. Eric M. Smith, "Advances in thermal design of heat exchangers: a numerical approach: direct sizing, step-wise rating, and transients", John Wiley & Sons, 1999.

17ME2053 MECHATRONICS

Credits: 3:0:0

Course Objectives:
To impart knowledge on
- The elements of Mechatronics systems
- Selection of sensors and actuators
- Application of mechatronics systems in automation

Course Outcomes:
Ability to
- Recognise the emerging trends in mechatronics and interpret the principle of sensors.
- Illustrate the working principles of valves, pneumatic and hydraulic drives
- Inference the suitable microprocessor or micro–controller for a real time application.
- Build a PLC program for an industrial application
- Design a ladder logic program for a particular application.
- Identify an appropriate drive for an industrial application

Unit I - INTRODUCTION TO MECHATRONICS: Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers**:** Static and dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance sensors – Strain gauges – Eddy current sensor – Hall effect sensor – Temperature sensors – Light sensors.
Unit II - PNEUMATIC AND HYDRAULIC ACTUATORS: DCVS, FCVs, special valves like Servo and Proportional Controls Valves, different types of Pumps and Motors – computation of performance of them.
Unit III - 8085 MICROPROCESSOR AND 8051 MICROCONTROLLER: Introduction – Architecture of 8085 – Pin Configuration – Addressing Modes –Instruction set, Timing diagram of 8085 – Concepts of 8051 microcontroller – Block diagram, selecting a microcontroller.
Unit IV - PROGRAMMABLE LOGIC CONTROLLERS: Architecture, Types of PLCs – Ladder Programming – Latching and internal relays – sequencing – timers and counters, Introduction – Architecture of 8255, Keyboard interfacing, LED display – interfacing, ADC and DAC interface, Temperature Control – Stepper Motor Control – Traffic Control interface.
Unit V - ACTUATORS AND MECHATRONIC SYSTEM DESIGN: Types of Stepper and Servo motors – Construction – Working Principle – Advantages and Disadvantages. Design process–stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Engine Management system – Automatic car park barrier.

Text Books:
1. W Bolton, "Mechatronics–Electronic Control Systems in Mechanical and Electrical Engineering", 4th Edition, Pearson Education, 2012.

2. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Prentice Hall, 2002.

Reference Books:

1. Er. R. K. Rajput, "A Text Book of Mechatronics", 3rd Edition, Chand & Company – New Delhi, 3rd Edition, 2007.
2. Dan Necsulescu, "Mechatronics", Pearson Education Asia, 2009.
3. Devadas Shetty, Richard Akolk, "Mechatronics System Design" First reprint 2001.

17ME2054 INDUSTRIAL SAFETY ENGINEERING

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Recognition, investigation, analysis, and control of hazards.
- Management's role in safety and assess the importance.
- The multiple hazards associated with welding

Course Outcomes:

Ability to

- Apply the basic concepts and scope of engineering safety.
- Implement the standards of professional conduct that are published by professional safety organizations and certification bodies.
- Illustrate the importance of safety of employees while working with machineries
- Express Safety in terms of Risk and to recognize unacceptable/inappropriate levels of Risk
- Identify hazards arising from runaway reactions, explosions and fires
- Suggest the various methods to prevent the hazards working with machineries

Unit I - SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES: General safety rules, Occupational Safety and Health act of USA– OSHAS 18000 – ISO 14000 – Benefits and Elements principles, maintenance, Inspections of manufacturing machines, hazards, Risks. Applications of ergonomic principles in the shop floor.

Unit II - PRINCIPLES OF MACHINE GUARDING: Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding of hazards – point of operation protective devices.

Unit III - SAFETY IN WELDING AND GAS CUTTING: Gas welding and oxygen cutting, resistances welding, arc welding and cutting, personal protective equipment, training, safety precautions during welding.

Unit IV - SAFETY IN COLD FORMING AND HOT WORKING OF METALS: Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism.

Unit V - SAFETY IN FINISHING, INSPECTION AND TESTING: Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in inspection and testing, dynamic balancing, hydro testing. Applicable standards in Industrial safety management.

Text books:

1. Philip E. Hagan, John Franklin Montgomery, James T. O'Reilly "Accident Prevention Manual" NSC, Chicago, 2009.
2. Charles D. Reese, "Occupational Health and Safety Management", CRC Press, 2015.

Reference books:

1. John Davies, Alastair Ross, Brendan Wallace, Safety Management: A Qualitative Systems Approach, CRC Press, 2003.
2. Accident Prevention Manual, National Safety Council (NSC), Chicago, 1982. 2. Occupational safety Manual, BHEL, Trichy, 1988.
3. John V. Grimaldi and Rollin H. Simonds, Safety Management, All India Travelers Book Seller, New Delhi, 1989.
4. N.V. Krishnan, Safety in Industry, Jaico Publishery House, 1996.
5. Indian Boiler Acts and Regulations, Government of India.
6. Safety in the use of wood working machines, HMSO, UK 1992.
7. Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.

17ME2055 BASIC AUTOMOBILE ENGINEERING

Credits: 3:0:0

Course objectives:

To impart knowledge on

- basic principles of engines used for automobiles and different systems.
- various transmission and drive line units of automobiles.
- importance of sensors and fuel injection systems.

Course Outcomes:

Ability to

- Identify the importance and functions of vehicle frame.
- Describe the thermodynamic principles behind the working of petrol and Diesel.
- Recognize the construction and working principles of SI and CI engines.
- Express the functions and components of fuel injection and ignition systems.
- Summarize the functions and components of engine cooling, lubrication and ignition systems.
- Outline the functions and components of electric and hybrid vehicles.

Unit I - INTRODUCTION: Classification of vehicles, body and load (definition only) - Layout of an automobile chassis, Function of major components of a vehicle and introduction to their different systems such as Frame, transmission (clutch and gear box), braking system, steering and suspension systems (just line diagrams and utility)

Unit II - THERMODYNAMICS: Zeroth, First, second and third law of thermodynamics (concept only), Otto cycle, diesel cycle, fuel used properties of fuels, air requirement for complete combustion of fuel.

Unit III - IC ENGINES: Concept of two stroke and four stroke petrol and diesel engines and their applications to automobiles. Various terms, Valves and Actuating mechanisms – Inlet and Exhaust manifolds. Specification of automobile engines.

Unit IV - AUTOMOTIVE SYSTEMS: Automobile fuel system: Fuel tank, filters, spark plug, ignition systems, Multi point fuel injection (MPFI), Gasoline Direct Injection (GDI), Common Rail Direct Injection (CRDI), Cooling & Lubrication systems.

Unit V - AUTO INDUSTRY IN INDIA AND FUELS FOR HYBRID VEHICLES: History, leading manufacturers, development in automobile industry, trends, new products. Pollution control methods and packages. Electric and Hybrid vehicles: types, applications.

Text books:

1. Kirpal Singh,” Automobile Engineering” vol1 and vol2.Standard Publishers, 20011.
2. Ramalingam K.K., ‘Automobile Engineering’ SciTech Publications Pvt. Ltd., 2005.

Reference books:

1. Robert Bosch, “Automotive Hand Book”, SAE 9th Edition, 2014.
2. Bechhold, “Understanding Automotive Electronics”, SAE, 1998.
3. Newton. K, Steeds.W, Garret.T.K. and Butterworth. ‘Motor Vehicle’, IE, 1989.

17ME2056 INDUSTRIAL ROBOTICS

Credits: 3:0:0

Course Objective:

To impart knowledge on the fundamental principles of

- Robot configurations,
- Sensors and transducers,
- Actuating systems and Robot programming skills.

Course Outcomes (COs):

Ability to

- Infer the robot history and configurations.
- Assess various components of a robot and choose the control system.
- Compute the kinematic equations and select an actuator for robot configurations
- Identify the suitable sensor for a particular robot application.

- Write a robot Programe for an industrial application.
- Identify the robot application for a unique operation.

Unit I - INTRODUCTION: Automation – types. Definition of Robot - Basic Concepts –History, classifications, advantages and disadvantages of robots. Robot configurations, Robot anatomy, work volume. -Basic robot motions –point to point control - Continuous path control.
Unit II - COMPONENTS AND CONTROL SYSTEMS: Basic Components of robot **–** Manipulators, Grippers and effectors, Tools as end effectors, Basic control system concepts – Closed and open loop control systems. Examples of control systems.
Unit III - ACTUATORS AND KINEMATICS OF ROBOT: Types of Robot drives- electric, pneumatic and hydraulic drives. Numerical problems. Coordinate transformation, coordinate mappings. Direct kinematics – position analysis and Inverse kinematics. Brief Robot dynamics. Numerical Problems
Unit IV - SENSING AND MACHINE VISION: Range sensing - Proximity sensing - Touch sensing - Force and Torque sensing. Introduction to Machine vision - Sensing and digitizing - Image processing and analysis. Robot Programming**:** Methods of programming – Robot languages - Capabilities and limitation - Artificial intelligence – Knowledge representation – Search techniques.
Unit V - INDUSTRIAL APPLICATIONS: Application of robots in machining - Welding - Assembly – Material handling - Loading and unloading - CIM –Hostile and remote environments. Robotics in future applications.

Text books:

1. Mikell P. Groover, Mitchell Weiss, "Industrial Robotics, Technology, Programming and Applications ", McGraw Hill International Editions, Edition 2008.
2. Saeed B. Niku “Introduction to Robotics” John Wiley & Sons, 2010

Reference books:

1. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic Engineering - An Integrated Approach", Prentice Hall India, 2002
2. Ibrahim Zeid, “CAD/CAM Theory and Practice”, McGraw Hill, 2003
3. K.S. Fu., R.C.Gonalez, C.S.G.Lee," Robotics Control sensing ", Vision and Intelligence, Mcgraw Hill Education, ISBN: 9780070265103, 0070265100, Edition: 1st Edition, 2008
4. John J. Craig , “Introduction to Robotics: Mechanics and Control” ,by Pearson India, ISBN:9788131718360, 8131718360. Edition: 3rd Edition, 2008.

17ME2057 HEAT ENGINES AND FLUID MACHINERY

Credits: 3:1:0

Course Objective:
To impart Knowledge on
- The basic principles of thermodynamics via real-world engineering examples, to show students how thermodynamics is applied in engineering practice.
- The basics of Fluid mechanics and fluid machinery components.
- The fundamentals of Heat Transfer and apply it to solve simple problems..

Course Outcome:
Ability to
- Understand the basic concepts in thermodynamics and its application in different fields.
- Apply the first law of thermodynamics for closed and open systems to solve simple engineering problems
- Understand and solve conduction, convection and radiation problems.
- Analyze the performance of Internal Combustion engines..
- Explain the fundamental aspects of fluid properties and flow behavior.
- Apply principles of fluid mechanics to the operation, design, and selection of fluid machinery such as pumps, blowers and turbines.

Unit I - FLUID PROPERTIES: Properties of fluids: density, specific weight, specific volume, specific gravity. Viscosity: units, kinematic viscosity, Newtons law of viscosity, variation of viscosity with temperature, types of fluids. Surface tension and capillarity: surface tension on liquid droplet, hollow bubble. Manometers: Peizometer, u-tube manometer, single column manometer tube differential manometer. PUMPS: reciprocating pumps, centrifugal pumps - operating principles.

Unit II - TYPES OF FLOW AND TURBINES: Types of flow- steady and unsteady, uniform and non uniform, laminar and turbulent, compressible and incompressible, rotational and irrotational, one, two and three dimensional flows. Impact of jets- Impulse momentum equation- moment of momentum equation, jet on vertical plate, inclined, curved plate. Turbines: classification-working principles -Pelton wheel, Francis, Kaplan turbines. Simple problems.

Unit III - THERMODYNAMICS: Basic concepts - thermodynamic system - properties - processes - cycle - equilibrium - First law of thermodynamics - application of first law to non flow and flow process - Second law of thermodynamics - Kelvin Planck's statement -Clausius statement - Reversibility - Carnot theorem - heat engine.

Unit IV - I.C.ENGINES: Classification of I C engines–engine components-four stroke engines and two stroke engines differences-air standard cycles - air standard efficiency - Otto, Diesel –problems.

Unit V - HEAT TRANSFER: Modes of heat transfer – one dimensional steady state heat conduction equation – plain wall - convection - empirical relations - Radiation - laws of radiation.

Text books:

1. Dr.Bansal R.K, "A Text Book of Fluid Mechanics and Hydraulic Machines", Laxmi Publications 9th Edition, 2009.
2. P.K.Nag Engineering Thermodynamics, Tata McGraw-Hill, Fifth Edition.2014

Reference books:

1. Som.S.R, and Biswas and Chakraborty.s. "Introduction to Fluid Mechanics and Fluid Machines", McGraw Hill Education, 3rd Edition, 2011
2. Holman J.P, "Heat Transfer", McGraw Hill International, 10th Edition, 2011.
3. Cengel A. "Introduction to Thermodynamics and Heat Transfer", Tata McGraw Hill, New Delhi, 2006.

17ME2058 FUNDAMENTALS OF THERMAL AND FLUID SCIENCES

(Use of Steam tables, Heat and Mass Transfer Data Book is permitted)

Credits: 3:0:0

Course Objectives:

To impart Knowledge on

- The basic principles of thermodynamics via real-world engineering examples, to show students how thermodynamics is applied in engineering practice.
- The basics of Fluid mechanics and fluid machinery components.
- The fundamentals of Heat Transfer and apply it to heat exchangers.

Course Outcomes:

Ability to

- Understand the basic concepts in thermodynamics and its application in different fields.
- Apply the first law of thermodynamics for closed and open systems to solve simple engineering problems
- Understand and solve conduction, convection and radiation problems.
- Design and analyze the performance of heat exchangers.
- Explain the fundamental aspects of fluid properties and flow behavior.
- Apply principles of fluid mechanics to the operation, design, and selection of fluid machinery such as pumps, blowers and turbines.

Unit I - THERMODYNAMICS: Basic concepts – Thermodynamic system – Properties – Processes – Cycle – Equilibrium –First law of thermodynamics – Application of first law to non-flow and flow process – Second law of thermodynamics– Kelvin Planck's statement – Clausius statement – Reversibility – Carnot theorem – Heat engine.

Unit II - HEAT TRANSFER: Modes of heat transfer – One dimensional steady state heat conduction equation – Plain wall – Convection– Empirical relations – Radiation – Laws of radiation.

Unit III - STEAM GENERATORS AND HEAT EXCHANGERS: Classification of boilers – Boiler terms – Performance of steam generator – Boiler efficiency – Heat losses in a boiler plant and heat balance calculations – Types of heat exchangers –Overall heat transfer coefficients – LMTD and NTU method – Fouling factor – Problems in heat exchangers, Effectiveness.

Unit IV - FLUID PROPERTIES: Properties of fluids: Density, Specific weight, Specific volume, Specific gravity – Viscosity: Units, Kinematic Viscosity, Newtons law of viscosity, Variation of viscosity with temperature, Types of fluids – Surface tension and capillarity: Surface tension on liquid droplet, Hollow bubble – Manometers: Piezometer, U– tube manometer, Single column manometer tube differential manometer – PUMPS: Reciprocating pumps, Centrifugal pumps – operating principles.

Unit V - TYPES OF FLOW AND TURBINES: Types of flow: Steady and unsteady, Uniform and non uniform, Laminar and turbulent, Compressible and incompressible, Rotational and irrotational, One, two and three dimensional flows – Turbines: Classification, Working Principle – Pelton wheel, Francis, Kaplan turbines, Simple problems.

Text books:

1. Dr.Bansal R.K, "A Text Book of Fluid Mechanics and Hydraulic Machines", Laxmi Publications 9th Edition, 2009.
2. P.K.Nag Engineering Thermodynamics, Tata McGraw-Hill, Fifth Edition, 2014.

Reference books:

1. Som.S.R, and Biswas and Chakraborty.s. "Introduction to Fluid Mechanics and Fluid Machines", McGraw Hill Education, 3rd Edition, 2011.
2. Holman J.P, "Heat Transfer", McGraw Hill International, 10th Edition, 2011.
3. Cengel. A., "Introduction to Thermodynamics and Heat Transfer", Tata McGraw Hill, New Delhi, 2008.

17ME2059 MACHINE DESIGN

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Design principles and basic design procedures.
- Using design data for the design of mechanical elements.
- Applying topics learned in Engineering Mechanics and Mechanics of Solids to actual machine elements.

Course Outcomes:

Ability to

- Understand the standard design procedure for Design of machine elements.
- Analyse stresses acting on components and determine the size based on theories of failure.
- Design machine components for a given load condition using design data hand books.
- Decide specifications as per standards given in design data and select standard components to improve interchangeability.
- Design and develop nonstandard machine components.
- Prepare a detail design layout and drawing of machine components

Unit I - FUNDAMENTALS OF MACHINE DESIGN: General considerations in machine design – strength properties of engineering materials. Limits and tolerances – Types of Fits – simple stresses in machine elements – tension – compression – shear and bearing stresses. Torsional and bending stresses in machine parts-torsional stresses in shafts, bending stresses in beams – combined stresses. Theories of failure – Rankine's and Guest theory

Unit II - DESIGN OF FASTENERS: Design of permanent joints – Welded joints – comparison of welded and riveted joints – types of welded joints – transverse and parallel strength of fillet welds – design of butt joints – Rivets and riveted joints – failure modes of riveted joints – design of non-permanent joints – threaded fasteners – stresses in screwed fastening due to static loading.

Unit III - DESIGN OF MACHINE ELEMENTS: Keys and couplings – strength of sunk keys-Shaft couplings – design of sleeve coupling and flange coupling. Design of cotter and knuckle joints – Design of shafts – shafts subjected to torsion, bending and combined stresses. Power screws – design of screw jack.

Unit IV - DESIGN OF TRANSMISSION SYSTEM COMPONENTS: Belt drives - flat belts –V-belt design – power calculation and selection – chain drive – design. Spur gear – classification – gear terminology –bevel gear – terminology – design. Bearings – types of bearings - rolling contact bearings– design of Journal bearing, springs – types of springs – properties of spring material – terminology – design of helical springs.

Unit V - DESIGN OF ENGINE SYSTEM: Design of Gear Box, Design of piston, Cylinder, connecting rod, and flywheel.

Text books:

1. S.Md. Jalaludeen, “Machine Design”, Anuradha Publications, Chennai 2011.
2. Prabhu. T.J, “Design of Transmission Elements”, Mani Offset, Chennai, 2000.

Reference books:

1. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett, “Mechanical Engineering Design”, 8th Edition, Tata McGraw–Hill, 2015.
2. Bhandari V, “Design of Machine Elements”, 4th Edition, Tata McGraw–Hill Book Co., 2016.
3. Sundarrajamoorthy T.V. and Shanmugam, ‘Machine Design’, Khanna Publishers, 2003.
4. Bernard Hamrock, “Fundamentals of Machine Elements”, McGrawHill, 2014.
5. Hall and Allen, “Machine Design”, Schaum Series, 2001.

Hand book:

1. Design Data – Data Book for Engineers, PSG College of Technology, Coimbatore, Kalaikathir Achchagam 2012.

17ME2060 HEAT POWER ENGINEERING

Credits: 2:0:1

Course Objectives:

To impart knowledge on

- fuels and combustion
- classification and principles of IC engines
- air compressors and boilers

Course Outcomes:

Ability to

- Evaluate the properties of fuels
- Classify different types of internal combustion engines.
- Analyze performance of spark ignition and compression ignition engines.
- Predict the efficiency of compressors and boilers
- Conduct a variety of experiments in internal combustion engines
- Determine the principle of various parameters in the performance of Boiler

Unit I - TYPES AND PROPERTIES OF FUELS: Fuels – types and properties-higher and lower heating values, their determination -properties of gas mixtures, ideal and real gases – Dalton’s law of partial pressures-Internal energy, enthalpy, entropy and specific heats of gas mixtures –Gibb’s function.

Unit II - COMBUSTION: Combustion of fuels, stoichiometric air requirement – excess air-gravimetric analysis and volumetric analysis of products of combustion and their conversions.

Unit III - CLASSIFICATION AND PRINCIPLES OF IC ENGINES: Classification-engine components-Four stroke cycle- principle-valve timing diagram-P-V diagram- two stroke cycle- principle-valve timing diagram-P-V diagram. Spark ignition engine-working principle and thermal efficiency-carburettors-types-fuel pump-coil ignition and magneto systems-sparking plug. Compression ignition engine-working principle and thermal efficiency-fuel pump and injector. Gas engine –working principle-turbocharging.

Unit IV - AIR COMPRESSORS AND BOILERS: Air compressors-reciprocating, rotary and centrifugal types-work done and efficiency-slip factor. Measurement of steam quality – throttling process – separating and throttling calorimeter – electrical calorimeter. Heat exchangers – principle – types. Boilers – classification – working principle of fire tube and water tube boilers – vertical and horizontal boilers - principles, construction and operation - Cochran, Lancashire, Cornish, Scotch, Velox, Locomotive, Babcock and Wilcox boilers –principles – boiler mountings and accessories – pressure regulators – blow off fittings - boiler performance – boiler operation, inspection, safety and maintenance.

Unit V - PRACTICAL:

1. Measurement of performance parameters on two stage reciprocating air compressor
2. Performance test on variable compression ratio, 4 stroke petrol engine
3. Performance test on four–stroke twin cylinder vertical Diesel engine
4. Heat balance test on four stroke single cylinder Diesel engine
5. Retardation test on four stroke single cylinder vertical Diesel engine
6. Performance test and study on the boiler apparatus

Text Books:

1. Kothandaraman, C.P, Domkundwar S., "Thermal Engineering", DhanpatRai & Sons, 6th edition, New Delhi, 2015.
2. Mathur. R.B. and R.P. Sharma, "Internal Combustion Engines", Dhanpat Rai & Sons 2010.

Reference Books

1. Rajput. R.K ., "Thermal Engineering", Laxmi Publications(P) Ltd., 9th Edition, New Delhi, 2014
2. Ramalingam. K.K., "Internal Combustion Engine Fundamentals", Scitech Publications, 2011.
3. Colin, Ferguson. R., "Internal Combustion Engines", John Wiley and Sons, 2015.
4. Ganesan. V., "Internal Combustion Engines", Tata McGraw Hill, New Delhi, 2012

17ME2061 CAD/CAM AND COMPUTER GRAPHICS

Credits: 0:0:2

Course Objectives:

To impart knowledge on

- Application of various line types, arcs and methods to draw using AutoCAD.
- Modelling products of industrial system.
- Computer Numerical Control (CNC) programming for various machining operation.

Course Outcomes:

Ability to

- Construct drawings using various line types, arcs, and circles using CAD software.
- Prepare drawings using modify, draw, layers and properties tool bars to draw orthographic views.
- Recognize the applications of software in 3D modelling/analysis of Mechanical Engineering components
- Construct the 3D model using various commands like extrude, mirror, revolve etc
- Model 3D mechanical components like knuckle joint, plumber block using appropriate modelling/ assembling commands
- Prepare CNC Programming for different mechanical parts using G codes and M codes

List of Exercises:

1. Snap, Grid, Limits, OSNAP, line types and weights, text, pdf file creation and plotting.
2. Modifying Commands: Erase, trim, array, lengthen, break, mirror, offset, move, copy etc.
3. Methods of Drawing lines, arcs and circles and applications.
4. Isometric view of primitive solids and combination of primitive solids.
5. 3D modeling using Extrude, Round, Mirror commands
6. 3D modeling using Revolve, Hole, shell, and pattern commands
7. Assembly of Knuckle Joint or Universal Joint/Plummer block or flange coupling/ Lathe Tailstock
8. Advanced modeling commands Sweep and Blend.
9. Step turning in CNC
10. Taper turning in CNC
11. Ball Turning in CNC
12. Drilling in a CNC drilling machine

17ME3001 FINITE ELEMENT METHODS IN ENGINEERING

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- finite element analysis fundamentals.
- formulate the design problems into FEA.
- basic aspects of finite element technology and various types of elements.
- implementation of Galerkin's formulation into the Finite Element Method for the solution of ordinary and partial differential equations.

Course Outcomes:

Ability to:

- identify mathematical model for solution of common engineering problems.

- formulate simple problems into finite elements.
- determine engineering design quantities for structural , heat transfer and fluid mechanics Problems
- use professional-level finite element software to solve engineering problems in Structural Mechanics, fluid mechanics and heat transfer.
- derive integral statements for linear partial differential equations, such as the Laplace/Poisson equation, the wave equation, and the elasticity equations.
- derive element matrix equation using different methods by applying basic laws in mechanics and integration by parts.

Unit I - INTRODUCTION: Basic concepts- General applicability of the method to structural analysis, heat transfer and fluid flow problems- general approach of finite element method with case studies - classical analysis techniques- finite element packages - Solution of equilibrium problems- solution of Eigen value problem -Solution of propagation problems

Unit II - GENERAL PROCEDURE: Discretization of Domain- basic element shapes- interpolation polynomials natural coordinates- formulation of element characteristic matrices and vectors-direct approach -variational approach and weighted residual approach-Continuity conditions-Formulation of one dimensional, two dimensional, three dimensional elements - isoparametric elements- curve sided elements-higher order elements-Lagrangian element- serendipity element.

Unit III - FIELD PROBLEMS: Heat Transfer Problems- Basic equations of heat transfer derivation using finite element Method for 1D & 2D problems. Fluid mechanics problems- Basic equations- Solutions procedure- compressible flows- Galerkin approach. Structural Problems- Equations of elasticity- plane elasticity problems - Bending of elastic plates

Unit IV - TORSION OF NON-CIRCULAR SECTION: Two dimensional field equation- governing differential equations- Integral Equations for the element matrices- Element matrices- Triangular element, Rectangular element. Torsion of Non circular sections: General theory- Twisting of a square bar -shear stress components- Evaluation of the twisting torque.

Unit V - DYNAMIC ANALYSIS: Dynamic equations of motion- consistent and lump mass matrices- Free vibration analysis – dynamic response calculation.

Reference Books :

1. Rao. S.S.The Finite element method in Engineering, 2nd Ed., Pergamon Press, Oxford, 2003.
2. David.V.Hutton, Fundamentals of Finite Element Analysis, Tata McGraw Hill,2003
3. Tirupathi.R.Chandrupatla, Ashok.D.Belegundu. Introduction to Finite Elements in Engineering', Prentice Hall of India, 2004.
4. J. N. Reddy.An Introduction to the Finite Element Method, 3rd ed., McGraw-Hill Education, 2005.
5. Larry .J.Segerland. Applied Finite Element Analysis,Wiley India Pvt.Ltd.,2011.
6. C.S. Desai and J.P. Abel. Introduction to Finite Element Method, Affiliated East West Press, 2002.

17ME3002 COMPUTER APPLICATION IN DESIGN

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- how computer can be used in mechanical engineering design.
- the basics of CAD and Visual realism
- the assembly of parts, tolerance analysis, mass property calculation, solid modeling techniques and rapid prototyping.

Course Outcomes:

Ability to

- understand the basics and applications of CAD
- know the theory for geometry creation and transformation
- apply different CAD software for creating CAD Models.
- apply the knowledge of assembly modeling.

- determine the graphic standards used for solid modeling and surface modeling
- decide on the various data exchange formats to be used for advanced applications

Unit I - INTRODUCTION TO CAD :CAD/CAM Contents and tools – History of CAD Development, Graphics Displays – Refresh Display – DVST – Raster Display. Design and Manufacturing Process-Conventional and Computer representations of Drawings and Diagrams, its strength and weaknesses-Product cycle - Sequential and concurrent engineering
Unit II - COMPUTER GRAPHICS ALGORITHMS: DDA Algorithm – Bresenham's Algorithm – Coordinate systems – Transformation of geometry - Translation, Rotation, Scaling, Reflection, Homogeneous transformations – 2D Transformations - Concatenation – Clipping and Hidden line removal algorithms
Unit III - GEOMETRIC MODELING: Wireframe models and entities – Curve representation – parametric representation of analytic curves – circles and conics – Synthetic curves – Cubic splines – Bezier curve and B-Spline curves. Surface Modeling – Surface models and entities – Parametric representation of analytic surfaces – Plane surfaces – Synthetic surfaces – Bicubic Surface and Bezier surface.
Unit IV - SOLID MODELING & ASSEMBLY OF PARTS: Models and Entities – Fundamentals of solid modelling –B-Rep, CSG and ASM. Top down Approach. Bottom up approach Assembly of parts, tolerance analysis and mass property calculations, mechanism simulation.
Unit V - VISUAL REALISM & EXCHANGE FILE FORMATS: Hidden line- surface- Solid removal algorithms shading- coloring. Introduction to parametric and variational geometry based on software's and their principles creation of prismatic and lofted parts using these packages.
Rapid prototyping – data exchange- Documentation- Customizing- solid modeling system. IGES, GKS systems.

Reference Books:

1. Ibrahim Zeid, " CAD/CAM- Theory and Practice" McGraw Hill, 2009.
2. Mikell. P. Grooves and Emory, W. Zimmers Jr. " CAD/CAM Computer aided Design and Manufacturing " Prentice Hall of Inc., 1995.
3. Donald Hearn and M Pauline Baker " Computer Graphics with OpenGL,Third Edition", Prentice Hall Inc. 2004.
4. P.N. Rao, CAD/CAM Principles And Applications, Tata McGraw-Hill, 2014.
5. Chris McMahon and Jimmy Browne." CAD / CAM, Principles, Practice and Manufacturing Management", Pearson Education, 2002.
6. Kun Woo Lee "Principles of CAD/CAM "Addison Wesley, 1999.

17ME3003 ADVANCED MECHANICAL VIBRATIONS

CREDITS: 3:0:0

Course Objective:
To impart knowledge on
- formulating mathematical model for vibration problems
- analyzing the vibration behavior of mechanical systems subjected to loading
- methods to reduce vibration and the equipment used for collecting response data.

Course Outcome:
Ability to
- classify the systems of vibration and formulate equations of motion for vibratory systems.
- solve vibration problems with multi-degrees of freedom.
- suggest methods to regulate vibration
- perform vibration tests and acquire data from vibration measuring instruments.
- present the theoretical and the experimental principles of mechanical vibrations to gain practical understanding in the field of vibration
- understand unwanted vibration, noise in machines and proficient with instrumentation used in noise, vibration control tests

Unit I - VIBRATION OF SINGLE DEGREE OF FREEDOM SYSTEM: Introduction –Equation of motion - Newton's law, Energy methods – free vibration- forced vibration – damping models - Solutions of problems for one degree of freedom systems for transient and harmonic response. – Vibration isolation and transmissibility.

Unit Ii - VIBRATION OF TWO AND MULTI DEGREE FREEDOM SYSTEMS: Equations of motion for Two Degree of freedom systems-Vibration absorber – Lagrange's equation, influence coefficients- mode of vibration-principle modes-principle of orthogonal generalized coordinates – dynamic vibration absorber – semi definite systems-Multi degree of freedom system-Continuous system-.Vibration equation, Natural frequency and mode shape for beams.
Unit III - NUMERICAL METHODS TO SOLVE VIBRATION PROBLEMS: Numerical methods in vibration problems to calculate natural frequencies - matrix iteration –Stodola's method, Holzer's method -mechanical impedance method –Matrix iteration technique.
Unit IV - ENGINEERING ACOUSTICS: Basic physical acoustics- acoustic levels and spectra- decibels, sound power, Sound pressure, power and intensity - Character of noise – Addition of two noise sources -Noise source identification. Noise radiation from vibrating bodies sound- properties of the various sources that create noise - Noise in machines and machine elements.
Unit V - VIBRATION AND NOISE MEASUREMENT, TESTING: Vibration instruments- vibration exciters - measuring devices- analysis- vibration Tests- Free, forced environmental vibration tests. Example of vibrations test- data acquisition – Modal and FFT analysis– Industrial case studies. Introduction to Acoustic Standards, Acoustic / Noise sensors, instrumentation, measurement and noise control instruments and noise propagation.

Reference Books:

1. Singiresu.S.Rao. Mechanical Vibrations, Addison Wesley Longman , 2003.
2. Benson H Tongue.Principles of vibration(2nd edition)Oxford University Press, 2002.
3. Thomson, W.T.Theory of Vibration with Applications, CBS Publishers and Distributers, NewDelhi, 2002
4. Kelly.Fundamentals of Mechanical Vibrations, Mc Graw Hill Publications, 2000.
5. Rao V. Dukkipati, J. Srinivas.Vibrations : problem solving companion, Narosa Publishers, 2007.
6. Ambekar.A.G. Mechanical Vibrations and Noise Engineering, Prentice Hall of India, New Delhi,2006.
7. Kewal Pujara. Vibrations and Noise for Engineers, Dhanpat Rai & Co, 4^{rth} Edition, 2007.

17ME3004 ADVANCED STRENGTH OF MATERIALS

CREDITS: 3:0:0

Course Objectives:

To impart knowledge on

- thorough understanding of advanced topics concerning the response of materials and structural elements to applied forces of deformation.
- material behavior under various stress conditions.
- development of stresses in the material for various shape and loading conditions.

Course Outcomes:

Ability to

- apply concepts in stress, displacement, and transformations to 2D, and 3D solids under load.
- apply concepts in elasticity for calculating strength on components subjected to concentrated loads
- determine strength, predict failure, and incorporate design considerations in shafts and beams.
- determine stresses in open and closed sections in torsion and bending of standard sections.
- apply stress functions, and calculate stresses in plates and shells, thick circular cylinders, and discs.
- apply and use energy methods to find force, stress, and displacement in simple structures.

Unit I - ANALYSIS OF STRESS AND STRAIN: Introduction-Definition and Components of Stress-internal Force-Resultant and Stress Relations- -Stress Transformation- -Principal Stresses and Maximum In-Plane Shear Stress-Mohr's Circle for Two-Dimensional Stress-Three-Dimensional Stress Transformation-Principal Stresses in Three Dimensions-Normal and Shear Stresses on an Oblique Plane-Mohr's Circles in Three Dimensions-Deformation-Strain Defined-Equations of Compatibility-State of Strain at a Point- Measurement of Strain: Strain Rosettes.
Unit II - PROBLEMS IN ELASTICITY: Introduction-Plain Elastic Problems-Governing Equations- Conversion between plane stress and plane strain problems-Airy's Stress Function-Solution of Elasticity Problems-Thermal

Stresses-Basic Relations in Polar Coordinates-Stresses Due to Concentrated Loads- Stress Distribution Near Concentrated Loads-Stress Concentration Factors.
Unit III - FAILURE CRITERIA: Introduction-Failure-Failure by Yielding-Failure by Fracture-Yield and Fracture Criteria-Maximum Shearing Stress Theory-Maximum Distortion Energy Theory-Octahedral Shearing Stress Theory-Comparison of Yielding Theories-Maximum Principal Stress Theory-Mohr's Theory-Coulomb-Mohr Theory-Fracture Mechanics-Fracture Toughness-Failure Criteria for Metal Fatigue-Impact or Dynamic Loads-Dynamic and Thermal Effects.
Unit IV - TORSION OF PRISMATIC BARS: Introduction-Elementary Theory of Torsion of -Stresses on Inclined Planes-General Solution of the Torsion Problem-Prandtl's Stress Function-Prandtl's Membrane Analogy-Torsion of Narrow Rectangular Cross Section-Torsion of Multiply Connected Thin Walled Sections-Fluid Flow Analogy and Stress Concentration-Torsion of Restrained Thin-Walled Members of Open Cross Section.
Unit V - APPLICATIONS OF ENERGY METHODS: Introduction-Work Done in Deformation-Strain Energy-Components of Strain Energy-Saint-Venant's Principle-Reciprocity Theorem-Castigliano's First Theorem-Complementary Energy Theorem- Castigliano's Second Theorem-Statically Indeterminate Systems-Principle of Virtual Work-Principle of Minimum Potential Energy-Rayleigh-Ritz Method.

Reference Books:

1. R. G. Budynas, "Advanced Strength and Applied Stress Analysis", 2nd Edition, McGraw Hill Education (India) Pvt ltd., 2013
2. L. S. Srinath, "Advanced Mechanics of Solids", 2nd Edition, TMH Publishing Co. Ltd., New Delhi, 2003.
3. Ferdinand P. Beer, E. Russell Johnston, John T. DeWolff and David F. Mazurek Mechanics of Materials, 5th ed. in SI Units, McGraw-Hill, 2009.
4. Boresi, Arthur P. and Schmidt, Richard J., Advanced Mechanics of Materials, 6th Ed., John Wiley & Sons, 2003.
5. Young, Warren C. and Budynas, Richard G., Roark's Formulas for Stress and Strain, 7th Ed., McGraw-Hill, 2002.

17ME3005 ENGINEERING MATERIALS AND APPLICATIONS

Credits: 3:0:0

Course Objectives:
To impart the knowledge on

- Structure, composition and behavior of Metals
- fracture behavior of materials
- the principles of design, selection and processing of materials.

Course Outcomes:
Ability to

- Apply the concepts of Materials Science for material selections towards new product development.
- Analyse the elastic and plastic behavior of materials
- Suggest modern metallic materials for engineering applications.
- Evaluate fracture behavior of materials in engineering applications.
- Appraise the utility of new age material for specific application.
- Synthesise and develop the unique customized composites for special needs.

Unit I - ELASTIC AND PLASTIC BEHAVIOR: atomic model of Elastic behavior – Rubber like Elasticity an elastic behavior - plastic deformation- slip- shear strength of perfect and real crystals- movement of dislocation
Unit II - FRACTURE BEHAVIOR: Ductile and Brittle fracture – Energy and stress intensity approach, fracture toughness- Ductile Brittle Transition Fatigue- Creep in Materials.
Unit III - MODERN METALLIC MATERIALS: Patented Steel wire - Steel martensite - micro alloyed steels-precipitation hardened aluminum alloys- Maraging steels – metallic glasses.
Unit IV - NEW AGE MATERIALS: Shape memory alloys smart Materials- TRIP Steels Ceramics and glasses: Properties, applications, Ceramic Structures- silicate ceramics- carbon –diamond- graphite imperfections and impurities in ceramics –applications

Unit V - COMPOSITES: Metal matrix composites, polymer matrix and ceramic materials, Bio compatible, Materials for medical implants, Applications of composites.

Reference Books:

1. V. Raghavan, “Materials Science and Engineering – Prentice Hall of India (P) Ltd., New Delhi. 2004.
2. Raymond A. Higgins, “Properties of Engineering Materials”, English Language Book Society, 2000.
3. Thomas H. Courtney “Mechanical Behaviour of Materials” McGraw Hill International Edition, 2005.
4. Williams D, Callister “ Material Science and Engineering” John Wiley and Sons Inc. 2009.
5. Joshua Pelleg, “ Mechanical Properties Materials”, Springer, 2013.
6. Kenneth.G,Michael, K.Budinski, “ Engineering Materials”, Properties and selection, Prentice Hall, 2010.

17ME3006 ADVANCED MECHANISM DESIGN

Credits : 3:0:0

Course Objectives:

To impart knowledge on

- the fundamentals of a mechanism and machines.
- kinematics of a mechanism.
- forces in the joints and links of a mechanism and a robot.

Course Outcomes:

Ability to

- identify the type and find degree of freedom of a given mechanism
- conduct kinematic analysis of a mechanism
- apply the path curvature theories in the analysis of a mechanism.
- synthesis of a mechanism for a given application.
- investigate forces in the joints and links of a mechanism.
- employ the capabilities of a robot in design.

Unit I - INTRODUCTION: Review of fundamentals of kinematics- mobility analysis- formation of one degree of freedom. Multiloop kinematic chains, Network formula- Gross motion concepts. Kinematic Analysis: Position Analysis- Vector loop equations for four bar, slider crank, inverted slidercrank, geared five bar and six bar linkages. Analytical methods for velocity and acceleration. Analysis - four bar linkage - Jerk analysis. Plane Complex mechanisms.

Unit II - PATH CURVATURE THEORY: Path Curvature theory. Fixed and moving centrodes, inflection points and inflection circle. Euler Savary equation, Bobilier’s construction constructions- Cubic of stationary curvature.

Unit III - SYNTHESIS OF MECHANISMS: Type synthesis- Number synthesis- Associated Linkage concept. Dimensional synthesis –function generation, path generation, motion generation, Graphical methods. Cognatelinkage- coupler curve synthesis, Design of six-bar mechanisms. Algebraic methods. Application of instant centre in linkage design. Cam Mechanisms- determination of optimum size of Cams.

Unit IV - DYNAMICS OF MECHANISMS: Static force analysis with friction – inertia force analysis- combined static and inertia force analysis, shaking force, kinetostatic analysis. Introduction to force and moment balancing of linkages.

Unit V - SPATIAL MECHANISM AND ROBOTICS: Introduction, topology arrangements of robotics arms, Kinematic Analysis of spatial RSSR mechanism. Denavait- Hartenberg parameters, Forward and inverse kinematic of Robotic manipulators. Study of mechanism using simulation software packages’.

Reference Books:

1. Uicker J.J., Pennock G.R., and Shigley J. E. “ Theory of Mechines and Mechanism”, Oxford International Student Edition, 3rd Editon 2009.
2. Nortorn R. L. “ Design of Machinery”, Mc Graw Hill, 1999.
3. Kenneth J. Waldron, “Gary L Kinzel, “Kinematics, Dynamics and Design of Machinery”, John Wiley-Sons 1999.
4. Amitabha Ghosh and Ahsok Kumar Mallik, “Theory of mechanism and Machines”, EWLP, Delhi, 1999.

5. Sandor G. N. and Erdman. A. G., " Advanced mechanism Design analysis and synthesis", Prentice Hall, 1984.
6. David Myszka, "Machines and Mechanisms: Applied Kinematic Analysis", 4th Edition, Pearson, 2012

17ME3007 EXPERIMENTAL STRESS ANALYSIS

Credits: 3:0:0

Course Objectives:
To impart knowledge on

- applied stress and strain involved in solid mechanics.
- the relation between theory of mechanics and experimental stress and strain analysis
- experimental method of finding the response of the structure to different types of load.

Course Outcomes:
Ability to :

- use suitable instruments in the measurement of stress and strain
- analyse stress and strain in machine elements.
- apply appropriate techniques to measure stress and strain.
- apply photoelasticity methods to measure stress and strain
- extract stress magnitude using brittle coating
- apply Moire methods in the measurement of stress

Unit I - MEASUREMENTS AND EXTENSOMETER: Principles of measurements, Accuracy, Sensitivity and range of measurements. Mechanical, Optical Acoustical and Electrical extensometers and their uses, Advantages and disadvantages.
Unit II - STRESS: Stress at a point - Stress equations of Equilibrium - Laws of stress transformation Principal stresses- Maximum Shear
Unit III - STRAIN MEASUREMENT: Principle of operation and requirements, Types and their uses, Materials for strain gauge. Calibration and temperature compensation, cross sensitivity, Rosette analysis, Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators.
Unit IV - PHOTOELASTICITY METHODS: Double refraction - stress optic law - effects of stressed model in a plane polariscope fringe multiplication - isochromatic fringe patterns - isoclinic fringe pattern compensation techniques - calibration methods - separation methods - scaling model to prototype stresses – materials.
Unit V - MOIRE AND BIREFRIGENT COATING METHODS: Mechanism of formation of Moire fringe - geometrical approach to Moire fringe analysis - displacement field approach to Moire fringe analysis - out of plane measurements experimental procedure.Coating stresses and strains - sensitivity - materials and applications - effect of thickness - stress separation.

Reference Books:
1. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K. "Experimental Stress Analysis", Tata McGraw-Hill, New Delhi, 1984.
2. R. G. Budynas, "Advanced Strength and Applied Stress Analysis", 2nd Edition, McGraw Hill Education (India) Pvt ltd., 2013
3. Dally, J.W., and Riley, W.F., "Experimental Stress Analysis", McGraw-Hill Inc., NewYork, 2005, IV edition.
4. Hetyenyi, M., "Hand book of Experimental Stress Analysis", John Wiley and Sons Inc.,New York, 1972.

17ME3008 ENGINEERING PRODUCT DESIGN AND DEVELOPMENT STRATEGIES

Credits 3:0:0

Course Objectives:
To impart knowledge on

- modeling, simulation, material selection and GD & T.
- important practices followed during designing and developing a product in industries.

- product life cycle right from its conceptual stage to its development stage.

Course Outcomes:

Ability to

- apply the appropriate design process and modelling techniques to design components.
- categorize the models used in product design and use appropriately for product analysis.
- choose the right material selection process and calculate the economics of materials.
- design a product for sustainability, environment friendly considering human factors engineering.
- use GD & T principles for better product manufacturing.
- design and develop a product using quality, robust design and optimization.

Unit I - NATURE AND SCOPE OF PRODUCT ENGINEERING: Importance of product design, Design Constraints, Safety and reliability considerations, The Design process-A simplified approach, Consideration of a Good Design, Detail description of Design process (Morphology of Design), Technological Innovation and the design process; Product and Process cycle. Green Technology Application-Integrated CAD/CAM, Statistical process controls (SPC).

Unit II - MODELING AND SIMULATION: The role of Models in Engineering Design-Mathematical modeling, Similitude and scale modeling, Simulation, Finite-Difference method, Geometric modeling on the computer, Finite Element Analysis-Introduction to simulation modeling-Simulation programming software-Monte Carlo Simulation

Unit III - MATERIAL SELECTION AND MATERIALS IN DESIGN: Relation of Materials Selection to Design, Performance Characteristics of materials, The Materials Selection process – Design process and materials selection, Ashby charts, Material selection in Embodiment design, Economics of materials, Methods of material selection- Selection with Computer-Aided database, Weighted Property Index, Value analysis, Design examples-Materials systems, Material substitution; simple problems.

Unit IV - DESIGN FOR SUSTAINABILITY AND THE ENVIRONMENT: The Environmental Movement-Sustainability -Challenges of Sustainability for Business- End-Of-Life Product Transformations -Role of Material Selection in Design for Environment-Tools to Aid Design for the Environment and Sustainability- Influence of Space, Size, Weight, etc., on Form design, Aesthetics- Human factors Design-Industrial Ergonomic considerations.

Unit V - GEOMETRIC DIMENSIONING AND TOLERANCING: Introduction to Dimensioning-Dimensioning Basics -Dimensioning Characteristics and Definitions-Fundamental Dimensioning Rules-Dimensioning Components -Dimensioning Symbols-Dimensioning Systems -Dimensioning Fundamentals-Introduction to GD&T Symbols -Datums -Applying Material Condition and Material-Boundary Symbols--Limits of Size Application -Perfect Form Boundary -Applying Regardless of Feature Size and-Regardless of Material Boundary -Applying Maximum Material Condition -Applying Least Material Condition-Quality-Robust Design and optimization.

Reference Books:

1. Dieter. G. E, ‘Engineering Design’, 5^{th} Ed. Tata McGraw Hill, 2010.
2. David A. Madsen, ‘Engineering Drawing and Design’, Delmar Thomson Learning Inc. 2002,
3. Jones J.C., ‘Design Methods’, Inderscience, 2008
4. Kevin Otto and Kristin Wood, ‘Product Design’, Pearson Educational Inc. 2004.
5. Karl T Ulrich, Steven D Eppinger, ‘Product Design and Development’, Irwin Homeward Boston Publishers, 2004.

17ME3009 ENGINEERING FRACTURE MECHANICS

Credits : 3:0:0

Course Objectives:

To impart knowledge on

- stress and strain field around a crack in a body for different fracture modes
- factors governing crack growth , crack arrest and fatigue.
- the applications of fracture mechanics.

Course Outcomes:

Ability to

- estimate stress and strain field around a crack.
- understand plastic material behaviour around the crack tip
- estimate the fracture toughness value of a material for various fracture modes.
- design of components that contain crack under static and fatigue load condition

- provide solution to prevent crack growth and fatigue failures.
- Analyze of fatigue crack propagation using empirical methods

Unit I - ELEMENTS OF SOLID MECHANICS: The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation – limit analysis – Airy's function – field equation for stress intensity factor.
Unit II - STATIONARY CRACK UNDER STATIC LOADING: Two dimensional elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation - plastic zone size – Dugdaale model – determination of J integral and its relation to crack opening displacement.
Unit III - ENERGY BALANCE AND CRACK GROWTH: Griffith analysis – stable and unstable crack growth – Dynamic energy balance – crack arrest mechanism –K1c test methods - R curves - determination of collapse load.
Unit IV - FATIGUE CRACK GROWTH CURVE: Empirical relation describing crack growth law – life calculations for a given load amplitude –effects of changing the load spectrum -- rain flow method– external factors affecting the K1c values.- leak before break analysis.
Unit V - APPLICATIONS OF FRACTURE MECHANICS: Crack Initiation under large scale yielding – thickness as a design parameter – mixed mode fractures - crack instability in thermal and residual stress fields - numerical methods.

Reference books:

1. Prashant Kumar, "Elements of Fracture Mechanics", Tata McGraw-Hill, 2009.
2. T.L. Anderson, "Fracture mechanics fundamentals and applications", CRC Press, 2005.
3. R.W. Hertzberg, "Deformation and Fracture Mechanics of Engineering Materials", Wiley, 2014.
4. Tribikram Kundu, "Fundamentals of Fracture Mechanics", CRC, Press, 2012.
5. Kare Hellan, "Introduction of Fracture Mechanics", McGraw-Hill Book Company, 1985.
6. David Broek, "Elementary engineering fracture mechanics", Martinus Nijhoff Publishers, The Hague, 1982.

17ME3010 DESIGN OF MECHANICAL SYSTEM ELEMENTS

Credits 3:0:0

Course Objectives:
To impart knowledge on
- applications and design of mechanical system elements
- applying the design concept in product design and development.

Course Outcomes:
Ability to
- understand the design principles of mechanical systems
- design the machine elements and systems
- design the material handling equipment
- learn about construction ,working principle and design of the conveyor systems
- select appropriate machine elements for mechanical systems
- design and develop new products which can be used in mechanical systems.

Unit I - MATERIAL HANDLING EQUIPMENTS: Types, Selection and applications, Method for determining stresses-Terminology and ligament efficiency-Application.
Unit II - INTRODUCTION: Stresses in a circular ring, cylinder-Membrane stress analysis of vessels shell components-Cylinder shells, to spherical heads, conical heads-Thermal stresses ,Discontinuity stresses in pressure vessels. Design Of Vessels: Design of tall cylinder self supporting process columns-Supports for short vertical vessels Stress concentration at a variable thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of reinforcement-Pressure vessel design.
Unit III - DESIGN OF AUTOMOTIVE TRANSMISSION SYSTEM: clutches – power transmitted brake – Cams – gear box.
Unit IV - DESIGN OF HOISTING ELEMENTS: Welded and roller chains-Hemp and wire ropes. –Design of ropes, pulleys, pulley system, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks crane grabs-lifting magnets-Grabbing attachments-Design of arresting gear-Brakes: Shoe, band and cone types.

Unit V - CONVEYORS: Types-description-Design and applications of belt conveyors, apron conveyors and escalators pneumatic conveyors, screw conveyors and vibratory conveyors.

Reference Books:

1. Richard G. Budynas, J. Keith Nisbett, "Shigley's Mechanical Engineering Design", McGraw Hill, 2016
2. John.F.Harvey, "Theory & Design of Pressure Vessels", "CBS Distributors", 1987.
3. Rudenko.N, "Materials Handling Equipments", Elnvee Publishers, 1970.
4. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000.
5. Alexandrov.M. "Materials HandlingEquipmets", MIR publishers, 1981.
6. Henry.H.Bedner "Pressure Vessels", Design HandBook, CBS Publishers & Distributors, 1987.

17ME3011 INDUSTRIAL TRIBOLOGY

Credits 3:0:0

Course Objectives:

To impart knowledge on

- friction , wear and lubrication aspects of machine components
- material properties which influence the tribological characteristics of surfaces.
- analytical behavior of different types bearings and design of bearings based on analytical /theoretical approach

Course Outcomes:

Ability to

- select material / surface properties based on the tribological requirements
- identify the methodology for deciding lubricants and lubrication regimes for different operating conditions
- analyse different types of bearings for given load/ speed conditions.
- Outline the methods to improve surface engineering
- Identify wear mechanisms on macro–scale in metals.
- Apply concepts of friction mechanisms and analyze performance of design components based on relative motion.

Unit I - SURFACE INTERACTION AND FRICTION : Topography of Surfaces – Surface features-Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction –Rolling Friction-Friction properties of metallic and non-metallic materials – friction in extreme conditions –Thermal considerations in sliding contact

Unit II - WEAR AND SURFACE TREATMENT: Types of wear – Mechanism of various types of wear – Laws of wear –Theoretical wear models-Wear of Metals and Non metals – Surface treatments – Surface modifications – surface coatings methods- Surface Topography measurements –Laser methods – instrumentation - International standards in friction and wear measurements.

Unit III - LUBRICANTS AND LUBRICATION REGIMES : Lubricants and their physical properties- Viscosity and other properties of oils –Additives-and selection of Lubricants- Lubricants standards ISO,SAE,AGMA, BIS standards – Lubrication Regimes –Solid Lubrication-Dry and marginally lubricated contacts- Boundary Lubrication-Hydrodynamic lubrication –– Elasto and plasto hydrodynamic - Magneto hydrodynamic lubrication – Hydro static lubrication – Gas lubrication.

Unit IV - THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION: Reynolds Equation,-Assumptions and limitations-One and two dimensional Reynolds Equation-Reynolds and Sommerfeld boundary conditions- Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings-Long and short bearings-Pad bearings and Journal bearings-Squeeze film effects-Thermal considerations-Hydrostatic lubrication of Pad bearing- Pressure , flow , load and friction calculations-Stiffness considerations- Various types of flow

Unit V - HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION: Rolling contacts of Elastic solids- contact stresses – Hertzian stress equation- Spherical and cylindrical contacts-Contact Fatigue life- Oil film effects- Elasto Hydrodynamic lubrication Theory-Soft and hard EHL-Reynolds equation for elasto hydrodynamic lubrication- - Film shape within and outside contact zones-Film thickness and friction calculation- Rolling bearings- Stresses and deflections-Traction drives.

Reference Books:

1. Rabinowicz.E, "Friction and Wear of materials", John Willey &Sons ,UK,1995

2. Cameron, A. “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 1981
3. Williams J.A. “Engineering Tribology”, Oxford Univ. Press, 1994.
4. B. Bhushan “Principles and Application of Tribology”, , Wiley, 2013.
5. S.K.Basu, S.N.Sengupta & B.B.Ahuja ,”Fundamentals of Tribology”, Prentice – Hall of India Pvt Ltd , New Delhi, 2005
6. G.W.Stachowiak and A.W .Batchelor, Engineering Tribology, Butterworth-Heinemann,UK, 2006.

17ME3012 QUALITY CONCEPTS IN DESIGN

Credits 3:0:0

Course Objectives:
To impart knowledge on
- the basic concepts in Total Quality Management
- statistical process control
- reliability computation and reliability improvement

Course Outcomes:
Ability to
- apply the basic tools of quality in product development
- analyze the basic tools of quality in improving or redesigning the production process
- adopt/adept TQM and SPC tools in product/process Industries
- conduct experiments and to analyze the significance of proceeds parameters
- compute reliability of parallel, series and mixed configurations
- improve the reliability of the systems by redundancy

Unit I - BASIC CONCEPTS: Basic concepts in quality engineering and management, TQM, Cost of quality, quality engineering and Six Sigma. Review of Probability and Statistics, Frequency distributions and Histograms, Test of Hypothesis.
Unit II - STATISTICAL PROCESS CONTROL: DMAIC process for process and design improvement, Acceptance Sampling, SPC (Statistical Process Control), Process Capability, Gage Reproducibility and Repeatability, Quality Function Deployment.
Unit II - FAILURE ANALYSIS: Failure mode effect analysis, Fault-tree analysis APQP, Embodiment checklist-Advanced methods: systems modeling, mechanical embodiment principles.
Unit IV - DESIGN OF EXPERIMENTS: Procedure for DOE, Fractional, Full and Orthogonal Experiments, Regression model building, Taguchi methods for robust design. Six Sigma sustainability, Six Sigma and lean production.
Unit V - RELIABILITY: Definition, Survival and Failure rates-Series and parallel and mixed systems-Mean time between failure, Mean time to failure,-Availability models-redundancy

Reference Books:
1. Evans, J R and W M Lindsay, “An Introduction to Six Sigma and Process Improvement”, 2nd Edition, Cengage Learning, 2015.
2. J.M.Juran, “ Quality planning and analysis”,Mc Graw Hill, 5th Edition,15 th Reprint 2015
3. Montgomery, “Design and analysis of Experiments”, Wiley India ,5th Edition 2004
4. Amitava Mitra, “Fundamentals of quality control and Improvement”, Wiley India ,3rd Edition 2013
5. M.Mahajan, “Statistical Quality Control”, Dhanpat Rai Sons, 11th Edition 2007
6. Eugene L Grant, “Statistical Quality Control”, McGraw-Hill Higher Education; 25th edition, 1997.

17ME3013 ROTOR DYNAMICS

Credits 3:0:0

Course Objective:
To impart knowledge on
- rotor dynamics phenomena with the help of simple rotor models
- behavior of fluid film lubrication and rotor bearing system in rotor system
- performance of bearings under dynamic conditions

Course Outcome:
Ability to

- apply the principles of rotor dynamics in design and analysis of mechanical components
- analyze the bearing behavior under dynamic conditions
- acquire knowledge in rotor balancing.
- measure vibration and conduct dynamic analysis in rotating machine elements
- model a rotating machine element theoretically
- study the effect of vibration in rotating machinery

Unit I - INTRODUCTION: Brief history of rotor dynamics- overview of rotor dynamics phenomena and Recent trends - development of rotor dynamics analysis tools- software for rotor dynamic analysis - different rotor models-Torsional vibrations in rotating machinery-Equation of motion- Problems in torsional vibration-single and multiple rotor system- Transfer Matrix Methods for Torsional Vibration.
Unit II - INSTABILITY IN ROTATING MACHINES: Oil whip and Oil whirl-stability analysis using linearized stiffness and damping coefficients-Instability due to stream whirl and seals- Theory of Balancing of Rotors- Rigid rotor classification-Balancing criteria-Balancing of rigid rotors-Balancing of flexible rotors-Balance criteria for flexible rotors
Unit III - ROTOR MODELS: Single dof undamped rotor model for both free and forced vibration- single dof damped rotor model-attenuation of vibration-Rankine rotor model-Jeffcott rotor model-simple rotor systems with Gyroscopic effects-synchronous motion, asynchronous rotational motion- Asynchronous General Motion-Gyroscopic Effects by the Dynamics Approach
Unit IV - BEARING IN ROTORS: Rolling element bearings-Hydrodynamic oil lubricated journal bearing-types of hydrodynamic bearing-Reynolds equation and its basic assumptions-Basic concepts and assumptions of fluid-film bearing models-Short and long hydrodynamic radial bearings-Dynamic characteristics of fluid-film bearings-Dynamic seals and its classifications.
Unit V - SIGNAL PROCESSING AND CONDITION MONITORING IN ROTOR DYNAMICS: Vibration generating mechanism- Condition monitoring - Noise spectrum-Signal processing in rotating machineries-Measurements in rotating machineries-Real time analysis & Knowledge based (data base)-Expert systems-Display of vibration measurement instruments-Signature Analysis of Common Rotor Faults-Signature Analysis of Common Rotor Faults.

Reference Books:

1. Rao J.S., ‘Rotor Dynamics’, New Age International, New Delhi, 2012 .
2. Genta G., ‘Dynamics of Rotating Systems’, Springer, New York, 2005.
3. Muszynska A., ‘Rotor dynamics’, Series: Dekker Mechanical Engineering, Vol. 188, CRC Press, 2005.
4. Robert B.M., ‘Rotating Machinery: Practical Solutions to Unbalance and Misalignment’, CRC Press, 2003.
5. Rao J.S., ‘Vibratory Condition Monitoring of Machines’, Narosa Publishing House, New Delhi, 2000.
6. Chen W.J., and Gunter E.J., ‘Introduction to Dynamics of Rotor-Bearing Systems’, Trafford Publications, Canada, 2005.

17ME3014 DESIGN FOR MANUFACTURING AND ASSEMBLY

Credits 3:0:0

Course Objectives:
To impart the knowledge on:

- Product functionality, product design, product planning and assembly.
- Developing quality products by incorporating the reliability, safety functions and robustness.
- Product and process sheet using Geometric Dimensioning and Tolerancing principles

Course Outcomes:
Ability to

- reproduce the DFM principles, poka-yoke and six signam concepts in a design process in order to visualize the creative engineering thinking and analysis.
- classify the tolerance analysis methods and solve the process capabilities for various tolerance grades.
- use Geometric Dimensioning and Tolerancing principles to compare the various tolerance positions and select appropriate datum for geometric analysis and applications.

- illustrate the interchangeable part manufacture and selective assembly features and redesign of castings based on parting line considerations.
- identify and classify different datum features for geometric analysis and applications
- prepare the process drawings for different operations and apply DFM principles for environmental issues.

Unit I - DFM APPROACH: DFM principles and approach, guidelines, standardization - comparison of materials on cost basis, design for assembly, DFA index, poka-yoke, lean principles, six sigma concepts. Materials: Selection of Materials for design Developments in Material technology - criteria for material selection - Material selection interrelationship with process selection process selection charts.

Unit II - TOLERANCE ANALYSIS: Cumulative effect of tolerances - Worst case method, root sum square method, dimensions following truncated normal distributions, Monte Carlo simulation. Tolerance synthesis, non-linear tolerance analysis, tolerance cost relationships. Process Capability, mean, variance, C_p, C_{pk}, cost aspects, feature tolerances, geometric tolerances - ISO standards - surface finish, review of relationship between attainable tolerance grades and different machining and sheet metal processes.

Unit III - GEOMETRIC DIMENSIONING AND TOLERANCING: Introduction to GD&T, ASME Y 14.5 standard - Examples for application of geometric tolerances - True Position Theory - Comparison between co-ordinate and convention method of feature location, tolerancing and true position tolerancing, virtual size concept, floating and fixed fasteners, projected tolerance zone, zero true position tolerance, functional gauges, paper layout gauging, compound assembly, examples.

Unit IV - DATUM FEATURES AND SELECTIVE ASSEMBLY: Datums, datum feature, simulate datum feature, datum targets - Grouped datum system with spigot and recess, pin and hole - computation of translational and rotational accuracy, geometric analysis and applications. Interchangeable part manufacture and selective assembly, deciding the number of groups - Model-I: Group tolerances of mating parts equal; Model-II: total and group tolerances of shaft equal. Control of axial play - introducing secondary machining operations, laminated shims, examples.

Unit V - FORM DESIGN OF CASTINGS AND WELDMENTS: Redesign of castings based on parting line considerations, minimizing core requirements, redesigning cast members using weldments, form design aspects of sheet metal components. Design for the environment- Introduction - Environmental objectives - Global issues - Regional and local issues - Basic DFE methods - Design guide lines - Example application.

Reference Books:

1. George E.Dieter, Linda C. Schmidt " Engineering Design", 5th ed., Tata McGraw-Hill, 2012.
2. Geoffrey Boothroyd, Petre Dewhurst, Winston A Knight, "Product Design for Manufacture and Assembly", CRC Press, Taylor & Francis Group, 2010.
3. Robert Matousek, " Engineering Design- A Systematic Approach" Blackie and Son Ltd., London, 2008.
4. A.K.Chitale, R.C.Gupta, Product Design and Manufacturing Prentice Hall of India, 2007.
5. C.Poli, "Design for Manufacturing", Butterworth-Heinemann, Reed Elsevier Group, 2001.
6. James G,.Bralla, " Hand Book of Product design for Manufacturing", McGraw Hill publications, 1999.
7. Spotts M F, "Dimensioning and Tolerance for Quantity Production", Prentice Hall Inc., 1983.

17ME3015 MODAL ANALYSIS OF MECHANICAL SYSTEMS

Credits 3:0:0

Course Objectives:
To impart knowledge on
- modal testing methods.
- mathematical models of mechanical systems
- modal analysis of single and multi- degree of freedom systems.

Course Outcomes:
Ability to
- helps the students to get familiarized with the modal testing,
- employ modal analysis of single and multi- degree of freedom systems.
- apply suitable measurement techniques
- extract the parameters using correct method
- understand the working principle of transducer and modal anlyser

- develop mathematical models

Unit I - MODAL TESTING: Introduction to Modal Testing – Applications of Modal Testing – Philosophy of Modal Testing – Summary of Theory – Summary of Measurement Methods – Summary of Analysis – Review of Test Procedure.

Unit II - THEORETICAL BASIS: Introduction – Single Degree of Freedom (SDOF) System Theory – Presentation and Properties of FRF Data for SDOP System – Undamped Multi-degree of freedom (MDOF) system – Proportional Damping – Hysteretic Damping – General Case – Viscous Damping – General Case – Characteristics and presentation of MDOF – FRF Data – Complete and incomplete models - Non- sinusoidal vibration and FRF Properties – Analysis of Weakly Nonlinear Structures.

Unit III - MOBILITY MEASUREMENT TECHNIQUES: Introduction – Basic Measurement System – Structure preparation – Excitation of the Structure – Transducers and Amplifiers – Analyzers – Digital Signal Processing – Use of Different Excitation types – Calibration – Mass Cancellation – Rotational Mobility Measurement – Measurement on Non linear structures – Multi point excitation methods.

Unit IV - MODAL PARAMETER EXTRACTION METHODS:
Introduction – Preliminary checks of FRF Data – SDOF Modal Analysis-I – Peak-amplitude – SDOF Modal Analysis-II – Circle Fit Method – SDOF Modal Analysis III – Inverse Method – Residuals – MDOF curve-fitting procedures – MDOF curve fitting in the Time Domain – Global or Multi-Curve fitting – Non linear systems.

Unit V - DERIVATION OF MATHEMATICAL MODELS: Introduction – Modal Models – Display of Modal Model – Response Models – Spatial Models – Mobility Skeletons and System Models.

Reference Books:

1. Ewins D J, "Modal Testing: Theory and Practice ", John Wiley and Sons Inc., 1988
2. Nuno Manuel Mendes Maia et al," Theoretical and Experimental Modal Analysis",
3. Wiley John & sons, 1997.
4. Zhi-Fang Fu and Jimin He, "Modal Analysis", Butterwoth-Heinemann, 2001

17ME3016 ADVANCED MANUFACTURING PROCESSES

Credit 3:0:0

Course Objectives:

To impart knowledge on

- advanced manufacturing and material processes.
- additive manufacturing processes.
- micro machining processes.

Course Outcomes:

Ability to

- understand the types of metal forming
- compare advanced manufacturing processes.
- select the techniques for material processing.
- choose appropriate micro machining processes.
- propose additive manufacturing processes.
- identify measurement techniques in Micro machining.

Unit I - METAL FORMING: Roll forming, High velocity hydro forming, High velocity Mechanical Forming, Electromagnetic forming, High Energy Rate forming (HERF), Spinning, Flow forming, Shear Spinning.

Unit II - ADVANCED WELDING, CASTING AND FORGING PROCESSES: Friction Stir Welding – Introduction, Tooling, Temperature distribution and resulting melt flow Advanced Die Casting - Vacuum Die casting, Squeeze Casting.

Unit III - ADVANCED TECHNIQUES FOR MATERIAL PROCESSING: STEM: Shape tube Electrolytic machining, EJT: Electro Jet Machining, ELID: Electrolytic In process Dressing, ECG: Electrochemical Grinding, ECH: Electro-chemical Etching Laser based Heat Treatment

Unit IV - MICRO MACHINING AND ADDITIVE MANUFACTURING PROCESSES: Diamond micro machining, ultrasonic micro machining, micro electro discharge machining. Introduction and principles, Development of additive manufacturing Technologies, general additive manufacturing processes, powder based fusion process, extrusion based system, sheet lamination process, direct write technologies

Unit V - MEASUREMENT TECHNIQUES IN MICRO MACHINING: Introduction, Classification of measuring System, Microscopes : Optical Microscope, Electron Microscopes, Laser based System, Interference Microscopes and comparators, Surface profiler, Scanning Tunneling Microscope, Atomic force micro scope, Applications.

Reference books:

1. E.P. DeGarmo, J. T Black, "Materials and Processes in Manufacturing" (8th Edition), Prentice Hall of India, 2006.
2. A. Ghosh, and A.K. Mallik, "Manufacturing Science" Affiliated East-West Press Pvt. Ltd. 2010.
3. G.F.Benedict, Marcel Dekker, "Nontraditional Manufacturing Processes", Inc. 1987

17ME3017 CONTROL OF CNC MACHINE TOOLS

Credits 3:0:0

Course objectives:

To impart knowledge on

- CNC programming, hydraulic system.
- CNC interpolation, DDA integrator.
- CNC control loops and architecture

Course Outcomes:

Ability to

- Design control systems for CNC machine tool.
- Understand the principles of motors and hydraulic system
- Compare the interpolation methods in CNC control system.
- Recommend PID controllers, servo controller, Numerical control Kernel types.
- Select the components of CNC architecture.
- Propose the PLC programming Languages.

Unit I - INTRODUCTION TO CNC SYSTEMS AND PROGRAMMING: Introduction to CNC systems, Coordinate systems of CNC machines, Economics. CNC programming- Interpolation, CNC programming - feed, tool and spindle functions (G-codes).

Unit II - CNC DRIVES AND CONTROLLERS: CNC drives Hydraulic systems, servo and stepping motors, response analysis, Feedback devices and counter.

Unit III - CNC HARDWARE AND SOFTWARE INTERPOLATORS: CNC Interpolation - Hardware interpolators- DDA integrator, linear, circular, complete interpolators, Software interpolators, Tustin method, NURBS and polynomial interpolators, Acceleration and deceleration control techniques.

Unit IV - CNC CONTROL LOOPS: CNC control loops, PID control, servo controller, gain tuning, feed forward control, Mathematical analysis of control loops.

Unit V - CNC ARCHITECTURE: CNC Architecture - Numerical control kernel- types, PLC, programming, languages, Human-Machine Interface functions, structure, Introduction to Open CNC architecture.

Reference books:

1. Suk-Hwan Suh and Ian Stroud, Gloud “Theory and Design of CNC Systems”, Springer, 2008
2. Yoram Koren and Joseph Ben Uri, “Numerical Control of Machine Tools”, Khanna Publishers, 2000.
3. Yoram Koren, “Computer Control of Manufacturing Systems” McGrawHill, 1985.
4. Bollinger, “Computer Control of Machines and Processes”, Addison Wesley, 1989.
5. Yusuf Altintas, “Manufacturing Automation Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design”, Second edition, Cambridge University Press, 2012.
6. Gene F. Franklin, J. David Powell, Abbas Emami-Naeini, “Feedback Control of Dynamic Systems”, 6th Edition, Peason Education, 2009.

17ME3018 THEORY OF METAL CUTTING

Credits 3:0:0
Course Objectives:
To impart knowledge on

- fundamentals of metal cutting theory, the types of tool and their nomenclature
- measurement of cutting force and cutting temperature
- mechanisms of tool wear, machine tool chatter

Course Outcomes:
Ability to

- identify cutting conditions suitable for machining a component.
- Select the machine tool based on the operation to be done
- Analyse and compare the optimized cutting conditions
- Select of cutting fluid to reduce the temperature during machining
- predict the tool life by reducing the tool wear
- diagnose vibration and chatter

Unit I - METAL CUTTING FUNDAMENTALS: Basic mechanism of chip formation-types of chips-Chip breaker-Orthogonal Vs Oblique cutting- force and velocity relationship and expression for shear plane angle in orthogonal cutting-Energy Consideration in machining-Modern theories in Mechanics of cutting -Review of Merchant and Lee Shaffer Theories critical comparison.
Unit II - TOOL NOMENCLATURE AND CUTTING FORCES: Nomenclature of single point tool - Systems of tool Nomenclature and Conversion of rake angles - Nomenclature of multi point tools like drills, milling cutters and broaches. Forces in turning, drilling and milling - specific cutting pressure- measurement of cutting forces.
Unit III - THERMAL ASPECTS OF MACHINING: Thermodynamics of chip formation - Heat distributions in machining-Effects of various parameters on temperature - Method of temperature measurement in machining - Hot machining - cutting fluids.
Unit IV - TOOL MATERIALS, TOOL LIFE AND TOOL WEAR: Essential requirements of tool materials - Developments in tool materials-ISO specifications for inserts and tool holders-Tool life- optimum tool life - Conventional and accelerated tool life tests- Concepts of machinability and machinability index - Economics of machining
Unit V - WEAR MECHANISMS AND CHATTER IN MACHINING: Reasons for failure of cutting tools and forms of wear-mechanisms of wear - chatter in machining - Factors effecting chatter in machining - types of chatters-Mechanism of chatter based on Force Vs Speed graph, Mechanism of grinding - Various parameters affecting grinding process.

Reference books:

1. M.C. Shaw, “Metal cutting Principles ", Oxford clarendon Press, 2005.
2. B.L. Juneja and G.S. Sekhon - “Fundamentals of metal cutting and machine tools", New Age International (p) Ltd., 2015.
3. Bhattacharya. - "Metal Cutting Theory and Practice ", new central Book Agency pvt. Ltd., Calcutta 2016.
4. Venkatesh .V.C. & Chandrasekharan.H. “Experimental Techniques in Metal cutting", Prentice Hall of India, 1987.
5. Xing Sheng LI & Low I.M., Editors Advanced Ceramic Transtech Publications, 1994.
6. Kuppuswamy.G."Principles of metal cutting", Universities Press (India)Ltd., 1996
7. Boothroy.D.G. and Knight. W.A "Fundamentals of Machining and Machine tools", Marcel Dekker, New York, 1989.

17ME3019 COMPUTER INTEGRATED MANUFACTURING SYSTEMS

Credits: 3:0:0

Course objectives:
To impart knowledge on

- the use of computers in the area of manufacturing
- new technology in the area of manufacturing
- artificial intelligence and expert systems in manufacturing systems

Course outcomes:

Ability to

- employ computers in the area of manufacturing to reduce manual processing
- understand group technology,
- apply computer aided process planning,
- examine Material Requirement Planning (MRP) and Enterprise Resource Planning **(**ERP**)**
- apply computer aided quality control and Flexible manufacturing systems,
- recommend Artificial intelligence and Expert systems.

Unit I - INTRODUCTION: Objectives of a manufacturing system-identifying business opportunities and problems classification production - systems-linking manufacturing strategy and systems-analysis of manufacturing operations.

Unit II - GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING: Introduction-part families-parts classification and cooling - group technology machine cells benefits of group - technology. Process planning function CAPP - Computer generated time standards.

Unit III - COMPUTER AIDED PLANNING AND CONTROL: Production planning and control-cost planning and control-inventory management-Material requirements planning - (ERP)-shop floor control-Factory data collection system-Automatic identification system-barcode technology automated data collection system.

Unit IV - PRODUCTION MONITORING: Types of production monitoring systems-structure model of manufacturing process-process control & strategies direct digital control-supervisory computer control-computer in QC - contact inspection methods non-contact inspection method - computer-aided testing - integration of CAQC with CAD/CAM.

Unit V - INTEGRATED MANUFACTURING SYSTEM: Definition - application - features - types of manufacturing systems-machine tools-materials handling system computer control system - DNC systems manufacturing cell. Flexible manufacturing systems (FMS) - the FMS concept-transfer systems - head changing FMS – variable mission manufacturing system. Human labor in the manufacturing system-computer integrated manufacturing system benefits. Rapid prototyping - Artificial Intelligence and Expert system in CIM.

Reference Books

1. Groover, M.P., "Automation, Production System and CIM", Prentice-Hall of India,2008.
2. David Bedworth, "Computer Integrated Design and Manufacturing", TMH, New Delhi, I Edition 1999
3. Yorem Koren, "Computer control Manufacturing Systems", McGraw Hill, 1999.
4. Ranky, Paul G., "Computer Integrated Manufacturing", Prentice Hall International 1999
5. Kant Vajpayee,S., ―Computer Integrated Manufacturing‖, Prentice Hall of India, New Delhi, 2007.
6. James A.Retrg, Herry W.Kraebber, ―Computer Integrated Manufacturing‖, Pearson Education, Asia, 2001.

17ME3020 ADVANCED METROLOGY AND MEASUREMENT SYSTEMS

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- the science of measurement and measuring machines commonly used.
- limits, fits and tolerances, geometric dimensioning aspects
- the methods of acceptance test for conventional machine tools.

Course Outcomes:

Ability to

- use different measuring instruments in industries.
- utilize Geometrical Dimensioning and Tolerancing symbols and apply them in inspection and testing process.
- apply the concepts of Laser metrology in quality control.
- examine the surface roughness of workpieces from various production processes.
- choose the modern manufacturing methods using advanced metrology systems.
- recommend calibration standards towards measuring instruments.

Unit I - INTRODUCTION TO MECHANICAL MEASUREMENTS: Science of measurement: Mechanical measurement – types, measurement standards– terms used in rating instrument performance. Precision and Accuracy.
Unit II - GEAR MEASURING MACHINES: Study of Measuring Machines, gear tooth measurement-measurement of gear profile, Isometric Viewing of Surface Defects, Image Shearing Microscope for Vertical Dimensions.
Unit III - ELECTRON AND LASER MICROSCOPY: Laser metrology and microscopy: Laser Metrology - Vision systems- Principles and applications, Principles of Scanning and Transmission Electron Microscopy and its applications.
Unit IV - CALIBRATION AND SURFACE ROUGHNESS MEASUREMENT: Acceptance tests for machine tools and surface finish measurements, calibration of machine tools, introduction to ball bar measurement, Measurement of surface roughness.
Unit V - GEOMETRIC DIMENSIONING AND TOLERANCING: Introduction to Tolerancing and Dimensioning: Introduction; Indian Standard System of Limits and Fits (IS :919-2709) ; Designation of Holes ,Shafts and Fits. Meaning of GD and T, Various Geometric symbols used in GD and T, Datum feature, Material Conditions.

Reference books:

1. Ernest O Doeblin, "Measurement systems", McGraw Hill Publishers, 2003.
2. R. K . Jain, "Engineering Metrology", Khanna Publishers, New Delhi, 2009.
3. Geometric Dimensioning` and Tolerance for Mechanical Design,"Gene R. Cogorno, McGraw Hill, 2004
4. I.C Gupta, "Engineering Metrology", Danpat Rai Publications, 2004.
5. Beckwith Thomas G, "Mechanical Measurements", Pearson Education, 2008.
6. M.Mahajan,"A Text Book of Metrology", Dhanpat Rai &Co. 2010
7. The Metrology Handbook, Jay L. Bucher ,Amer Society for Quality, 2004.

17ME3021 INDUSTRIAL ROBOTICS

Credits 3:0:0

Course Objectives:
To impart knowledge on
- components and applications of robots.
- fundamentals of Robotics and primary actuating systems.
- sensors and transducers.

Course Outcome:
Ability to
- Illustrate the developments in robotics and familiarise the basic configurations.
- Inspect various end effectors and choose right one for an application.
- Solve the kinematic and dynamic equations associated with robot configuration.
- Identify an appropriate sensor for an industrial application.
- Design a robot programme for a particular application.
- Analyse the applications of robots in various industries.

Unit I - INTRODUCTION –ROBOT: Definition and Basic Concepts (Brief History), Robot configurations. Types of Robot drives, Basic robot motions - Point to point control & Continuous path control.
Unit II - ROBOT COMPONENTS: Basic control system concepts control system analysis, Robot actuators, Types of Robot end Effectors- Grippers, Tools as end effectors.
Unit III - MANIPULATORS AND SENSORS: Coordinate transformation, Direct and Inverse kinematics, Brief Robot dynamics. Range and Proximity sensing, Touch sensing, Force and Torque sensing, Introduction to Machine vision -Sensing and digitizing, Image processing and analysis.
Unit IV - ROBOT PROGRAMMING: Methods, Languages - Capabilities and Limitation. Artificial intelligence - Knowledge representation, Search techniques

Unit V - APPLICATION OF ROBOTS: Application of robots in Machining, Welding & Assembly Applications, Material handling, Loading and unloading Applications, Hostile and remote environment applications., Application of Robots in CIM.

Reference books:

1. Mikell P. Groover, Mitchell Weiss, "Industrial Robotics, Technology, Programming and Applications ", McGraw Hill International, 2008.
2. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic Engineering - An Integrated Approach", Prentice Hall 2002.
3. Saeed B Niku, "Introduction to Robotics", Prentice Hall, 2009
4. K.S. Fu., R.C. Gonalez, C.S.G. Lee, "Robotics Control Sensing ", Vision and Intelligence, McGraw Hill International Edition, 1987.
5. Wesley E Snyder R, 'Industrial Robots, Computer Interfacing and Control', Prentice Hall International Edition, 1988.
6. Gordon Mair, 'Industrial Robotics', Prentice Hall (U.K.) 1988

17ME3022 ADVANCED TOOL DESIGN

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Tool design and advanced cutting tool materials.
- design of cutting tools, forming tools and jigs
- press tool design and fixtures for CNC machines

Course Outcomes:

Ability to

- select appropriate materials for tool, jigs and fixtures
- understand the requirements and challenges in the development of cutting tools.
- design Jigs and fixtures for conventional machines
- develop Jigs and fixtures for CNC machines
- design Dies and Press tools for conventional machines
- develop Dies and Press tools for CNC machines

Unit I - INTRODUCTION TO TOOL DESIGN: Introduction –Tool Engineering – Tool Classifications– Tool Design Objectives – Tool Design in manufacturing- Challenges and requirements- Standards in tool design-Tool drawings -Surface finish – Fits and Tolerances - Tooling Materials- Ferrous and Non ferrous Tooling Materials- Carbides, Ceramics and Diamond -Non metallic tool materials-Designing with relation to heat treatment

Unit II - DESIGN OF CUTTING TOOLS: Mechanics of Metal cutting –Oblique and orthogonal cutting- Chip formation and shear angle - Single-point cutting tools – Milling cutters – Hole making cutting tools- Broaching Tools - Design of Form relieved and profile relieved cutters-Design of gear and thread milling cutters

Unit III - DESIGN OF JIGS: Introduction – Fixed Gages – Gage Tolerances –selection of material for Gages – Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – Chip formation in drilling – General considerations in the design of drill jigs – Drill bushings – Methods of construction –Thrust and Turning Moments in drilling - Drill jigs and modern manufacturing

Unit IV - DESIGN OF FIXTURES AND PRESS TOOLS: Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures – Modular Fixtures – Cutting Force Calculations. Types of Dies –Method of Die operation–Clearance and cutting force calculations- Blanking and Piercing die design – Pilots – Strippers and pressure pads- Presswork materials – Strip layout – Short-run tooling for Piercing – Bending dies – Forming dies – Drawing dies-Design and drafting.

Unit V - TOOL DESIGN FOR CNC MACHINE TOOLS: Introduction –Tooling requirements for Numerical control systems – Fixture design for CNC machine tools- Sub plate and tombstone fixtures-Universal fixtures– Cutting tools– Tool holding methods– Automatic tool changers and tool positioners – Tool presetting– General explanation of the Brown and Sharp machine.

Reference books:
1. C. Donaldson, G. H.Lecain and V. C.Goold , Tool Design, Tata McGraw- Hill, 2007
2. E.G.Hoffman," Jig and Fixture Design", Thomson Asia Pvt Ltd, Singapore, 2004
3. Prakash Hiralal Joshi, "Tooling data", Wheeler Publishing, 2000
4. Venkataraman K., "Design of Jigs, Fixtures and Presstools", TMH, 2005

17ME3023 DESIGN OF FLUID POWER SYSTEMS

Credits 3:0:0

Course Objectives:

To impart knowledge on:
- Laws and governing equations for hydraulics and pneumatics with ISO symbolic representations.
- Working principles of hydraulic and pneumatic drives and develop circuits for engineering applications.
- Trouble shooting the hydraulic and pneumatic systems.

Course Outcomes:

Ability to
- Interpret the standard symbols and laws used in FPC Systems
- Infer the working principles of pumps and motors
- Identify the suitable elements of a fluid power systems for a particular application.
- Examine hydraulic circuits for an industrial application.
- Assess the optimal components of pneumatic system
- Build a logic circuit for an industrial problems.

Unit I - FLUID POWER ELEMENTS: Industrial Prime Movers, basic laws, applications, types of fluid power systems, fluid types and properties. Comparison of power systems, Fluid power symbols. fluid reservoir , Cylinders, Mechanics of cylinder loading, Pressure accumulators-types, DCV,FCV, relief valve, hydraulic servo systems, Cartridge valves, Hydraulic fuses, Temperature and pressure switches, Shock Absorbers , electromechanical devices like relays and solenoids.

Unit II - HYDRAULIC PUMPS AND MOTORS: Types – design and construction , gear pumps, vane pumps, piston pumps and pump performance, numerical problems, Hydraulic Motors –Types, theoretical torque , power and flow rate, performance and numerical problems.

Unit III - DESIGN OF HYDRAULIC CIRCUITS: Reciprocation, quick return, Speed control circuits, sequencing, synchronizing circuits, clamping and accumulator circuits, press circuits and hydro-pneumatic circuit.

Unit IV - DESIGN OF PNEUMATIC CIRCUITS: Basic elements -Compressor, Cylinders, DCV,FCV, other special valves, Boolean algebra, truth tables, reciprocation, quick return circuit, cascade circuits/ sequencing circuits like A+B+ A- B- , electro-pneumatic circuits,

Unit V - INDUSTRIAL APPLICATIONS: MPL control of Fluid power circuits, fluidic elements and fluidic sensors, Basic concepts of programmable logical control, Fail-safe Circuits, Intensifier circuits, Box-sorting System, Electrical Control of Regenerative Circuit, Hydro-pneumatic circuit. Fault finding and maintenance, Trouble Shooting In Fluid Power Systems. Piping Design for Fluid Power Systems

Reference books:
1. R. Srinivasan "Hydraulic and Pneumatic Controls" 2nd Edition ,Tata McGraw - Hill Education 2008.
2. Anthony Esposito," Fluid Power with Applications", Pearson Education Inc., Seventh Edition, 2014. ISBN 9780135136904.
3. John J Pippenger, Adrian Mitchell, Richard J Mitchell, "Fluid Power Maintenance Basics and Troubleshooting," Hardcover, Edition: 01, 1997.
4. M.K. Medhat, Dr Khalil "Electro-Hydraulic Components and Systems: Hydraulic Systems Volume 2" Hardcover – Import, 1 Jan 2017.
5. K. Shanmugasundaram, "Hydraulic and Pneumatic controls", Chand & Co, 2012.
6. S. Ilango, V. Soundararajan, "Introduction to Hydraulics and Pneumatics" Paperback, PHI Learning Pvt. Ltd.., 2011.
7. S.R.Majumdar,"Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw Hill, 2002.
8. S.R.Majumdar,"Pneumatic Systems – Principles and Maintenance", Tata McGraw Hill, 2002.

17ME3024 MANUFACTURING SYSTEM AND SIMULATION

Credits: 3:0:0

Course Objective:
To impart knowledge on
- various modeling techniques.
- random number generation
- manual and computer assisted simulation techniques.

Course Outcome:
Ability to
- Create model of the real manufacturing system.
- Generate random numbers for simulation experiments
- Resolve practical problems in manufacturing sectors using simulation.
- Analyse material handling problem and to give solutions.
- Optimise the performance of a discrete system
- Verify and validate the simulation model

Unit I - BASICS OF SIMULATION: Simulation-Introduction, advantages and limitations, areas of application, systems and system environment, components of a system, discrete and continuous system, models of a system, Types of models, Discrete event system simulation, steps in simulation study

Unit II - SIMULATION OF INVENTORY AND MAINTENANCE PROBLEMS: Random number generations Random numbers generation- methods and techniques-montecarlo simulation to solve inventory problem and maintenance problem. Queuing models: Review of terminology and concepts, characteristics of queuing systems, Queuing notations, Transient and steady state behavior-long run measures of performance of queuing systems

Unit III - DISCRETE EVENT SIMULATION: Concepts in discrete event simulation: Event scheduling/Time advance algorithm-manual simulation using event scheduling-list processing Programming for discrete event systems in GPSS.

Unit IV - MANUFACTURING SIMULATION: Simulation of manufacturing & material handling system, manufacturing models - Types and uses, material handling –Goal and performance measures-Issues in Manufacturing &Material handling simulation-case studies-Introduction to softwares-SIMFACTORY,AIM,ARENA and TAYLOR II

Unit V - VERIFICATION AND VALIDATION: Simulation experiments, Verification and validation of simulation models. –Face validity-Validation of model assumptions, validation of input-output transformation-input-output validation

Reference books:

1. Jerry Banks and John S. Carson, "Discrete –Event System Simulation", Prentice Hall Inc,2009
2. Ronald G Askin, "Modeling and Analysis of Manufacturing Systems", John Wiley and Sons, Inc, 2000.
3. Gordon G, "System Simulation", Prentice Hall of India Ltd, 2009
4. Mengchu Zhou, "Modeling, Simulation, and Control of Flexible Manufacturing Systems", world scientific publication, Reprint 2000
5. Nersing Deo, "system simulation", Prentice Hall of India Ltd, 2007
6. D.S.Hira, "System Simulation", S.Chand & Company Ltd, 2010.
7. Law.M.Kelton, "Simulation Modeling and Analysis", McGraw Hill, NY, 2007

17ME3025 ADVANCED THERMODYNAMICS

Credits 3:0:0

Course Objectives
To impart knowledge on
- application of first and second law of thermodynamics to reactive systems.
- Prediction of availability and irreversibility associated with the thermodynamic processes and Chemical availability of reactive systems
- achieving of real gas equations and multi component systems.

Course Outcomes:
Ability to

- describe first and second laws of thermodynamics to thermal systems.
- Demonstrate concept of entropy to design effective thermal systems
- Apply correlations for the important properties
- Analyze the behavior of ideal and real gas mixture
- Assess chemical thermodynamics for reacting mixtures and combustion process
- formulate the concept of kinetic theory of gasses for performing statistical analysis

Unit I - FIRST LAW OF THERMODYNAMICS: Energy balance analysis, application to closed and open systems.
Unit II - SECOND LAW OF THERMODYNAMICS: Second-law efficiency,concept of entropy, exergy analysis, availability analysis of simple cycles.
Unit III - REAL GAS BEHAVIOUR AND MULTI-COMPONENT SYSTEMS: Equations of State Compressibility, fugacity coefficient, Real gas mixtures, Ideal solution of real gases, Gibbs phase rule.
Unit IV - THERMODYNAMIC PROPERTY RELATIONS: Thermodynamic Potentials, Maxwell relations, Generalised relations for changes in Entropy, Internal Energy and Enthalpy, Cp and Cv, ClausiusClayperon Equation, Joule- Thomson Coefficient.
Unit V - COMBUSTION: First and second law of thermodynamics applied to combustion process, heat of combustion, Adiabatic flame temperature, stoichiometry and excess air.

Reference books:

1. Yunus A Cengel, Michael Boles, 'Thermodynamics: An Engineering Approach', The McGraw Hill Companies, 7th Edition, 2010.
2. P.K. Nag., 'Engineering Thermodynamics', 4th Edition., McGraw Hill, 2008.
3. G.J. Van Wylen& R.E. Sonntag., 'Fundamentals of Thermodynamics', Willy Eastern Ltd., 2012.
4. J.P. Holman., 'Thermodynamics', 4th Ed., McGraw Hill, 1988.
5. Smith K. Van Ness H.C., 'Introduction to Chemical Engineering Thermodynamics', McGraw Hill, NY, 2005.

17ME3026 ADVANCED HEAT TRANSFER

Credits: 3:0:0

Course Objectives:
To impart knowledge on

- Conduction, convection, radiation, heat transfer during boiling and condensation.
- design of heat exchangers.
- principles of mass transfer.

Course Outcomes:
Ability to

- solve problems of heat transfer in complex systems by selecting appropriate choice between exact and approximate calculations.
- model heat transfer in complex internal flow systems and external flow configurations.
- design and analyze the performance of heat exchangers.
- understand the basic modeling and empirical correlations of two-phase heat transfer in boiling and condensation.
- model and solve mass transfer problems with applications varying from evaporative cooling, mass diffusion in gases.
- analyze the radiative heat exchange between surfaces and in diffuse, gray enclosures

Unit I - CONDUCTION: The heat diffusion equation. One dimensional steady state conduction with and without heat generation. The plane wall – Radial system. Heat Transfer from extended surfaces – effectiveness – efficiency. Insulation – critical thickness. Analytical method for two dimensional heat equation (The method of separation of variables). Finite difference method – formulation of nodal equation – solutions for two dimensional conduction problems. Transient conduction – the lumped capacitance method – semi-infinite solid.

Unit II - CONVECTION: Energy equation – thermal boundary layer. Forced convection – Practical correlations – flow over surfaces – internal flow. Natural convection, combined forced and free convection – combined convection and radiation in flows.
Unit III - HEAT EXCHANGER: Types – LMTD method and the effectiveness – NTU method.
Unit IV - BOILING AND CONDENSATION: Boiling – Pool and flow boiling, correlations. Condensation – modes and mechanisms – correlations and problems.
Unit V - RADIATION AND MASS TRANSFER: Radiative heat exchange between surfaces – radiation shape factor – reradiating surfaces. Radiation in gases. Mass transfer -Types – Fick's law of diffusion – mass diffusion equation, Equimolar counter diffusion – convective mass transfer. Evaporation of water into air.

Reference books:

1. Holman J.P., 'Heat and Mass Transfer', Tata McGraw Hill, 10th Ed., 2009.
2. Allen D.Kraus., 'Extended Surface Heat Transfer', Wiley-Interscience., 2001
3. Frank P. Incropera and David P. Dewit T., 'Fundamentals of Heat and Mass Transfer',6th Ed., John Wiley & Sons, 2007.
4. C.P. Kothandaraman., 'Fundamentals of Heat and Mass Transfer', 3rd Ed., New Age International, 2006.
5. Kays, W.M. ,Crawford W and Bernhard Weigand., 'Convective Heat and Mass Transfer', McGraw Hill Inc., 2004.
6. Kays, W.M. and Crawford W., 'Convective Heat and Mass Transfer', McGraw Hill Inc., 2004.

17ME3027 ADVANCED FLUID MECHANICS

Credits 3:0:0

Course Objectives:
To impart knowledge on

- Continuity, momentum and energy equations of fluid flow.
- Irrotational flows, flow past cylinders and Rankine body.
- Concepts of boundary layer, Prandtl mixing length, turbulent theory, universal velocity profile

Course Outcomes:
Ability to

- Choose method to describe the fluid motion.
- Solve fluid flow problems using Conservation principles.
- Analyze the forces acting on a fluid particle.
- Understand irrotational and vortex flows.
- Analyze the fluid flow over cylindrical and spherical bodies.
- Understand boundary layer formation in external and internal flows.

Unit I - FLUID FLOW: Method of describing fluid motion– Lagrangian-Eulerian Method, Local and individual time rates of change, acceleration, Eulerian and Lagrangian equation of Continuity. Bernoulli's equation from Euler's equation– solved problems related to liquid motion, related to equation of continuity.
Unit II - MOMENTUM AND ENERGY EQUATION: Forces and stress acting on fluid particles. Differential momentum equation. Navier Stokes Equations of Motion for simple cases in rectangular, cylindrical and spherical coordinate. Energy Equation.
Unit III - VELOCITY POTENTIAL AND STREAM FUNCTION: Irrotational motion in two dimensions, sources and sink, Complex potential due to a source, due to a doublet, Images with respect to straight line, solved problem. Vortex motion-Vortex tube, Helmohltz's vorticity theorem, velocity potential and stream function.
Unit IV - FLOW OVER OBJECTS: Flow over Circular cylinders, sphere, solution of Laplace equation, Joukowshi transformation, Flow past cylinder with and without circulation, flow past Rankine body. Liquid streaming past a fixed sphere and solved problems. Analytic function Conformal Transformation of infinite and semi – infinite strip.
Unit V - BOUNDARY LAYER PRINCIPLES: Flat plate, conduits, curved solid bodies, Blasius Solution, Prandtl mixing length turbulent theory, universal velocity profile, and momentum eddy concept – simple applications. Von Karman integral equation to Boundary layer –with and without pressure gradient.

Reference books:

1. V.L.Streeter, E.B.Wylie and K.W.Bedford., "Fluid Mechanics", Tata McGraw-Hill, ninth edition, 2010.
2. M.D.Raisinghania., "Fluid Dynamics' S Chand, Fifth Revised Edition, 2003.
3. Herrmann Schlichting and Klaus Gersten., "Boundary Layer Theory" Springer, Eighth Revised Edition, 2003.
4. Frank M White., "Fluid Mechanics", Tata McGraw Hill, Eighth Edition, 2016.
5. Fox and McDonald., "Introduction to Fluid Mechanics", Wiley India, ninth edition, 2016.
6. Yunus A Cengel and John M Cimbala., "Fluid Mechanics: Fundamentals and applications", Tata McGraw-Hill, Third Edition 2014.

17ME3028 DESIGN OF THERMAL POWER EQUIPMENT

Credits: 3:0:0

Course Objectives:

The impart knowledge on

- thermal systems used in power generation.
- design considerations for boilers heaters and condensers.

Course Outcomes:

- compare and contrast different types of boilers for power plant application
- design of boilers for power plant applications according to standards
- recognize waste heat recovery options in power plants using accessories such as economizers, super heaters, re-heaters and air pre-heaters.
- design chimney and fans for the draught system in thermal power plants.
- design condensers and cooling towers for steam power plants
- recognize significance of water and steam purification mechanisms in thermal power

Unit I - DESIGN CONSIDERATIONS: Services – requirements - parameters to be considered in Boiler Design - IBR Code Furnace Design: Heat Transfer in Furnace – heat balance – types of refractory walls – Furnace – Water wall arrangements. Heat release rates – furnace bottoms – Slag removal – Cold primary air system – wind box assembly Different types of furnaces for solids and liquids.

Unit II - WATER SIDE DESIGN: Circulation-natural, forced-circulation ratio. Design of condensers – Economic selection of condensers. Types-Direct contact, surface condensers. Vacuum efficiency – Air leakage into the condenser-air removal-dry, wet pumps. Cooling tower-Types and design for power plant application.

Unit III - PERFORMANCE OF BOILER: Equivalent evaporation-Boiler efficiency-boiler trail-heat losses in boiler. Economiser-types, design. Super Heater –Design, Economy of super heat limit of super heat, super heater performance, steam mass flow gas mass flow and pressure drop in super heater. Super heat temperature control. Desuperheater-design. Design of Reheater.

Unit IV - WATER AND STEAM PURIFICATION : Chemical treatment mechanical carry over – Silica carry over gravity separation – drum internals – steam washing typical arrangements of boiler drum internal in H.P. boilers.

Unit V - AIR PRE-HEATERS: Types of Air heater, recuperative and regenerative – Design considerations – Higher temperature and low temperature applications. Draft system design: Power requirement for draft fans, Pressure losses – Diameter and height of the chimney Design – Forced, induced, balanced drafts – Ash separators by ESP Electrostatic precipitators.

Reference books:

1. P.K. Nag., 'Power Plant Engineering', 4th edition Tata McGraw Hill, New Delhi, 2014.
2. C.D. Shields., 'Boilers', McGraw Hill, 1982.
3. Homi, P. Serval., 'Boilers Pressure Vessels', Multitech Publishing Company, Bombay, 1989.
4. Skrotzki & W.A. Vepot., Power Station Engg. Economy, Tata McGraw Hill, NewDelhi, 1987.
5. Morse, T.F., ' Power Plant Engineering', Van Nostrand East West Press, revisedEdn.,1983.
6. David Sunn, Robert Houston., 'Industrial Boilers', Longman Science & Technology,1989.
7. 'Modern Power Station Practice', Vol. 8, Central Electricity Generating Board,UK,Pergamon Press, 2014.

17ME3029 COMBUSTION IN ENGINES

Credits: 3:0:0
Course Objectives:
To impart knowledge on

- the combustion principles and chemical kinetics
- combustion in SI and CI engines
- combustion in gas turbine, generated pollution

Course Outcomes
Ability to

- compute air requirements and adiabatic flame temperatures.
- differentiate between laminar and turbulent combustion.
- recognize reasons for differences among operating characteristics of SI engine types and designs
- ecognize reasons for differences among operating characteristics of CI engine types and designs
- compare and contrast requirements for efficient performance of gas turbines with differing configurations of combustion chambers
- develop an understanding of the combustion process, engine emissions, pollutants and their harmful effects

Unit I - COMBUSTION PRINCIPLES: Thermodynamics concepts of combustion, first law and second law of thermodynamics applied to combustion process, heat of combustion, adiabatic flame temperature, stoichiometry and excess air, combustion calculations, minimum air required for complete combustion of fuel, chemical equilibrium and dissociation.
Unit II - COMBUSTION THEORIES AND KINETICS: Theories of combustion, homogeneous and heterogeneous mixtures, laminar and turbulent flame propagation in various engines.
Unit III - COMBUSTION IN SI AND CI ENGINES: Initiation of combustion, stages of combustion, flame front propagation, factors influencing the flame speed, knocking in SI Engines, effect of engine variables on knock, combustion chambers for SI engine, stratified charge engine and heat balance test in SI engine. Various stages of combustion in CI engines, air fuel ratio in CI engines, delay period or ignition lag, variables affecting delay period, diesel knock, air swirl, general functions and characteristics of the combustion chamber, comparison of some basic design of CI Engine combustion chambers and heat balance test in CI engine.
Unit IV - COMBUSTION IN GAS TURBINE: Flame stabilization, re-circulation, requirements of the combustion chamber, combustion process, combustible fuels for gas turbines, configuration of combustion chamber.
Unit V - COMBUSTION GENERATED POLLUTANTS, MONITORING AND CONTROL: Types of combustion generated pollutants, monitoring techniques, control measures of each pollutants- -its merits and demerits, present technologies in control of pollutants, harmful effects on living organisms and ecology, Indian and Euro emission norms.

Reference Books

1. Edward E. Obert., 'Internal Combustion Engines and Air Pollution', Internal Educational Publishers, New York, 2005.
2. Cohen H. Rogers, GEC and Saravanamutto, H.I.H., 'Gas Turbine Theory', Longman Group Ltd., 2007.
3. Treager, 'Air Craft Gas Turbine Engine Technology', Tata McGraw Hill, 3rd Ed., 2006.
4. J.K. Jain, 'Gas Dynamics and Jet Propulsion', Khanna Publishers, 2004
5. Mathur M.L. and Sharma. 'A Course in Internal Combustion Engines', R.P. Dhanpat Rai Publications, 2009 .
6. PV. Ganesan., 'Internal Combustion Engines', Tata McGraw Hill Publishing Company Ltd., 2010.
7. Gupta H.N, "Fundamentals of Internal Combustion Engines", Prentice Hall of India, 2006

17ME3030 ENERGY CONSERVATION AND MANAGEMENT

Credits: 3:0:0

Course Objectives:
To impart knowledge on

- energy conservation
- energy auditing
- energy management

Course Outcomes
Ability to
- State the importance of energy conservation
- Discuss the present status of national energy scenario
- Apply various energy auditing methods
- Analyze the energy conservation areas in thermal systems
- Estimate the energy conservation areas in electrical systems
- Choose the different financial management methods

Unit I - ENERGY RESOURCES AND PATTERN: Introduction - Energy resources - Energy use patterns - Scope for conservation - World energy supply and demand - National status – Programs and decisions - Difference between energy conservation and efficiency
Unit II - ENERGY AUDITING: Importance of energy auditing - energy auditing in engineering and process industry - Types of energy auditing - Identification of areas for energy auditing
Unit III - ENERGY CONSERVATION IN THERMAL SYSTEMS: Introduction - Energy conservation in thermal systems – Boilers and Heat Exchangers. Energy conservation in buildings - Tips for energy efficiency in thermal systems
Unit IV - ENERGY CONSERVATION IN ELECTRICAL SYSTEMS: Introduction - Energy conservation in electrical systems - Electric motors – Refrigeration and Air-conditioning System – Pumps – Compressors - Tips for energy efficiency in electrical systems.
Unit V - ENERGY MANAGEMENT: Energy management principles, need for organization and goal setting - Life cycle costing and other methods - Factors affecting economics - Introduction to financial management - Simple payback period - Net present value method - Internal rate of return method.

Reference books

1. Albert Thumann, Plant Engineers and Managers guide to energy conservation, 10th Edition. Fairmount Press, 2011.
2. Shinskey E.G., Energy Conservation through control, Academic Press, 1978.
3. General Aspects of Energy Management and Energy Audit Guide Book, Bureau of Energy Efficiency, Third Edition, 2010.
4. Energy Efficiency in Thermal Utilities Guide Book, Bureau of Energy Efficiency, Third Edition, 2010.
5. Energy Efficiency in Electrical Utilities Guide Book, Bureau of Energy Efficiency, Third Edition, 2010.

17ME3031 ADVANCED INSTRUMENTATION IN THERMAL ENGINEERING
Credits: 3:0:0

Course Objectives:
To impart knowledge on
- The working of measuring instruments and errors associated with them
- error analysis and uncertainty of measurements
- the measurement and data acquisition applicable to a thermal systems

Course Outcomes:
Ability to
- identify experimental data and predict correlation
- interpret uncertainties in various measurements
- apply measurement techniques of intensive and extensive properties
- analyze specific functional characteristics of thermal instruments.
- estimate the control system parameters using analog and digital controllers
- formulate concepts to reduce errors in measurements

Unit I - MEASUREMENT CHARACTERISTICS: Introduction to measurements, errors in measurements, statistical analysis of data, regression analysis, correlation, estimation of uncertainty and presentation of data.
Unit II - MEASUREMENTS IN THERMAL SYSTEMS: Basic Electrical measurements, Transducers and its types, Measurement of temperature, pressure, velocity, flow - simple and advanced techniques.

Unit III - MEASUREMENT OF THERMO-PHYSICAL PROPERTIES: Thermal conductivity, viscosity, surface tension, specific heat capacity, radiation properties of surfaces.
Unit IV - MEASUREMENT OF FUEL PROPERTIES: Flame ionisationdetector, non-dispersive infrared analyser, smoke meters, and gas chromatography
Unit V - DATA LOGGERS: Data logging and acquisition, sensors for error reduction, elements of computer interfacing, timers and counters.

Reference books:

1. Doebelin O.E., 'Measurement Systems and Design', McGraw Hill Co., 2003.
2. Holman J.P., 'Experimental Methods for Engineers', McGraw Hill Co, 2001.
3. Beckwit T.G. and Buck M.L., 'Mechanical Measurements', Addition Wesley, 2011.
4. B.C. Nakra 'Instrumentation measurement and Analysis', Tata McGraw-Hill Publishing Company, 2002
5. R.K. Jain, 'Mechanical and Industrial Measurements' Khanna Publishers, 2000.

17ME3032 ADVANCED REFRIGERATION AND AIRCONDITIONING SYSTEMS
Credits 3:0:0

Course Objectives:
To impart knowledge on
- working principle of refrigeration and air-conditioning cycle
- components of cooling load
- air distribution system

Course Outcomes
Ability to
- identify various refrigeration and air-conditioning cycles
- estimate the performance of refrigeration and air-conditioning cycles
- analyze psychometrics processes
- evaluate the space cooling load
- design the duct
- choose the fan for the desired applications

Unit I - REVIEW OF THERMODYNAMIC PRINCIPLES: Bell Colemen cycle - vapour compression cycle - Theoretical and actual - multi stage system - cascade system - performance evaluation - COP comparison
Unit II - REFRIGERATION: Thermoelectric refrigeration - Vortex refrigeration - Steam jet refrigeration - Pulse tube refrigeration. Introduction to cryogenics - manufacture of dry ice – liquefaction of gases – Linde and Claude system.
Unit III - VAPOUR ABSORPTION SYSTEMS: Theory of mixtures, enthalpy composition diagrams, absorption system calculations, aqua ammonia systems, LiBr water system, Three fluid absorption systems, solar refrigeration system.
Unit IV - COOLING LOAD ESTIMATION IN AIRCONDITIONING SYSTEMS: Review of psychometric process - Sensible heat factor and bypass factor - RSHF, GSHF, ESHF -Cooling load estimation using ISHRAE Standards
Unit V - AIR DISTRIBUTION SYSTEM: Components of air distribution system – methods of duct design - equal friction method – pressure drop calculations. Fan performance curves and efficiencies – similarity laws.

Reference books:

1. Stocker W.F. and Jones J.W., 'Refrigeration and Air-conditioning ', McGraw Hill, 1982.
2. Manohar Prasad., 'Refrigeration and Air Conditioning', 2nd edition Willey Eastern Ltd., 2011
3. Lanqley Billy., 'Refrigeration and Air Conditioning', 3rd Ed., Englewood Cliffs (NJ),Prentice Hall, 1989.
4. Aiconditioning HandBook, ISHRAE, 2014.
5. Roy J. Dossat., 'Principles of Refrigeration', Pearson Fourth Edition, 2008.
6. R.S. Khurmi and J.K. Gupta., 'A textbook of refrigeration and air-conditioning', Eurasia Publishing House (P) Ltd, 2011.

17ME3033 DESIGN AND ANALYSIS OF HEAT EXCHANGERS

Credits 3:0:0

Course Objectives:

To impart knowledge on

- the classification of Heat exchangers
- the basic design methods of heat exchangers
- the design of Shell and tube, Compact heat exchangers

Course Outcomes

Ability to

- identify the constructional aspects of various types of heat exchangers.
- Predict the effectiveness of heat exchangers NTU method.
- Calculate the design parameters of shell-and-tube heat exchanger.
- analyze compact heat exchanger.
- Evaluate the performance of condensers.
- Formulate concepts of single and multi-effect evaporators.

Unit I - VARIOUS TYPES OF HEAT EXCHANGER: Introduction; Recuperation and regeneration; Transfer processors; Geometry of construction, tubular heat exchangers, plate heat exchangers, extended surface heat exchangers ; Heat transfer mechanisms, Flow arrangements; Selection of heat exchangers.

Unit II - BASIC DESIGN METHODS OF HEAT EXCHANGERS: Arrangement of flow path in heat exchangers; basic equations in design; Overall heat transfer coefficient; LMTD and NTU methods for heat exchanger analysis, Heat exchanger design calculation, Variable overall heat transfer coefficient, Heat exchanger design methodology.

Unit III - SHELL AND TUBE HEAT EXCHANGER: Basic components-shell types, tube bundle types, tubes and tube passes, tube layout, baffle type and geometry, allocation of stream; basic design procedure of a heat exchanger- unit size, performance rating.

Unit IV - COMPACT HEAT EXCHANGER: Plate-fin heat exchanger, tube-fin heat exchangers, Heat transfer, pressure drop in finned-tube and plate-fin heat exchanger.

Unit V - CONDENSERS AND EVAPORATORS: Shell-and-tube condensers-horizontal shell-side condensers, vertical tube-side condensers, horizontal in-tube condensers ; steam turbine exhaust condensers ; Plate condensers ; Air-cooled condensers ; Direct contact condensers ; Thermal design of shell-and-tube condensers**,** Single and multi effect evaporators.

Reference books:

1. Kays, W.M. and London A.L., ‘Compact Heat Exchangers’, 3rd Ed., Krieger Publishing Company, 1998.
2. Afgan, N.H. and Schliinder., ‘ Heat exchangers, Design and Theory Source Books’ McGraw Hill Book Company,1974.
3. Frass, A.P. and Ozisik, M.N., ‘Heat Exchanger Design’, John Wiley and Sons Inc., 1965.
4. Wlker G., ‘Industrial Heat Exchangers’, A basic guide, McGraw Hill V Book Co., 1980.
5. Standards of the Tubular Exchanger Manufacturer Association’, 6th Ed., Tubular Exchanger Manufacturers Association, New York, 2007.
6. Donold Q Kern., ‘Process Heat Transfer’, McGraw Hill Book Co., 1988.
7. E.A.D. Saunders., ‘Heat Exchangers’, Longman Scientific and Technical, New York, 1988

17ME3034 BIOMASS ENERGY

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- classify the biomass resources and biomass conversion processes
- construct a small size gasifier and biogas plant
- explain the alcohol production method from biomass

Course Outcomes:

Ability to

- list the thermo chemical conversion process of biomass

- design a community biogas plant
- select a biogas plant for the given application
- develop a small size biomass gasifier
- explain the application of bio-fuels
- demonstrate the power generation techniques using biomass waste

Unit I - ENERGY FROM BIOMASS: biomass resources, energy plantation, design and management of energy plantation, advantages of energy plantation, plants proposed for energy plantation, photosynthesis, biomass conversion technologies, thermo chemical conversion, direct combustion, biochemical conversion, biodegradability.
Unit II - BIOGAS GENERATION: classification of biogas plants, biogas generation, anaerobic digestion, floating drum plant, fixed dome type plant, continuous and batch type, Janta biogas plant, Deen Bandhu biogas plant, khadi and village industries type biogas plant, ferro-cement digester biogas plant, biogas from plant wastes, wet and dry fermentation, problem in straw fermentation, pilot plants using plant wastes, community biogas plants, materials used for biogas generation, additives, factors affecting bio-digestion.
Unit III - DIGESTER DESIGN: design based on methane production rate, design based on end user requirements, scaling of biogas plants, digester sizing, methods for maintaining biogas production, problems related to biogas plants, starting a biogas plant, filling a digester for starting, fuel properties of biogas, selection of site for a biogas plant.
Unit IV - UTILIZATION OF BIOGAS: modification of SI and CI engine, biogas use in stationary power plants, mobile power plants, use of biogas in refrigerators, gas turbines, economic viability of biogas technology, biogas technology scenario in India, purification, scrubbing, compression and storage of biogas, biogas burners.
Gasifier: gasification process, gasification of wood, wood gas purification and shift conversion, gasification equipment, use of wood gas in engines, classification of biomass gasifiers, fixed bed gasifier, fluidized bed gasifier, applications of the gasifier, problems in development of gasifiers.
Unit V - ELECTRICITY PRODUCTION FROM BIOMASS WASTES: pyrolysis, pyrolysis yields from the dry wood, types of pyrolysis, biodiesel from vegetable oil and pyrolysis oil, use of biodiesel in engine, alcohol fuels, ethanol production from wood and sugar cane, methanol production, electricity production from municipal solid wastes, animal wastes, plant residues, pulp and paper industry wastes, distillery waste, high rate digester for industrial waste water treatment.

Reference books:
1. G.D.Rai, Non-Conventional Energy Sources, Eighth reprint, 2013, khanna publishers, 2013
2. Nijaguna, B.T, “Biogas Technology”, 1stEdition, New Age International Private Ltd, New Delhi, 2009.
3. N.H.Ravindranath, Hall D.O., “Biomass, Energy and Environment”, Reprinted Edition, Oxford University Press, Oxford, 2002.
4. Chawla O.P., “Advances in biogas technology”, Publications and Information Division, Indian Council of Agricultural Research, New Delhi, 2009.
5. Mital, K.M,“Biogas Systems: Principles and Applications”, 1st Edition, New Age International Private Ltd, New Delhi, 2009.

17ME3035 ADVANCED TURBOMACHINERY

Credits: 3:0:0

Course Objectives:
To impart knowledge on
- list the types of turbine, pump and compressor
- analyze the performance and efficiency of turbines, pumps and compressors.
- examine the fluid flow pattern in turbo machines
- discuss about the application of turbo machines

Course Outcomes:
Ability to
- Classify the types of turbine, pump, and compressors
- Explain the working principle of turbines, pumps and compressors
- Compare the performance of turbo machines
- Summarize the application of turbo machines

- Analyze the flow pattern in turbo machines
- Develop micro and small turbo machines

Unit I - TURBO MACHINERY: Introduction, application of pi theorem, incompressible fluid in turbo machines , effects of Reynolds Number and Mach number, energy transfer between a fluid and a rotor, Euler turbine equation , components of energy transfer , impulse and reaction turbine, efficiencies.
Unit II - RADIAL FLOW PUMPS AND COMPRESSORS: head capacity relationship, axial flow pumps and compressors, degree of reaction, dimensionless parameters, efficiency and utilization factor in turbo Machinery. Centrifugal pumps and centrifugal compressors, inlet section, cavitation, NPSH, flow in the impeller channel, flow in the discharge casing, pump and compressor characteristics.
Unit III - THERMODYNAMICS OF TURBO MACHINE PROCESSES: compression and expansion efficiencies, stage efficiency, Infinitesimal stage and finite stage efficiencies
Unit IV - FLOW OF FLUIDS IN TURBO MACHINES: flow and pressure distribution over an airfoil section, effect of compressibility, blade terminology, cascades of blades, blade spacing, radial pressure gradient, free vortex flow, losses in turbo machines.
Unit V - TYPES OF TURBINE: Radial flow turbines, inward flow turbines for compressible fluids, velocity and flow coefficients, gas turbine – performance and analysis of Kaplan turbine , Francis turbine and Pelton wheels, gas turbine and steam turbine.

Reference books:
1. Lee, 'Theory and Design of Steam and Gas Turbine', McGraw Hill, 2001.
2. S.M Yahya., 'Turbines, Compressions and Fans', Tata McGraw Hill, 2009.
3. D.G. Stephard, 'Principles of Turbo machines', Macmillan Co., 2005.
4. A.Valan Arasu, "Turbo machines" Vikas publishing house pvt Ltd, 2002
5. Kadambi.V., Manohar Prasad., "An Introduction to Energy Conversion, Volume III Turbomachinery" New Age International Publishers , 2005
6. William J Kerten, 'Steam Turbine Theory and Practice', CBS Publisher and distributors, 2003.
7. Bathe WN, 'Fundamentals of Gas Turbines', Willey and Sons, 2006.

17ME3036 TWO PHASE FLOW AND HEAT TRANSFER

Credits 3:0:0

Course Objectives:
To impart knowledge on
- Two phase flow and circulation in boiler
- Heat transfer with change of phase in condensation and boiling
- Fluidized beds and gas-liquid fluidization

Course Outcomes:
Ability to
- Understand vertical, horizontal and inclined two phase flow
- Determine effective pressure head in boiler tubes
- choose various types of fluidized beds
- evaluate heat transfer during condensation
- Analyze heat transfer with change of phase in boiling
- Explain various Gas- Liquid fluidization

Unit I - TWO PHASE FLOW: simultaneous flow of liquids and gases, horizontal two phase flow, lock hart and Martenelli procedure flow factor method, vertical two phase flow, Two phase flow
through inclined pipes
Unit II - CIRCULATION IN BOILER: natural and forced circulation, effective pressure head in boiler tubes, variation of major parameters of drum during transient conditions, The hydrodynamics stability of vapour – liquid system.
Unit III - FLUIDIZED BEDS: simultaneous flow of fluids and solids, dynamics of particles submerged in fluids, flow through packed bed. Fluidization, calculation of pressure drop in fixed bed, determination of minimum

fluidization velocity, Expanded bed, dilute phase, moving solids fluidization, Elutriation in fluidized Bed, Semi fluidization, applications, Pulsating column, oscillating fluidized beds.

Unit IV - CONDENSATION AND BOILING: Film wise condensation of pure vapours, Drop wise condensation in plated surfaces, condensation in presence of non-condensable gas, Pool boiling, Boiling in forced flow inside tubing.

Unit V - GAS – LIQUID FLUIDIZATION: Gas liquid particle process, Gas liquid particle operation, Gas liquid fluidization. Flow of Gas - Bubble formation, bubble growth gas hold up, Gas mixing liquid holdup, liquid mixing, flow of liquid mixing, Gas liquid mass transfer.

Reference books:

1. Ginou J.N., 'Two Phase Flow & Heat Transfer', McGraw Hill, New York, 1978.
2. Mc Adams., 'Heat Transmission', McGraw Hill, 1954.
3. Daugherty and Franzini., 'Fluid Mechanics with Engineering Applications', McGraw Hill, 1997.
4. S.C. Kutateladeze., 'Problems of Heat Transfer and Hydraulics of Two Phase Media', Pergamon Press, 2013.
5. Davidson J.F and Harrison D., 'Fluidization', Prentice Hall, 1976.
6. L.S. Tong., 'Boiling Heat Transfer and Two Phase Flow', 2nd edition Wiley, New York, 1997.

17ME3037 SOLAR ENERGY UTILIZATION

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Solar energy and techniques to utilize it efficiently and cost effectively.
- Conversion of sunlight to heat for either direct usage or further conversion to other energy carriers.
- Design a solar thermal system for a given criteria.

Course Outcomes:

At the end of the course students will be able to

- Understanding of the available solar energy and the current solar energy conversion and utilization processes.
- Analyze performance of flat plate collectors.
- develop skills to design, model, analyze and evaluate solar thermal systems.
- Understand how photovoltaic cells operate.
- Estimate the PV array requirement for small residential and industrial applications.
- Solve simple to complex problems of solar thermal energy conversion and storage.

Unit I - INTRODUCTION: Energy alternatives – New energy technologies – Solar thermal process Solar Radiation – Solar constant – extra terrestrial radiation – clear sky irradiation – solar radiation measurement – estimation of average solar radiation – solar radiation on tilted surface.

Unit II - FLAT PLATE COLLECTORS: Energy balances equation and collectors efficiency – collector performance – collector improvements, effect of incident angle, dust and shading – thermal analysis of flat plate collector and useful heat gained by the fluid - collector design – heat transfer factors

Unit III - CONCENTRATION COLLECTORS AND REFLECTORS: Parabolic concentrators, non-imaging concentrators, other forms of concentrating collectors. Tracking – receiver shape and orientation – performance analysis – reflectors – reflectors orientation – performance analysis.

Unit IV - SOLAR ENERGY STORAGE: stratified storage – well mixed storage – comparison – Hot water system – practical consideration – solar ponds – principle of operation and description of Non-convective solar pond – extraction of thermal energy application of solar ponds.

Unit V - APPLICATIONS OF SOLAR ENERGY: Solar electric power generation, photo voltaic cells. Solar furnace, Solar Chimney, heaters – power generation system. Tower concept – solar refrigeration system, thermo electric refrigeration system.

Reference Books:

1. John.A. Duffie and Willam A.Beckman., 'Solar Engineering of Thermal Processes', Wiley, 2006.
2. Suhatme, S.P., 'Solar Energy Principle of Thermal Collection and Storage', Tata McGraw Hill, 2008.

3. Kriender, J.M., ‘Principles of Solar Engineering’, McGraw Hill, 2000.
4. Mangal, V.S., ‘Solar Engineering’, Tata McGraw Hill, 1992.
5. Bansal, N.K., ‘Renewable Energy Source and Conversion Technology’, Tata McGraw Hill, 1989.
6. Peter J. Lunde., ‘Solar Thermal Engineering’, John Willey and Sons, New York, 1988.

17ME3038 NUCLEAR POWER ENGINEERING

Credits: 3:0:0

Course Objectives:
To impart knowledge on

- The fundamental terms and concepts of nuclear power engineering
- The neutron life cycle, heat flow, radiation, fluidized bed reactor.
- The safety principles and methods utilized in designing, constructing and operating a safe nuclear power plant.

Course Outcomes:
Ability to

- Explain fundamental physics that applies to a broad range of nuclear technologies.
- Understand the coolant channel orificing, hot spot factors.
- Acquire knowledge on reactor hydraulics, different bed reactors.
- Determine thermal reaction equation, temperature, pressure coefficient.
- Estimate safety calculations in support of the preparation of an abbreviated Safety Analysis Report for an advanced reactor.
- Demonstrate an understanding of social, professional, and ethical issues related to the safe and wise development of nuclear science and engineering.

Unit I - REVIEW OF NUCLEAR PHYSICS: Nuclear Equations – Energy from Nuclear Reactions and Fission – Thermal neutrons – Nuclear Cross Sections – Neutron Flux distribution in cores, slowing down – Neutron life cycle – Thermal Reaction Equation – Buckling Factors – Reactivity and Reactor Period – Radio activity – half life – neutron interactions- cross sections.
Unit II - HEAT GENERATION IN REACTOR: Reactor Heat generation and Removal – Volumetric Thermal source Strength – Heat flow in and out of solid fuel element – Temperature variations across Fuel elements – Coolant channel orificing – Hot spot factors – Absorption of Core radiation – Total heat generated in the core. Heat removal in solids subjected to radiation – Thermal Shield quality and void fractions in flow and non-flow systems .
Unit III - TYPES OF REACTOR: Boiling water reactor hydraulics-Change of Phase reactor. Fluidized Bed Reactor, Gas Cooled Reactor steam Cycle- Simple and Dual Pressure Cycle, Pebble Bed Reactors, Fluid Fuelled Reactors – Types – Corrosion and Erosion Characteristics.
Unit IV - FUSION ENERGY CONVERSION: Energy From Nuclear fusion, Thermonuclear Fusion, D-T Reaction, P-P Reaction, Fuel Cycle, Conditions for Fusion, Plasma confinement and Heating- Magnetic Confinement fusion, Inertial Confinement Fusion.
Unit V - SAFETY OF NUCLEAR PLANTS: Nuclear plant safety – safety systems-changes and consequences of an accident-criteria for safety.

Reference books:

1. Samuel Glass tone and Alexander Setonske, ‘Nuclear reactors Engineering’, 4th Edition, CBS Publishers and Distributors, 2004.
2. Singhal R.K., “Nuclear Reactors”, New age international Private limited, 1st Edition 2014.
3. Vaidyanathan G “Nuclear Reactor Engineering”, S. Chand &Company, 2012.
4. Kenneth D.Kok “Nuclear Engineering Handbook”, CRC Press 2016.
5. John R Lamarsh “Introduction to Nuclear Engineering”, Pearson 3rd Edition 2001.

17ME3039 VIBRATION LABORATORY

Credits: 0:0:1

Course objectives:

- To train students with the sensors, signal conditioning and associated instrumentation for vibration measurement
- To instruct fundamentals of digital data acquisition, signal processing, data reduction and display.
- To impart knowledge on the use of vibration measurement equipment

Course outcome:

Ability to

- study the effect of dynamics on vibrations
- be proficient with instrumentation used in vibration control tests
- understand the working principle of vibration measuring instruments
- adapt and evaluate the way to measure vibration.
- learn fundamental information about vibration phenomenon and find remedy of the vibration problems encountered in machineries.
- understand the behaviour of vibration in simple mechanical systems.

List of Experiments

1. Longitudinal Vibration for single degree of freedom system
2. Torsional vibration for single degree of freedom system
3. Forced vibration for spring mass system
4. Multiple degree of freedom system
5. Transmissibility ratio for vibration table
6. Vibration measurement using vibrometer for rotating machinery
7. Frequency measurement using Impact hammer
8. Real Time PC based vibration measurement
9. Measurement of Acoustic Emission signals
10. Real time FFT Analysis

(The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD and notify it at the beginning of each semester)

17ME3040 ADVANCED COMPUTER AIDED ENGINEERING LABORATORY

Credits: 0:0:2

Course Objectives:

To impart knowledge on

- how to prepare drawings for various mechanical components using any commercially available 3D modeling software's
- the use of Finite Element Analysis software to solve various field problems in mechanical engineering to optimize and verify the design of machine elements.

Course Outcomes:

Ability to

- get familiarized with the computer applications in design
- prepare drawings for various mechanical components.
- model and analyze various physical problems
- select appropriate elements and give boundary conditions
- solve structural, thermal, modal and dynamics problems.
- conduct coupled structural and thermal analysis

List of Experiments:

1. Assembly of knuckle joint
2. Assembly of plummer block
3. Structural analysis of 2D Truss
4. Analysis of Bicycle frame
5. 2D static analysis of bracket

6. Thermal Analysis of 2D chimney
7. 3D Fin Analysis
8. 2-D Transient mixed boundary
9. Design optimisation
10. Velocity Analysis of fluid flow in a channel
11. Modal analysis of cantilever beam
12. Harmonic analysis of cantilever beam
13. Coupled structural and thermal analysis
14. Magnetic Analysis of solenoid actuator

(The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD and notify it at the beginning of each semester)

17ME3041 CAD/CAM LABORATORY

Credit 0:0:2
Course Objectives:
To impart knowledge on
- Usage of computers and modelling softwares in design and Manufacturing.
- Visualization of objects in three dimensions and producing orthographic views, sectional views and auxiliary views of it.
- Writing the codes for CNC VMC and Tuning centres to produce components.

Course Outcome:
Ability to
- Model the components using the commands such as extrude, revolve, fillet, hole pattern.
- Use the commands rib, chamfer, draft and 3D sketch to modify the parts
- Create an assembly model of knuckle joint and screw jack and convert them into orthographic sketches.
- Write CNC codes for linear, circular interpolation step turning ball turning and external threading.
- Write CNC codes for creating holes on components using CNC drilling machine.
- Write CNC program for creating square pockets using vertical milling centre.

List of experiments
1. 3D Modeling with Extrude, Round (Fillet) and Mirror Commands
2. 3D Modeling With Revolve, Hole Pattern Commands
3. 3D Modeling With Rib, Chamfer, Draft and 3D sketching Commands
4. Modeling, Assembly and Drafting of Knuckle Joint
5. Modeling, Assembly and Drafting of Screw Jack
6. Advanced modeling commands-Sweep and Blend (Loft)
7. Study of CNC XL Mill Trainer and CNC XL Turn trainer
8. Profile cut using linear and circular interpolation
9. Drilling in a CNC drilling machine.
10. Square pocketing and Drilling in a VMC/CNC drilling machine
11. Step turning and external thread cutting in a CNC lathe
12. Ball tuning in a CNC turning Centre

17ME3042 HEAT TRANSFER LABORATORY

Credits: 0:0:1
Course Objectives
To impart knowledge on
- To study the heat transfer characteristics of various advanced heat transfer apparatus
- To perform design calculations of different modes of heat transfer
- To understand the behavior of two phase heat transfer system at different operating conditions

Course Outcomes
At the end of the course students will be able to
- Demonstrate skills in conducting condensation heat transfer experiment
- Demonstrate skills in finding the critical heat flux in two phase heat transfer
- Demonstrate skills in finding the nucleate pool boiling heat transfer coefficient

- Demonstrate skills in finding the performance capacity factors in air –conditioning
- Analyze the properties of air and water vapour mixtures
- Analyze the performance parameters of transient heat conduction

List of Experiments

1. Drop wise and film wise condensation heat transfer
2. Investigation of lumped thermal capacitance method of transient temperature analysis
3. Determination of bypass and capacity factors in air conditioning test rig
4. Experiments on psychrometric properties of air
5. Nucleate boiling experiment
6. Critical heat flux apparatus

17ME3043 AUTOMATION AND ROBOTICS LABORATORY

Credits: 0:0:1

Course Objectives:

To impart the knowledge on

- the design of pneumatic and electro pneumatic components for automation
- components, ladder logic design, programming for PLC/Microcontroller and robot
- the configuration of robot and reconfigure them for a custom application

Course Outcomes:

Ability to

- manipulate and program the Industrial Robot
- program the Robot for Pick and place operations
- program and control the different movements of robots.
- program logic circuitss
- design electro pneumatic circuits to control sequential circuits
- write Ladder logic program to control Motors and Traffic signals

List of Experiments:

1. Pick And Place Programming Using Fanuc
2. Pick and place programming using Mini robot
3. Pick and place programming using Scara robot
4. Pneumatic AND,OR logic circuit
5. Electro-Pneumatic Circuit For Reciprocating and Dual cylinder sequential circuit
6. Logic circuit design to control traffic light signals, motor using PLC or microcontroller

Reference Books

1. Mikell P. Groover, Mitchell Weiss, "Industrial Robotics, Technology, Programming and Applications ", McGraw Hill International, 2008.
2. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic Engineering - An Integrated Approach", Prentice Hall 2002.
3. Saeed B Niku, "Introduction to Robotics", Prentice Hall, 2009.

17ME3044 ADVANCED COMPUTATIONAL FLUID DYNAMICS LABORATORY

Credits: 0:0:2

Course Objectives:

To impart knowledge on

- Finite volume Computational Fluid Dynamics codes working strategies.
- actual setting up of the problem and solution procedure
- extracting the required data, post process and compare with available data

Course Outcomes:

Ability to

- familiarize computer applications in fluid dynamics

- model and analyze various physical problems
- select appropriate mesh type and give boundary conditions
- solve heat transfer and fluid flow problems.
- extract the post processing data and compare with available data
- examine the pictorial results of the problem

List of Experiments:

1. One dimensional steady state diffusion
2. One dimensional steady state diffusion with volume source
3. One dimensional steady state diffusion with surface source
4. One dimensional unsteady heat conduction
5. Conjugate heat transfer
6. Periodic flow and heat transfer
7. Laminar flow
8. Turbulent flow
9. Flow through porous media
10. Flow around an aerofoil
11. Modelling radiation and natural convection
12. Modelling solidification process

LIST OF COURSES

Sl. No	Course Code	Course Name	Credits
1	15ME2001	Dynamics Laboratory	0:0:2
2	15ME2002	CAM Laboratory	0:0:2
3	15ME3013	Advanced Welding Processes	3:0:0
4	15ME3014	Powder Metallurgy	3:0:0
5	16ME1001	Mechanical Machines and Systems	3:0:0
6	16ME1002	Engineering Drawing Lab	0:0:2
7	16ME1003	Engineering Practice	0:0:2
8	16ME2001	Automotive Chassis	3:0:0
9	16ME2002	Vehicle Dynamics	3:0:0
10	16ME2003	Vehicle Design Data Characteristics	3:0:0
11	16ME2004	Vehicle Maintenance	3:0:0
12	16ME2005	Vehicle Body Engineering	3:0:0
13	16ME2006	Automotive Engines	3:0:0
14	16ME2007	Automotive Transmission	3:0:0
15	16ME2008	Machining Practice	0:0:2
16	16ME2009	Thermal Engineering Laboratory	0:0:2
17	16ME2010	Heat Transfer Laboratory	0:0:2
18	16ME2011	Heat and Mass Transfer	3:0:0
19	16ME3001	Non-Conventional Manufacturing Processes	3:0:0

REVISED VERSION COURSES

Sl. No	Course Code	Version	Course Name	Credits
1	14ME1001	1.1	Geometric Drawing	0:0:2
2	14ME1002	1.1	Workshop Practice	0:0:2
3	14ME1003	1.1	Basic Mechanical Engineering	3:0:0
4	14ME2001	1.1	Engineering Mechanics	3:0:0
5	14ME2002	1.1	Metallurgy Laboratory	0:0:1
6	14ME2003	1.1	Material Science and Engineering	3:0:0
7	14ME2004	1.1	Manufacturing Processes	3:0:0
8	14ME2005	1.1	Machining Processes	3:0:0
9	14ME2006	1.1	Metrology and Measurement Systems	3:0:0
10	14ME2007	1.1	Fluid Power Control Engineering	3:0:0
11	14ME2008	1.1	Foundry, Smithy, Welding and Sheet Metal Laboratory	0:0:2
12	14ME2009	1.1	Metrology Laboratory	0:0:1
13	14ME2010	1.1	Fluid Power Control and Mechatronics Laboratory	0:0:2
14	14ME2011	1.1	CAM Laboratory	0:0:1
15	14ME2012	1.1	Lathe Shop	0:0:1
16	14ME2013	1.1	Special Machines Laboratory	0:0:1
17	14ME2014	1.1	Engineering Thermodynamics	3:0:0
18	14ME2015	1.1	Thermal Engineering I	3:0:0
19	14ME2016	1.1	Thermal Engineering II	3:0:0
20	14ME2018	1.1	Power Plant Engineering	3:0:0
21	14ME2019	1.1	Heat and Mass Transfer	3:1:0
22	14ME2020	1.1	Thermal Engineering Laboratory	0:0:1

23	14ME2022	1.1	Heat Transfer Laboratory	0:0:1
24	14ME2023	1.1	Internal Combustion Engines Laboratory	0:0:1
25	14ME2025	1.1	Computer Aided Design and Manufacturing	3:0:0
26	14ME2026	1.1	Mechanics of Machines	3:1:0
27	14ME2027	1.1	Dynamics of Machinery	3:1:0
28	14ME2028	1.1	Design of Transmission Systems	3:0:0
29	14ME2029	1.1	Design of Machine Elements	3:1:0
30	14ME2031	1.1	Computer Aided Design and Engineering Laboratory	0:0:2
31	14ME2032	1.1	Machine Drawing	0:0:2
32	14ME2036	1.1	Mechanical Vibrations	3:0:0
33	14ME2038	1.1	Tribology in Design	3:1:0

15ME2001 DYNAMICS LABORATORY

Co/Prerequisite: Dynamics of Machinery [14ME2027]

Credits: 0:0:2

Course objective:
To impart knowledge on
- Principle and operations of vibration based systems
- Measuring devices used for dynamic testing
- Effect of forces on various equipments based on theoretical and experimental methods

Course outcome:
Ability to
- Demonstrate the parameters of vibration using single and Multi degree of freedom system
- Demonstrate the effects of forces, moments of rotary masses, governor and gyroscope.

LIST OF EXPERIMENTS
The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15ME2002 CAM LABORATORY
Credits: 0:0:2

Prerequisite: Lathe Shop [14ME2012], Special Machines Laboratory [14ME2013]

Course Objective:
To impart knowledge on
- NC programming for CNC turning and milling operation and execution.
- Selection of tool for a machining operation.
- simulation and verifying machining processes.

Course Outcome:
Ability to
- Interpret part drawing and write CNC program using G codes and simulate.
- Select Cutting tools for different machining operations and demonstrate machining the component in CNC machine tool.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15ME3013 ADVANCED WELDING PROCESSES

Credits: 3:0:0

Course Objectives:

- Learn the basic principles behind the operation of advanced welding processes.
- Study the welding processes for various metals, nonmetals and dissimilar materials.
- Impart knowledge on the pre and post welding treatment processes.

Course Outcomes:

Ability to

- understand the applications of advanced welding processes.
- analyze the effects of process parameters on the quality of cast and weld products.
- select the pre and post welding treatment processes for weld components

Plasma arc welding, electron beam welding, laser beam welding, ultrasonic welding-hybrid welding–explosive welding – diffusion welding, stud welding and cold pressure welding – high frequency induction welding –twin wire active TIG welding-A-TIG welding- Hot wire TIG welding- Weld Surfacing & cladding, Friction welding-Friction stir welding-magnetic pulse welding - under water welding - Welding of aluminium, copper alloys, dissimilar metal and alloys-Pre and post welding heat treatments.

References:

1. R.S. Parmar, “Welding Processes and Technology”, Khanna Publishers, 1995.
2. H.S.Bawa "Manufacturing Technology-I" Tata Mc Graw Hill Publishers New Delhi, 2007.
3. S.V.Nadkami, Modem Arc Welding Technology, Oxford & IBH Publishing Co. Pvt. Ltd.
4. Cornu.J. “Advanced welding systems – Volumes I, II and III”, JAICO Publishers,1994.
5. Carry B., “Modern Welding Technology”, Prentice Hall Pvt Ltd., 2002

15ME3014 POWDER METALLURGY

Credits: 3:0:0

Course Objective:

- To understand procedures for preparing powders for processing
- To understand techniques to manufacture products based on powder processing methods
- To understand powder metallurgy application in aerospace, automobile and machining materials.

Course Outcomes:

- ability to identify materials for power metallurgy
- suggest suitable powder metallurgy processing techniques for different materials
- develop engineering parts using powder metallurgy technique

Materials for powder metallurgy, Powder manufacture and conditioning – mechanical methods, physical methods, powder conditioning, heat treatment, blending and mixing, self-propagating high-temperature synthesis (SHS), nano powder production methods, Characteristics and testing of metal powders, Powder compaction, isostatic pressing, powder rolling, forging and extrusion, explosive compaction. Sintering, finishing operations, special sintering processes, field assisted sintering, sintering of nanostructured materials. Applications.

References:

1. P.C. Angelo and R. Subramanian, "Powder Metallurgy: Science, Technology and Application" Prentice Hall, 2008
2. Anish Upadhya and G S. Upadhaya, "Powder Metallurgy: Science, Technology and Materials, Universities Press, 2011
3. Sinha A.K., "Powder Metallurgy", Dhanpat Rai & Sons. New Delhi, 1982
4. R.M. German, "Powder Metallurgy and Particulate Materials Processing" Metal Powder Industries Federation, Princeton, N.J., 2005
5. ASM Handbook Vol.7, "Powder Metallurgy", Metals Park, Ohio, USA, 1990.
6. Animesh Bose, "Advances in Particulate Materials" Butterworth – Heinemann New Delhi, 1995.
7. Kempton H Roll, "Powder Metallurgy" Metallurgical Society of AMIE, 1988.
8. Ramakrishnan P, "Powder Metallurgy – Opportunities for Engineering Industries", Oxford and IBH Publishing Co., Pvt. Ltd., New Delhi, 1987
9. Erhard Klar, "Powder Metallurgy Applications, Advantages and Limitations" American Society for Metals, Ohio, 1983.
10. Sand R.L and Shakespeare C.R. "Powder Metallurgy" George Newes Ltd., London, 1966

16ME1001 MECHANICAL MACHINES AND SYSTEMS

Credits: 3:0:0

Course Objective:

- To impart knowledge on mechanical machines and systems: automobile, fluid power systems, refrigeration, air conditioning, power plants, manufacturing and material handling.

Course Outcomes:

Ability to

- know the working principle of automobile Engines, flight and Power plants.
- Know the working principle of pump, refrigeration and air-conditioning.
- select appropriate metal processing methods.

Automotive vehicles and Aircrafts: IC engines – classification, construction and working. Basic theory of flight. **Refrigeration and Air-conditioning systems:** construction and working principles of Vapour compression, vapour absorption and air-conditioning systems, Thermoelectric cooling. **Fluid power machinery:** hydraulic and pneumatic systems, pumps, turbines, vacuum systems and compressors. **Power generation:** nonrenewable -thermal, hydro, nuclear, and renewable - Solar thermal, wind, ocean power plants. **Manufacturing Systems:** casting, forming, welding machines, Turning, Drilling, Milling Machines, RP Systems. **Material Handling Systems:** Cranes, conveyors, Hoists, elevators, Earth movers, fork lifter.

References:

1. G.Shanmugam, S.Ravindran, "Basic Mechanical Engineering", Tata McGraw Hill Education Private Limited, 2011.
2. Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2008.
3. I.E. Paul Degarmo, J.T. Black, Ronald A. Kosher, "Material and Processes in Manufacturing", 8th Edition, John Wiley and Sons, Inc., 1999.
4. Arora C.P., "Refrigeration and Air conditioning", Tata McGraw Hill, 3rd Edition, 2008.

5. Rudenko N., “Materials Handling Equipment”, Envee Publishers,2000

16ME1002 ENGINEERING DRAWING LAB

Credits: 0:0:2

Course Objective:

- To improve visualization skills and to inculcate proper understanding of the theory of projection.
- To enable students to understand various concepts like dimensioning, conventions and standards related to working drawings in order to become professionally efficient.
- To understand the usage of various line types, arcs and methods to draw using AutoCAD.
- To understand standard, modify, draw, layers and properties tool bars and use it to draw orthographic and isometric views

Course Outcome:

Ability to

- visualize the objects from the drawings and to apply the theory of projection and conventions to graphically represent details of engineering components.
- apply usage of various line types, arcs, and circles to draw using CAD software.
- apply, modify, draw, layers and properties tool bars and use it to draw orthographic and isometric views.

LIST OF EXPERIMENTS

Geometrical Drawing:

1. Geometrical constructions
   i) Introduction and use of drawing instruments & Lettering practice.
   ii) Construction of polygons using
      a. Semicircle and Bi-section of given side method
      b. Inscribing polygon in a circle method
      c. Special Method for Hexagon
   iii) Dimensioning practice of lines, circles, arcs using aligned and chain dimensioning systems.
2. First and third angle projections. Conversion of pictorial views into orthographic views (in first angle projection) of simple machine elements like V- block and bearing block.
3. Projection of points in different quadrants.
4. Projection of lines in first quadrant
   a. Parallel to both planes.
   b. Inclined to one plane and parallel to other.
   c. Parallel to one plane and perpendicular to other plane.
5. Projections of solids- prism, pyramid, cylinder and cone - axis parallel to one plane and perpendicular to the other plane, Parallel to both planes.
6. Introduction to Isometric projection, Isometric views of basic solids - prism, pyramid, cylinder and cone.

Computer Aided Drafting:

7. Snap, Grid, Limits, Osnap, line types and weights, text, pdf file creation and plotting
8. Modifying Commands: Erase, trim, array, lengthen, break, mirror, offset, move, copy etc.
9. Methods of Drawing lines, arcs and circles.
10. Application of lines, arcs and circles to draw simple geometries.
11. Dimensioning, hatching methods to show different materials, title block and layers.

12. Isometric view of primitive solids and combination of primitive solids.

References :

1. Leo Dev wins.K., ‘Engineering Drawing’, Pearson India Education, 2nd Edition, 2016.
2. Basant Agrawal, C.M. Agrawal, ‘Engineering Drawing’, Tata McGraw Hill Private Ltd., 2010.
3. Shyam Tickoo, ‘AUTOCAD 2012 ’ Pearson Publications, 2012.
4. Bhatt N.D., “Elementary Engineering Drawing”, 26th Edition. Chartor Publishing House, Anand, 2009.
5. Venugopal K. “Engineering Graphics”, 9th Edn. (Revised), New Age International Publishers, 2009

16ME1003 ENGINEERING PRACTICE

Credits: 0:0:2

Course Objective:

- Students would acquire mechanical engineering domain skill sets which are required in day-to-day life

Course Outcome:

Ability to

- apply the acquired skills for the project work
- realize the practical difficulties encountered in industries during any assembly work
- carryout simple electronic and electrical work throughout their career.
- solve simple problem related with fitting works, carpentry works and pipe fittings

LIST OF EXPERIMENTS

I ELECTRICAL SCIENCES

1. Soldering Simple Electronics Circuits
2. Characterization of basic Electronics Devices.
3. Wiring of Tube Lights & Staircase Wiring
4. Thermocouples & application
5. Assembly of PC
6. Installation of Operating System (OS) and Disc Partitioning
7. Mechanical joining- carpentry and fitting
8. Machining and Mechanical Measurements
9. Assembly and dismantling of Centrifugal pump/vacuum cleaner / Two wheeler engine
10. Simple pipe layout connection with different fittings and valves-Plumbing
11. Physical Joining -Welding
12. Sheet metal working, smithy and Casting

Reference Books:

1. S.Suyambazhahan, “Engineering Practices”, PHI, Second Edition 2012.
2. S.Bawa, “Engineering workshop practice”, Tata McGraw hill, 2013.
3. Prof.Vee Ess Workshop manual, V S Publications, Bangalore,2013.

16ME2001 AUTOMOTIVE CHASSIS

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- constructional details and theory of important drive lines, Structural, Steering, Braking and Suspension Systems of Automobiles.
- solving problems in Steering Mechanism, Propeller Shaft, Braking and Suspension Systems.

Course Outcomes:

Ability to

- demonstrate working principle of steering ,drive line and differential systems of automotive chassis.
- design suspension systems and select wheels, tyres and rear axles for different loading conditions.
- design braking system of automobiles.

Basic construction of chassis and types of chassis layout. Loads acting on vehicle frame. Types of front axles and stub axles and front wheel geometry. Steering types and mechanisms; condition for True rolling motion, power steering. Drive line, final drive and differential. Driving thrust and its effects. Propeller shaft, universal joints. Differential principle and constructional details, Differential locks. Rear axles, wheels, rims and tyres. Suspension systems - types -constructional details - shock absorbers - leaf and coil springs. Braking systems - Need for Brake systems, Stopping Distance, Time and Braking Efficiency, Effect of Weight Transfer during Braking, Classification of brakes , Braking Torque, drum brake and disc Brake Theory, Types and Construction of Hydraulic Braking System, Mechanical Braking System, Pneumatic Braking System, Power-Assisted Braking System, Servo Brakes, Retarders - antilock braking systems(ABS).

References:

1. Newton Steeds and Garret, "Motor Vehicles" 13th Edition, Butterworth, London, 2005.
2. Heinz Hazler, "Modern Vehicle Technology", Butterworth, London, 2005.
3. Giri N.K., "Automotive Mechanics" Khanna Publishers, New Delhi, 2005.
4. Milliken & Milliken, "Race Car Vehicle Dynamics", SAE, 2003.
5. J. Halderman, "Automotive Chassis System, Prentice hall, 2010.

16ME2002 VEHICLE DYNAMICS

Credits: 3:0:0

Course Objective:

- To impart knowledge on the application of basic principles of mechanics for carrying out dynamic analysis of vehicles.

Course Outcomes:

Ability to

- determine magnitude and frequency of free un-damped, damped and externally excited vibrating systems.
- predict passenger comfort by carrying out dynamic analysis of vehicle due to forces from tyre, wind and acceleration.
- design systems to improve vehicle stability.

Definitions, Modeling and Simulation, Global and Vehicle Coordinate System. Undamped and Damped Vibration. Transmissibility, Vibration absorber, Torsional vibration, Critical speed. Tyre forces and moments. Performance of tyre on wet surface. Tyre vibration. Vertical dynamics - Sources of Vibration.

Design and analysis of suspension. Influence of suspension stiffness. Air suspension system and their properties. Longitudinal dynamics and control -Aerodynamic forces and moments. Equation of motion. Load distribution for three wheeler and four wheeler. Calculation of Maximum acceleration, Reaction forces for Different drives. Braking and Driving torque. Prediction of Vehicle performance and control. Lateral dynamics -Steady state handling characteristics. Steady state response to steering input. Testing of handling characteristics. Stability of vehicle on banked road. Effect of suspension on cornering.

References:

1. Singiresu S. Rao, "Mechanical Vibrations", 5th Edition, Prentice Hall, 2010.
2. Joop Pauwelussen, "Essentials of Vehicle Dynamics", Butterworth, 2015.
3. Wong. J. Y., "Theory of Ground Vehicles", 4th Edition, Wiley-Interscience, 2008.
4. Rajesh Rajamani, "Vehicle Dynamics and Control", 1st Edition, Springer, 2005.
5. Dean Karnopp, "Vehicle Stability", 1st Edition, Marcel Dekker, 2004.
6. Nakhaie Jazar. G., "Vehicle Dynamics: Theory and Application", 1st Edition, Springer, 2008
7. Michael Blundell & Damian Harty, "The Multibody Systems Approach to Vehicle Dynamics", Elsevier Limited, 2004.
8. Hans B Pacejka, "Tyre and Vehicle Dynamics", 2nd Edition, SAE International, 2005.

16ME2003 VEHICLE DESIGN AND DATA CHARACTERISTICS

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- technical specifications of an automobile.
- vehicle performance parameters and design parameters.

Course Outcomes:

Ability to

- design vehicle considering air and rolling resistance to vehicle motion and estimate power.
- analysis of performance of the vehicle with performance curves.
- Determine turning moments and gear ratios.

Introduction - assumptions to be made in designing a vehicle - basics of automobile design. Resistance to vehicle motion - Calculation, Tabulation and Plotting of Curves for Air and Rolling Resistances at various vehicle speeds, Driving force, Power requirement for different loads and acceleration. Performance curves I - Calculation, Tabulation and Plotting of Torque and Mechanical Efficiency for different vehicle speeds, Interpolation of Pressure - Volume diagram, Calculation of frictional Mean Effective Pressure, Calculation of Engine Cubic Capacity, Bore and Stroke Length. Performance curves II - Connecting rod length to Crank Radius Ratio, Plotting of Piston Velocity and Acceleration against Crank Angle, Plotting Gas, inertia and Resultant force against Crank Angle. Turning Moment and Side Thrust against Crank Angle. Gear ratios - Determination of Gear Ratios, Acceleration and Gradient, Typical Problems on Vehicle performance

References:

1. Giri. N. K., "Automotive Mechanics", Khanna Publishers, New Delhi, 2005.
2. Heldt, P.M., "High Speed Combustion Engines", Oxford and I.B.H. Publishing Co., Kolkata, 2002.
3. Gupta. R.B., "Automobile Engineering", Sathya Prakashan, 8th Edition, 2013.
4. Smith, "Introduction to Modern Vehicle Design, Butterworth Heinemann, 2000.

16ME2004 VEHICLE MAINTENANCE

Credits: 3:0:0

Course Objective:

- To impart knowledge on the various methods of maintaining vehicles and their subsystems.

Course Outcomes:

Ability to

- diagnose engine systems and suggest procedures for maintenance.
- diagnose transmission systems and suggest procedures for maintenance.
- diagnose electrical subsystems and suggest procedures for maintenance.

Maintenance - Automotive service procedures - workshop operations. Safety - Personnel, machines and equipment. Basic tools - special service tools - measuring instruments - condition. Scheduled maintenance services - service intervals. Engine and engine subsystem maintenance - General Engine service - Dismantling of Engine components - Engine repair - Service of basic engine parts and engine sub-systems. Transmission and driveline maintenance and service. Suspension and brake system maintenance and service. Wheel alignment and balance. Tyres - rotation. Steering system maintenance and service. Automotive electrical and air-conditioning maintenance and service. Vehicle body repair.

References:

1. Srinivasan, “Automotive Mechanics”, Tata McGraw Hill, 2003
2. Ed May, "Automotive Mechanics Volume One", McGraw Hill Publications, 2003.
3. Ed May, "Automotive Mechanics Volume Two", McGraw Hill Publications, 2003.
4. Bosch Automotive Handbook, 6th Edition, 2004.
5. Hamilton, “Vehicle Maintenance and Repair, Delmar Publications, 2012.
6. Vehicle Service Manuals from reputed manufacturers.

16ME2005 VEHICLE BODY ENGINEERING

Credits: 3:0:0

Course Objective:

To impart knowledge on

- the design and construction of external body of the vehicles.

Course Outcomes:

Ability to

- apply knowledge of construction of vehicle, aerodynamic, concept and paneling to various vehicle layout.
- design the passenger car body taking into consideration of forces acting on the body.
- determine methods to visualize forces acting on the body and protect the body.

Car body details - Types of Car body. Visibility, regulations, tests for visibility. Driver seat design - Car body construction. Safety aspect of car body. Bus body details - Bus body layout for various types, Types of metal sections used - Regulations - Constructional details: conventional and integral. driver seat design - Safety aspect of bus body. Construction details -Commercial Vehicle - Light commercial vehicle - vehicle body dimensions. Drivers cab design - Regulations. Vehicle aerodynamics - Objectives, Vehicle drag and types. Various body optimization techniques for minimum drag. Wind tunnels - Principle of operation. Flow visualization techniques - measurement of various forces and moments. Body materials, trim mechanisms and repair. Corrosion: Anticorrosion methods.

References:

1. L Morello, “Automotive body”, Springer, 2014.
2. James E Duffy, "Body Repair Technology for 4-Wheelers", Cengage Learning, 2009.
3. Dieler Anselm., The passenger car body, SAE International, 2000.
4. Powloski, J., "Vehicle Body Engineering", Business Books Ltd., 1998.
5. Braithwaite, J.B., "Vehicle Body building and drawing", Heinemann Educational Books Ltd., London, 1997.
6. John Fenton, "Vehicle Body layout and analysis", Mechanical Engg. Publication Ltd., London, 1992.

16ME2006 AUTOMOTIVE ENGINES

Credits: 3:0:0

Course Objective:

- To impart knowledge on the basic principles of engines used for automobiles and different systems.

Course Outcomes:

Ability to

- demonstrate the construction, principle of operation of fuel systems.
- troubleshoot problems arising from combustion, super charging, turbo-charging, cooling and lubrication systems of automotive engines.
- propose suitable testing procedure to evaluate the engine performance.

Constructional and operational details of spark ignition (SI) and compression ignition (CI) engines. Two stroke and four-stroke SI and CI engines. Fuel systems - Air fuel ratio - metering of fuel. Use of governor in Diesel engines. Combustion and combustion chambers. Ignition timing - Chemical and physical delay - Detonation and knocking - Swirl, squish and turbulence. Supercharging, turbo - charging and inter-cooling. Dynamometers, Indicated thermal, brake thermal and volumetric efficiencies. Engine performance and testing standards. Need for cooling, types of cooling systems - air and liquid cooling systems. Thermo-syphon and forced circulation and pressurized cooling systems. Properties of coolants. Requirements of lubrication systems. Types-mist, pressure feed, dry and wet sump systems. Properties of lubricants.

References:

1. Ganesan V., "Internal Combustion Engines", Tata McGraw Hill, 2007.
2. Ramalingam K.K., “Internal Combustion Engines”, Sci-Tech Publications, 2005.
3. Mathur and Sharma "Fundamentals of Combustion Engines" Dhanpat Rai and Sons, 2002.
4. Gupta. H.N. "Fundamentals of Internal Combustion" Engines, reprint, PHI Learning Pvt. Ltd. 2006.
5. R.K. Rajput, “A Textbook of Internal Combustion Engines”, Laxmi Publications 2007.
6. Colin Ferguson, “Internal Combustion Engines – Applied Thermo Sciences , Wiley, 2015.

16ME2007 AUTOMOTIVE TRANSMISSION

Credits: 3:0:0

Course Objective:

- To impart knowledge on the various transmission and drive line units of automobiles.

Course Outcomes:

Ability to

- demonstrate the working principles of clutch, gear box and hydrodynamic transmission.
- demonstrate the working principles of fluid-coupling and epicyclic gear boxes in automatic transmission.
- identify and select drives for transmission.

Clutch, Gear box: determination of gear ratios for vehicles. Performance characteristics in different speeds Hydrodynamic transmission - Fluid coupling - Torque capacity. Reduction of drag torque in fluid coupling. Torque converter, Multistage torque converters and poly-phase torque converters. Epi-cyclic gearboxes, Wilson Gear box, Cotal electro-magnetic transmission. Hydraulic control system for automatic transmission. Applications of automatic transmission - Chevrolet "Turboglide" Transmission, Continuously Variable Transmission (CVT). Hydrostatic and electric drive. Advantages and limitations. Comparison of hydrostatic drive with hydrodynamic drive, construction and working of typical Janny hydrostatic drive. Electric drive - types - Principle of early and modified Ward Leonard Control system - Advantages & limitations.

References:

1. Newton Steeds and Garret, "Motor Vehicles" 13th Edition, Butterworth, London, 2005.
2. Naunheimer. H, "Automotive transmission: Fundamentals, Selection, Design and Application, 2nd Edition, Springer, 2012.
3. R. Fisher, "The Automotive Transmission Book, Springer, 2015
4. Heinz Heisler, "Advance vehicle Technology", Butterworth-Heinemann, 2002.
5. Heldt P.M., "Automotive Chassis" Chilton Co., New York, 1990.

16ME2008 MACHINING PRACTICE

Credit: 0:0:2

Co/Pre-requisite: Machining Processes [14ME2005]

Course Objectives:

To impart knowledge on

- basic knowledge about Metal cutting operation and execute it.
- selection of tools for machining operations.

Course Outcome:

Ability to

- demonstrate skills to machine components using Special Machines/Lathe.
- select appropriate cutting tools.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

16ME2009 THERMAL ENGINEERING LABORATORY

Credits: 0:0:2
Co/Pre-requisite: Thermal Engineering II [14ME2016]

Course Objectives:
To impart knowledge

- working principles of various thermal equipment like air blower, reciprocating compressors, Refrigeration & Air Conditioning Systems, Boilers.
- performance of different IC engines like air cooled, water cooled, low speed, single and twin cylinder engines.

Course Outcomes:
Ability to

- demonstrate engine performance tests and estimate emission contents in the exhaust gases through emission test.
- determine the performance of different thermal equipment like air blower, reciprocating compressors, refrigeration & air conditioning systems, Boilers.

LIST OF EXPERIMENTS

The faculty member conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

16ME2010 HEAT TRANSFER LABORATORY

(Use of standard Heat and Mass Transfer data book is permitted.)

Credit: 0:0:2
Co/Pre-requisite: Heat and Mass Transfer [16ME2011]

Course Objectives:
To impart knowledge on

- conducting the heat transfer experiments and
- determining heat transfer coefficients, thermal Conductivity, emissivity and effectiveness.

Course Outcomes:
Ability to

- demonstrate experiments in heat conduction, convection and radiation
- analyze the performance of various types of heat exchangers and perform boiling and condensation experiments

LIST OF EXPERIMENTS

The faculty member conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

16ME2011 HEAT AND MASS TRANSFER

(Use of standard Heat and Mass Transfer data book is permitted.)

Credits: 3:0:0
Prerequisite: Engineering Thermodynamics [14ME2014]

Course Objectives:
To impart knowledge on

- conduction, convection and radiation heat transfer.
- design of heat exchangers.
- basic principles of mass transfer.

Course Outcomes:
Ability to

- solve heat transfer problems by applying the principles of heat conduction, convection, radiation and mass diffusion.
- design heat exchanger systems for enhanced heat transfer performance.
- analyze and predict the flow patterns in two phase flow and heat transfer.

General Differential equation of Heat Conduction, One dimensional steady state heat conduction in plane wall and composite wall. Heat generation in plane wall, cylinder and sphere. Conduction in two dimensions, shape factor, numerical method of analysis. lumped heat capacity systems, significance of Biot and Fourier numbers. Concept of hydro dynamics and thermal boundary layers. Forced convective heat transfer over a flat plate, flow through pipes, Free Convection - heat transfer from vertical and horizontal surfaces. Types of heat exchangers, overall heat transfer coefficients, LMTD and NTU methods, fouling factor and effectiveness. Fick's law of diffusion, equi-molal counter diffusion, Convective mass transfer coefficient, black body concepts, gray body, radiation shape factor, radiation heat transfer between two surfaces and radiation Shields.

References:

1. Holman J.P., "Heat Transfer", SI Metric 10th Edition, McGraw Hill, ISE, 2011.
2. Sachdeva R.C., "Fundamentals of Engineering Heat and Mass Transfer", Wiley Eastern, 2nd Ed, 2010.
3. Frank P. Incropera and, David P. DeWitt "Principles of Heat and Mass Transfer", John Wiley, 7th Edition 2013.
4. Yunus A. Cengal, "Heat Transfer A Practical Approach", Tata McGraw Hill, 2010.
5. P.S. Ghoshdastidar, "Heat Transfer", Oxford University Press, 2nd Edition 2012.

16ME3001 NON-CONVENTIONAL MANUFACTURING PROCESSES

Credits: 3:0:0

Course objective

- To impart knowledge on different types of non-conventional manufacturing processes.

Course outcomes

- Ability to evaluate and select suitable manufacturing processes for specific applications.
- Apply appropriate manufacturing process for fabrication of desired component and shape.
- Develop new products by making use of new materials and processes.

Course Description:
Construction, working principle, types, process parameters, derivations, problems, merits, demerits and applications of non-conventional machining processes, non-conventional solid state welding processes, non-conventional forming processes and other non-conventional manufacturing processes such as Electrical discharge machining, Chemical machining, Ultrasonic machining for very hard fragile materials, for work pieces too flexible or slender, for intricate and highly complex shapes

Reference books

1. Serope Kalpakjian, Steven Schmid, Manufacturing Processes for Engineering Materials (5th Edition), 2003.
2. Pandey P.C., Shan H.S, "Modern Machining Processes", Tata McGraw Hill Education Private Limited, 2013.
3. Patel Mayank, Shrivastava Bhasker "Introduction to friction stir welding", Lambert academic publishing, 2013.
4. Marc J. Madou, "Fundamentals of Microfabrication and Nanotechnology", Third Edition, CRC Press, 2011.
5. Larry Jeffus, "Welding: Principles and Applications" Seventh Edition, Delmar Cengage learning, 2012.

14ME1001 GEOMETRIC DRAWING

Credits: 0:0:2 **(Version 1.1)**

Course Objectives:
To impart knowledge on

- theory of projection for improving visualization.
- dimensioning, conventions and standards related to working drawings.
- drawing and modifying lines , arcs and other geometric elements in AutoCAD and dimensioning them.
- orthographic and isometric views and Use layers and hatching.

Course Outcomes:
Ability to

- demonstrate theory of projection to graphically represent engineering components and buildings.
- apply CAD tools to draw, edit and modify drawings.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

References:

1. Basant Agrawal, C.M. Agrawal, "Engineering Drawing", Tata McGraw Hill Private Ltd., 2010.
2. Shyam Tickoo, "AUTOCAD 2012", Pearson Publications, 2012.
3. Bhatt N.D., "Elementary Engineering Drawing", 26th Edition. Chartor Publishing House, Anand, 2009.
4. Venugopal K. "Engineering Graphics", 9th Edition. (Revised), New Age International Publishers, 2009.
5. Natarajan K.V. "A Text Book of Engineering Drawing", 16th Edition, 2006.
6. Shyam Tickoo, "AUTOCAD 2007 for Engineers and Designers" DreamTech India (P) Ltd., 2007.

14ME1002 WORKSHOP PRACTICE

Credits: 0:0:2 **(Version 1.1)**

Course Objectives:

To impart knowledge on

- characterization of electronic devices and soldering techniques.
- wiring of tube lights and lights used in stair case.
- assembly and trouble shooting of PC.
- fitting, carpentry and plumbing work.

Course Outcomes:

Ability to

- demonstrate skills to carry out fitting, piping and carpentry work.
- develop simple electronic and electrical circuits.
- demonstrate skills to assemble computer hardware components.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

References:

1. S. Suyambazhahan, "Engineering Practices", PHI, Second Edition, 2012.
2. S. Bawa, "Engineering workshop Practice", Tata McGraw Hill, 2013.
3. Prof. Vee Ess, "Workshop Manual", V S Publications, Bangalore, 2013.

14ME1003 BASIC MECHANICAL ENGINEERING

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To impart knowledge on IC Engines, external combustion engines, boilers, power plants, metal forming, metal joining, machining process and materials.

Course Outcomes:

Ability to

- demonstrate the working principle of Engines, Boilers and Power plants.
- analyze stress and strain for ductile materials.
- select appropriate metal processing methods.

External combustion engine - Working of Steam Engine - Steam Turbine Boilers, petrol and Diesel Engine. Conventional, non-conventional power plants. Load - Types, stress and strain -Stress strain curve of ductile and brittle materials. Metal Casting and Forming Process - various steps in moulding process - patterns - melting of cast iron - cupola furnace - principles of forging, extrusion and Rolling. Arc welding, gas welding. Metal Machining**:** Working Principles and specifications of Lathe, drilling and milling machine. Properties of materials - ferrous metals and alloys - Nonferrous metals and alloys, Introduction to composites.

References:

1. K. Venugopal, V. Prabhuraja, "Basic Mechanical Engineering", Anuradha Agencies, 2013.
2. S.R.J. Shantha Kumar, "Basic Mechanical Engineering", HiTech Publications, 2001.

3. I.E. Paul Degarmo, J.T. Black, Ronald A. Kosher, “Material and Processes in Manufacturing”, 8th Edition, John Wiley and Sons, Inc., 1999.
4. S S Rattan , “Strength of materials”, Tata McGraw-Hill, 2008.
5. G. Shunmagam, “Basic Mechanical Engineering”, Tata McGraw Hill, 2001.

14ME2001 ENGINEERING MECHANICS

Credits: 3:0:0 **(Version 1.1)**

Course Objectives:
To impart knowledge on
- forces acting on particle and rigid bodies.
- free body diagrams for solving problems with structural members.
- geometrical properties of surfaces and solids.
- concepts of kinematics, kinetics of particle and rigid bodies.

Course Outcomes:
Ability to
- classify system of forces and resolve the components of force system in space.
- determine centroid and moment of inertia of solids and recognize their application in mechanics.
- analyze the motion of connected bodies and apply D-Alembert’s principle.

Statics of particle: Concurrent forces in space - Components of force in space, Equilibrium of a Particle in space - Application of statics of particle. Equilibrium of rigid bodies - Free body diagram. Moment of a force about a point - Varignon’s theorem - Moment of a couple - Resolution of a given force in to force and couple system. Applications of statics of rigid bodies. Properties of surfaces and solids - CG, Centroid and Moment of inertia Dynamics of particle: Kinematics, mass moment of inertia of simple solids Kinetics: Newton’s second law of motion - D-Alembert’s principle - Motion on connected bodies, Work - Energy method Motion of connected bodies - Impulse and momentum Equation. Dynamic Equilibrium, Impact of elastic bodies: Types of impact - Method of analysis.

References:
1. Beer F.P. and Johnston Jr. E.R. “Vectors Mechanics of Engineers”, Vol. 1 Statics and Vol. 2 Dynamics, McGraw-Hill International Edition, 2012.
2. Hibbeler R.C., ”Engineering Mechanics”, Vol. 1 Statics, Vol. 2 Dynamics, Prentice Hall, 2009.
3. Irving H. Shames, “Engineering Mechanics - Statics and Dynamics”, 4th Edition, Pearson Education Asia Pvt. Ltd., 2006.
4. Rajasekaran S, Sankarasubramanian, G., “Fundamentals of Engineering Mechanics”, Vikas Publishing House Pvt. Ltd., 2007.
5. Palanichamy M.S., Nagan S., “Engineering Mechanics - Statics and Dynamics”, Tata McGraw-Hill, 2002.

14ME2002 METALLURGY LABORATORY

Credits: 0:0:1 **(Version 1.1)**

Course Objective:
- To impart knowledge on metallographic techniques for studying the microstructures of alloys.

Course Outcomes:
Ability to
- demonstrate the working principle of optical microscope and prepare specimens for testing.
- identify the microstructures of different types of steels, aluminum and copper.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2003 MATERIAL SCIENCE AND ENGINEERING

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To impart knowledge on materials science, the structure of alloys, crystal defects, mechanical properties, phase diagrams, and heat treatments with their effects on properties.

Course Outcomes:

- identify crystal structures of common engineering materials and defects.
- analyze failures and predict service behavior of materials for various applications.
- determine the right compositions of metals, heat treatment procedures.

Structure of solid metals, polymorphism - Miller indices. Metallographic analysis - Optical microscope, SEM, TEM. Defects in crystals- diffusion - Fick's, Laws of diffusion - plastic deformation- slip and twinning - recovery re-crystallization and grain growth.- strengthening mechanisms-Fracture - ductile and brittle fracture - Griffith's theory of crack propagation - Creep - Fatigue failure, Solid solution, Phases - phase diagrams - Gibbs phase rule - cooling curves, types of Equilibrium diagrams, lever rule - Iron - Iron Carbide equilibrium diagram - heat treatment of steel. Properties and applications: Non-ferrous alloys, polymers and ceramics. Mechanical Testing.

References:

1. Raghavan. V, "Material Science and Engineering, Prentice Hall of India Pvt. Ltd, New Delhi, 2004.
2. Williams D. Callister, "Material Science and Engineering" John Wiley & Sons Inc. 2013.
3. Reza Abbaschian, Lara Abbaschian, Robert E. Reed-Hill, "Physical Metallurgy Principles", Cengage Learning, 2010.
4. Raymond A Higgins "Engineering Materials (Applied Physical Metallurgy) English Language Book Society, 2003.
5. Sidney Avner, "Introduction to Physical Metallurgy", Tata McGraw Hill, 1997.

14ME2004 MANUFACTURING PROCESSES

Credits: 3:0:0 **(Version 1.1)**

Course Objectives:

To impart knowledge on

- principle, procedure and applications of casting and welding processes.
- principle, procedure and applications of bulk metal forming, sheet metal forming and powder metallurgy process.

Course Outcomes:

Ability to

- demonstrate the principles associated with basic operations involving casting, bulk forming of materials.
- demonstrate the principles associated with basic operations welding, sheet metal and powder metallurgy of engineering materials.
- recommend the most appropriate manufacturing process and material.

Casting Processes and Machines: Types, Moulding Tools, Casting defects, Special casting processes. Bulk Forming Processes and Machines: Rolling, Forging - Extrusion, Drawing - Defects - Force calculations, Processing of Plastics. Sheet Forming Processes: Types, Clearance and shear on punch and die, Types of sheet metal dies. Welding Processes: Types, consumables, Weld defects and remedies. Powder Metallurgy: Production of metal powder - characteristics - equipment, shaping processes, Secondary and finishing processes.

References:

1. P.N. Rao, "Manufacturing Technology Foundry, Forming and Welding", Tata McGraw Hill, 4th Edition, 2013.
2. Kalpakjian S., "Manufacturing Engineering and Technology", Pearson Education India Edition, 2006.
3. Roy. A. Lindberg, "Processes and Materials of Manufacture", Pearson Education, 2006.
4. Nagpal G.R. "Metal forming processes", Khanna Publishers, New Delhi, 2004.
5. Heine, Richard, Carl R. Loper and Philip Rosenthal, "Principles of Metal Casting", Tata McGraw Hill Publishing Ltd., 2000.
6. George E Dieter., "Mechanical Metallurgy", Tata McGraw Hill; 3rd Edition, 2013.

14ME2005 MACHINING PROCESSES

Credits: 3:0:0 **(Version 1.1)**

Course Objectives:

To impart knowledge on

- concept and basic mechanics of metal cutting.
- working of machine tools such as lathe, shaping, milling, drilling, grinding and broaching.
- methods of gear manufacturing and to know the working concepts of Non-conventional machining processes.

Course Outcomes:

Ability to

- determine cutting force and machining parameters through metal cutting mechanics.
- recognize metal cutting operations done through traditional and nontraditional manufacturing processes.
- identify cutting tools for different manufacturing processes.

Chip Types, formation Mechanism, orthogonal cutting - Merchant and Lee and Shaffer theory -cutting force - Temperature in metal cutting - Tool life and tool wear - cutting tool materials - cutting fluids. Lathe: Construction, Types, Operations, special attachments, machining time and power estimation-capstan and turret lathes. Reciprocating machine tools: shaper, planer, slotter. Milling: Types, cutters, operations, indexing. Drilling, reaming, boring, tapping, machining time calculations - Broaching machines. Grinding: wheel designation and selection, types of machines, types of finishing Processes. Gear cutting methods. Non-conventional machining.

References

1. Rao P.N., "Manufacturing Technology", Metal Cutting and Machine Tools, Tata McGraw Hill, New Delhi, 3rd Edition, 2013.
2. Kalpakjian, S., "Manufacturing Engineering and Technology", Pearson Education India Edition, 2006.
3. HMT - Production Technology, Tata McGraw Hill, 2008.

4. S.K. Hajra Choudhray, S.K. Bose, “Elements of Workshop Technology, Vol. II, Machine Tools”, Media promoters & Publishers (P) Ltd, 13th Edition, 2010.
5. Gary F Benedict, “Nontraditional Manufacturing Processes”, Marcel Dekker Inc, 2005.

14ME2006 METROLOGY AND MEASUREMENT SYSTEMS

Credits: 3:0:0 **(Version 1.1)**

Course Objectives:

To impart knowledge on

- concept of measurements.
- various measurement systems.

Course Outcomes:

Ability to

- recognize the need of measurement standards and apply.
- identify appropriate measurement methods and instruments to measure product dimensions, shape and surface structure.
- demonstrate handling of measuring instruments to compare the quality of products with reference standards.

Definition - Standards of measurement - Errors in measurement - Accuracy, precision, sensitivity and readability. Length standard - Line and end standard - Slip gauges, micrometers, verniers, dial gauges comparators: various types - principle and applications, angular measuring instruments - bevel protractor, levels, sine bar and sine center, Straightness, flatness, surface texture, run out - various measuring instruments, Tool maker’s microscope. Measurement of threads - errors. Coordinate measuring machine, Interferometry - applications.

References:

1. R.K. Jain, "Engineering Metrology", Khanna Publishers, 2009.
2. I.C. Gupta, "A Text Book of Engineering Metrology", 7th Edition, Dhanpat Rai and Sons, 2012.
3. Ammar Grous, “Applied Metrology for Manufacturing Engineers”, Wiley, 2011.
4. Thomas G. Beckwith, Roy D. Marangoni and John H. Lienhard V, “Mechanical Measurements”, 6th Edition, 2006.
5. Manohar Mahajan, “A Text Book of Metrology”, Dhanpat Rai & Co., 2006.

14ME2007 FLUID POWER CONTROL ENGINEERING

Credits: 3:0:0 **(Version 1.1)**

Course Objectives:

To impart the knowledge on

- components of pneumatic and hydraulic circuits.
- Design and selection of components for an industrial application.

Course Outcomes:

- apply boolean algebra for logic design of FPC circuits with standard symbols.
- demonstrate working principles and constructional details of Fluid Power Control System components and drives.
- design and develop low cost automation circuits for industrial problems.

Introduction, application and design of pneumatic, hydraulic, electro pneumatic, electro hydraulic systems - Circuit and graphic symbols - Actuators - valves Cylinders - Energy transfer and preparation - Measuring instruments- Equipment combinations - Electrical circuit symbols - Electro-hydraulic control - Hydraulic circuit diagram - Electrical circuit diagram - Function diagram - Procedure for the construction of an electro-hydraulic system - Actuation of a single-acting cylinder - Direct solenoid valve actuation - Indirect solenoid valve actuation - Boolean basic logic functions - Actuation of a double-acting cylinder - Hydraulic Drives - Constant and Variable delivery types, gears, vane and piston pumps - linear motor cylinder and piston drives - Hydraulic and pneumatic Circuits - Reciprocation - quick return - sequencing - synchronizing - clamping and accumulator circuits - press circuits - fluidic elements - Fluidic sensors

References:

1. R. Srinivasan, "Hydraulic and Pneumatic Controls" 2nd Edition, Tata McGraw Hill, 2008.
2. Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2008.
3. Steward H.L. "Hydraulic and Pneumatic Power for Production, Industrial Press", New York, 1997.
4. D. Merkle, K. Rupp, "Electro Hydraulics", FESTO Didactic KG, D-73734 Esslingen, 1994.
5. Ramakrishnan M. "Industrial Automation", Swathi Publications, 1999.

14ME2008 FOUNDRY, SMITHY, WELDING AND SHEET METAL LABORATORY

Credits: 0:0:2 **(Version 1.1)**

Course Objectives:
To impart knowledge on
- principles and procedures of casting, welding, forming processes.
- handling tools and equipment for casting, welding and forming processes.

Course Outcome:
- Demonstrate process plans for components made of casting, welding and sheet metal processes.
- Select tools and equipment for casting, welding and sheet metal parts and produce.

LIST OF EXPERIMENTS

The faculty member conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2009 METROLOGY LABORATORY

Credits: 0:0:1 **(Version 1.1)**

Course Objectives:
To impart knowledge on
- working principles of linear and angular measuring instruments.
- measurement of linear and angular dimensions of a typical work piece specimen using the measuring instruments.
- methods of form measurements.

Course outcomes:
Ability to
- measure product dimensions, shape and surface structure using appropriate measurement methods and instruments.

- demonstrate measurement of linear and angular dimensions of a work-piece.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2010 FLUID POWER CONTROL AND MECHATRONICS LABORATORY

Credits: 0:0:2 **(Version 1.1)**

Course Objectives:

To impart knowledge on

- fluid power and Mechatronics systems and primary actuating systems.
- programming skills in Programmable logic controllers.
- pneumatics and hydraulics systems.

Course Outcomes:

Ability to

- apply boolean algebra for logic design of FP circuits using standard symbols.
- design and develop low cost automation circuits for industrial problems.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2011 CAM LABORATORY

Credits: 0:0:1 **(Version 1.1)**

Prerequisite: Lathe Shop [14ME2012], Special Machines Laboratory [14ME2013] [OR] 16ME2008 Machining Practice

Course Objectives:

To impart knowledge on

- NC programming for CNC turning and milling operation and execution.
- selection of tool for a machining operation.
- simulation and verifying machining processes.

Course Outcomes:

- demonstrate the working principles of CNC machine.
- produce components from CNC programs using G codes and M codes.

LIST OF EXPERIMENTS

The faculty member conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2012 LATHE SHOP

Credits: 0:0:1 **(Version 1.1)**

Course Objective:

- To impart knowledge on various operations on Lathe.

Course Outcomes:

- Demonstrate skills to machine components in lathe.
- Select appropriate cutting tools.

LIST OF EXPERIMENTS

The faculty member conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2013 SPECIAL MACHINES LABORATORY

Credits: 0:0:1 **(Version 1.1)**

Prerequisite: Lathe Shop [14ME2012]

Course Objectives:

To impart knowledge on

- basic knowledge about metal cutting operation and execute it.
- selection of tools for machining operations.

Course Outcome:

- Demonstrate skills to machine components using special machines.
- Select appropriate cutting tools.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2014 ENGINEERING THERMODYNAMICS

(Use of standard thermodynamic tables, Mollier diagram, Psychrometric chart are permitted)

Credits: 3:0:0 **(Version 1.1)**

Course Objectives:

To impart knowledge on

- basic concepts of engineering thermodynamics.
- first and second law of thermodynamics, properties of pure substances, gas mixtures and psychrometry.

Course Outcomes:

Ability to

- apply the concept of entropy to design thermal systems.
- determine steam quality using steam tables and Mollier chart and properties of Gas mixtures.
- analyze psychrometric processes.

Microscopic and macroscopic approach, modes of work, zeroth law of thermodynamics - First law of thermodynamics - application to closed and open systems. Kelvin's and Clausius statements of second law, reversibility and irreversibility, Carnot cycle, concept of entropy, availability. Thermodynamic properties of pure substances in solid liquid and vapour phases. Properties of ideal and real gases, Vander

Wall's equation of states compressibility. Sensible and Latent heat exchange processes. Adiabatic mixing, evaporative cooling.

References:

1. Nag P.K., "Engineering Thermodynamics", 5th Edition, Tata McGraw Hill, New Delhi, 2013.
2. Yunus Cengel, "Thermodynamics", 7th Edition, Tata McGraw Hill, 2011.
3. Holman J.P., "Thermodynamics", 4th Edition, McGraw Hill, 2002.
4. Roy Choudhury T., "Basic Engineering Thermodynamics", Tata McGraw Hill, 2000.
5. Vanwylen and Sontag,, "Fundamentals of Classical Thermodynamics", Wiley Eastern, 2005.

14ME2015 THERMAL ENGINEERING I

Credits: 3:0:0 **(Version 1.1)**

Prerequisite: Engineering Thermodynamics [14ME2014]

Course Objectives

To impart knowledge on

- steam generators, nozzle, turbine.
- air compressors, refrigeration systems.

Course Outcomes:

Ability to

- analyze the performance of a steam generator and steam nozzles
- determine the efficiency of the impulse and reaction turbine using velocity triangles
- evaluate the efficiency of a reciprocating compressor and demonstrate the working principle of refrigeration systems

Steam generators - classification - boiler terms - evaporative capacity - equivalent evaporation - factor of evaporation - efficiency - heat losses - heat balance. Steam nozzle - flow through nozzles - general relation for adiabatic flow - effect of friction - critical pressure ratio - super saturated flow. Steam turbines- types and compounding - velocity diagrams for simple and multistage turbines. Air compressor - work of compression with and without clearance -efficiencies, multistage compressor - intercooling - work of multistage compressor. Refrigeration cycles.

References:

1. Kothandaraman C.P, Domkundwar S., "Thermal Engineering", Dhanpat Rai & Sons, 2nd Edition, 2003.
2. Rajput R.K., "Thermal Engineering", Laxmi Publications (P) Ltd., 2009.
3. Rudramoorthy R., "Thermal Engineering", Tata McGraw Hill, New Delhi, 2010.
4. Nag P.K., "Engineering Thermodynamics", 3rd Edition, Tata McGraw Hill, New Delhi, 2005.
5. Mahesh M. Rathore, "Thermal Engineering", Tata McGraw Hill, New Delhi, 2010.
6. Cengel Y.A., Boles, M. A., "Thermodynamics, an Engineering Approach", Tata McGraw Hill, 2003.
7. Arora C.P., "Refrigeration and Air conditioning", Tata McGraw Hill, 2nd Edition, 2002.

14ME2016 THERMAL ENGINEERING II
(Use of standard thermodynamic tables, Mollier diagram, Psychometric chart and Refrigerant, property tables are permitted.)

Credits: 3:0:0 **(Version 1.1)**

Prerequisite: Engineering Thermodynamics [14ME2014]

Course Objectives:

To impart knowledge on

- testing and performance of IC Engines.
- various Gas Power cycles.

Course Outcomes:

Ability to

- evaluate the performance of an internal combustion engine and various gas power cycles.
- analyze gas turbines cycles and compare the operational aspects of jet engines.
- determine cooling loads in air-conditioning systems.

Internal combustion engines: Classification, components and functions. valve, port timing diagram, testing and performance. Lubrication and cooling system. Gas Power cycles - calculation of mean effective pressure and air standard efficiency. Air-conditioning: cycles, equipment, cooling load estimation. Gas dynamics: Isentropic flow - Mach number variation, Impulse function, mass flow rate, flow through nozzles and diffusers. Fanno flow equation and Rayleigh flow equation. Gas Turbines & Propulsion: Classification, Jet Propulsion, Rocket Propulsion

References:

1. Kothandaraman C.P., Domkundwar S., "Thermal Engineering", Dhanpat Rai & Sons, 2nd Edition, 2003.
2. Rajput R.K., "Thermal Engineering", Laxmi Publications (P) Ltd., 2010.
3. Rudramoorthy R., "Thermal Engineering", Tata McGraw Hill, 2010.
4. S.M. Yahya, "Fundamentals of Compressible Fluid Flow", New Age international Publishers, 2005.
5. Arora C.P., "Refrigeration and Air conditioning", Tata McGraw Hill, 2nd Edition, 2002.

14ME2018 POWER PLANT ENGINEERING

Credits: 3:0:0 **(Version 1.1)**

Course Objective

- To impart knowledge on various power generating systems.

Course Outcomes:

Ability to

- demonstrate the working principles of conventional and unconventional power plants.
- predict the fixed and operating costs of power plants.
- identify and solve environmental hazards of various power plants.

Vapour Power Cycles. Steam power plant - high pressure boilers - combustion systems - Boiler accessories - water treatment - condenser - cooling tower - Nuclear power plant - types of reactors - radiation shielding - waste disposal - Gas turbine power plant - open and closed cycle - Diesel engine power plant - selection of engine type - Hydroelectric power plant - storage and pumped storage type - selection of water turbines - environmental hazards of various power plants. Non-conventional power plant. Power plant economics - load curve - fixed and operating costs - comparison of economics of various power plants - energy audit.

References:

1. Arora and Domkundwar, "Power Plant Engineering", Dhanpat Rai & Sons, 2005.
2. R.K. Rajput, "Power Plant Engineering", Laxmi Publications (P) Ltd, New Delhi, 2002.
3. Roy Eckart and Joel Weisman., "Modern Power Plant Engineering", PHI, 1999.
4. Wakil M.M.El., "Nuclear Heat Transport, International text Book Company", London, 1990.
5. Wakil, M.M.E.l, "Power Plant Technology", McGraw Hill, 2000.
6. P.K. Nag, "Power Plant Engineering", Tata McGraw Hill, New Delhi, 2002.

14ME2019 HEAT AND MASS TRANSFER

(Use of standard Heat and Mass Transfer data book is permitted.)

Credits: 3:1:0 **(Version 1.1)**

Prerequisite: Engineering Thermodynamics [14ME2014]

Course Objectives:

To impart knowledge on

- conduction, convection and radiation heat transfer.
- design of heat exchangers.
- basic principles of mass transfer.

Course Outcomes:

Ability to

- solve heat transfer problems by applying the principles of heat conduction, convection, radiation and mass diffusion.
- design heat exchanger systems for enhanced heat transfer performance.
- analyze and predict the flow patterns in two phase flow and heat transfer.

Conduction equation in Cartesian, Cylindrical and Spherical coordinates. One dimensional steady state heat conduction in plane wall and composite wall. Heat generation in plane wall, cylinder and sphere. Conduction in two dimensions, shape factor, numerical method of analysis. lumped heat capacity systems, significance of Biot and Fourier numbers. Concept of hydro dynamics and thermal boundary layers. Forced convective heat transfer over a flat plate, flow through pipes, Free Convection - heat transfer from vertical and horizontal surfaces. Types of heat exchangers, overall heat transfer coefficients, LMTD and NTU methods, fouling factor and effectiveness. Fick's law of diffusion, equi-molal counter diffusion, Convective mass transfer coefficient, black body concepts, gray body, radiation shape factor, radiation heat transfer between two surfaces and radiation Shields.

References:

1. Holman J.P., "Heat Transfer", SI Metric 10th Edition., Mc Graw Hill, ISE, 2010.
2. Sachdeva, "Heat and Mass Transfer", Wiley Eastern, 2nd Edition, 2005.
3. Frank P. Incropera, David P. DeWitt, "Heat and Mass Transfer", John Wiley, 5th Edition 2005.
4. Yunus A. Cengal, "Heat Transfer", Tata McGraw Hill, 2nd Edition 2003.
5. P.S. Ghoshdastidar, "Heat Transfer", Oxford University Press, 2005.

14ME2020 THERMAL ENGINEERING LABORATORY

Credits: 0:0:1 **(Version 1.1)**

Co/Prerequisite: Thermal Engineering I [14ME2015]

Course Objective:

- To impart knowledge on working principles of various thermal equipments like air blower, reciprocating compressors, Refrigeration & Air Conditioning Systems, Boilers.

Course Outcomes:

- apply thermal engineering concepts to find solutions in thermal systems.
- determine the performance of different thermal equipment like air blower, reciprocating compressors, refrigeration & air conditioning systems, Boilers.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2022 HEAT TRANSFER LABORATORY

(Use of standard Heat and Mass Transfer data book is permitted.)

Credits: 0:0:1 **(Version 1.1)**

Prerequisite: Heat and Mass Transfer [14ME2019]

Course Objective:

- To impart knowledge on conducting the heat transfer experiments and practically learns how to find heat transfer coefficients, thermal Conductivity, emissivity and effectiveness.

Course Outcomes:

- demonstrate heat conduction, convection and radiation through experiments.
- analyze the performance of various types of heat exchangers and perform boiling and condensation experiments.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2023 INTERNAL COMBUSTION ENGINES LABORATORY

Credits: 0:0:1 **(Version 1.1)**

Co/Prerequisite: Thermal Engineering II [14ME2016]

Course Objective:

- To impart knowledge on the performance of different IC engines like air cooled, water cooled, low speed, single and twin cylinder engines.

Course Outcomes:

- demonstrate engine performance tests.
- estimate emission contents in the exhaust gases through emission test.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2025 COMPUTER AIDED DESIGN AND MANUFACTURING

Credits: 3:0:0 **(Version 1.1)**

Course Objectives:

To impart knowledge on

- the application of computer in the design and manufacturing.
- graphical elements used in CAD/CAM.
- computer numerical programming.

Course Outcomes:

Ability to

- develop algorithms for display of graphic entities.
- apply principles of geometric modeling for 2D and 3D modeling.
- prepare part programs for machining of components in CNC machines.

Introduction to CAD - Design Process - Product cycle - Sequential and concurrent engineering - Representation of curves - Bezier curves - Cubic spline curve - B-Spline curves - Rational curves - Surface Modeling techniques - surface patch - Coons patch - bi-cubic patch - Bezier and B-spline surfaces - CNC machine tools, Principle of operation of CNC, Constructional features, Work holding features, Tool holding features, Feedback system, machine control system, 2D and 3D machining on CNC. Numerical control codes-Standards - Manual Programming - Canned cycles and subroutines - Computer Assisted Programming, CAD/CAM approach to NC part programming - APT language, machining from 3D models.

References:

1. Ibrahim Zeid, "CAD-CAM Theory and Practice", Tata McGraw Hill, 2010.
2. Kunwoo Lee, “Principles of CAD/CAM/CAE Systems”, Addison Wesley, 2005.
3. Sadhu Singh, "Computer Aided Design and Manufacturing", Khanna Publishers, New Delhi, 2003.
4. P. Radhakrishnan and C.P. Kothandaraman, "Computer Graphics and Design", Dhanpat Rai and Sons, New Delhi, 2003.
5. Groover and Zimmers, "CAD/CAM: Computer Aided Design and Manufacturing” Prentice Hall of India, New Delhi, 2002.
6. Lalit Narayan.K, Mallikarjuna Rao, Sarcar. M.M.M, “Computer Aided Design and Manufacturing”, Prentice Hall of India, 2008.

14ME2026 MECHANICS OF MACHINES

Credits: 3:1:0 **(Version 1.1)**

Prerequisite: Engineering Mechanics [14ME2001]

Course Objectives:

To impart knowledge on

- linkages, mechanisms and cams.
- principles involved in the displacement, velocity and acceleration at any point in a link of a mechanism.
- concepts of toothed gearing and kinematics of gear trains.
- the effects of friction in motion transmission and in machine components.

Course Outcomes:

- determine mobility, position, velocity and acceleration of links in mechanism.

- design cam motion profiles, for different types of follower mechanisms.
- analyze gear trains and design transmission devices considering friction.

Basics of Mechanisms - Basic kinematic concepts and definitions - Description of some common mechanisms - Design of quick return crank-rocker mechanisms Kinematics of Linkage Mechanisms - Displacement, velocity and acceleration analysis of simple mechanisms - Coincident points - Coriolis component of Acceleration. Kinematics of Cam Mechanisms - Layout of plate cam profiles - Specified contour cams - Pressure angle and undercutting - sizing of cams. Gears and Gear Trains- Law of toothed gearing - tooth profiles - Non-standard gear teeth -Gear trains - Epicyclic Gear Trains - Differentials - Automobile gear box. Friction - Basics of friction- Sliding and Rolling friction - Friction drives - Friction in screw threads -Bearings and lubrication - Friction clutches - Belt and rope drives.

References:

1. Ambekar A.G., "Mechanism and Machine Theory", Prentice Hall of India, New Delhi, 2007.
2. Shigley J.E., Pennock, G.R., Uicker J.J., "Theory of Machines and Mechanisms", 4th Edition, Oxford University Press, 2011.
3. Rattan.S.S, "Theory of Machines", 4th Edition, Tata McGraw Hill, 2014.
4. Thomas Bevan, "Theory of Machines", CBS Publication, 2001.
5. Ghosh A. and Mallick A.K., "Theory of Mechanisms and Machines", 3rd Edition, Affiliated East-West Press Pvt. Ltd., New Delhi, 2006.
6. Khurmi R.S. "Theory of Machines" Khanna Publishers, 2006.

14ME2027 DYNAMICS OF MACHINERY

Credits: 3:1:0 **(Version 1.1)**

Prerequisite: Mechanics of Machines [14ME2026]

Course Objectives:

To impart knowledge on

- analysis of forces acting in mechanisms.
- effects of unbalance forces
- modeling and analyzing the vibration behavior of spring mass damper system
- the principles in mechanisms used for governing of machines.

Course Outcome:

- analyze the effect of static and dynamics forces on linkages
- analyze the dynamics of rotary and reciprocating masses in engines and subsystems - flywheels, governors and gyroscopes.
- determine vibration parameters of SDOF systems and study their effects

Force analysis - Static force analysis of simple mechanisms - Dynamic force analysis - Dynamic Analysis in reciprocating engines. Flywheel - Turning moment diagrams of reciprocating engines - fluctuation of energy - coefficient of fluctuation of energy and speed. Balancing - Static and dynamic balancing - partial balancing of reciprocating masses of in-line, V and radial engines. Free vibration - Undamped free vibration of single degree freedom systems. Damped Vibration - Types of Damping - Damped free vibration. Forced vibration of single degree freedom systems - Vibrating isolation and Transmissibility. Transverse vibration - Dunkerley's method - Whirling of shafts - Critical speed. Torsional vibration - Two rotor, three rotor and multi rotor systems. Mechanism for Control: Governors - Types - Characteristics - Effect of friction - Other Governor mechanisms. Gyroscopes - Gyroscopic effects in Automobiles, ships and airplanes.

References:

1. Ambekar A.G., "Mechanism and Machine Theory", Prentice Hall of India, New Delhi, 2007.
2. Shigley J.E., Pennock, G.R., Uicker J.J., "Theory of Machines and Mechanisms", 4th Edition, Oxford University Press, 2011.
3. Thomas Bevan, "Theory of Machines", CBS Publishers, 2001.
4. Ghosh A. and Mallick A.K., "Theory of Mechanisms and Machines", 3rd Edition, Affiliated East-West Press Pvt. Ltd., New Delhi, 2006.
5. Khurmi R.S. "Theory of Machines" Khanna Publishers, Delhi, 2006.
6. Rattan S.S, "Theory of Machines", 4th Edition, Tata McGraw Hill, 2014.

14ME2028 DESIGN OF TRANSMISSION SYSTEMS
(Use of Design Data Book is permitted)

Credits: 3:0:0 **(Version 1.1)**
Prerequisite: Design of Machine Elements [14ME2029]

Course Objectives:
To impart knowledge on

- concepts, procedures and the data, to design and analyse machine elements in power transmission systems.
- specification and selection of mechanical components for transmission systems.

Course Outcomes:
Ability to

- apply basic engineering principles and procedures to design the transmission elements.
- select appropriate engineering design data from standard data books for the design of mechanical transmission components.
- design the transmission systems components for given conditions using Design data hand book.

Design of Journal bearings - Sliding contact and rolling contact. Design of belts - Flat and V Belt, Design and selection of Chains, ropes drives. Design of gears - Spur, Helical, Herringbone, bevel, worm, skew gears. Design of gearbox and speed reducers. Design of Ratchet & pawl mechanism, Geneva mechanism. Design of cams - Contact stress and Torque calculation, Power screws. Design of plate clutches-axial and cone - Design of Internal and External Shoe brakes.

References:

1. Sundarajamoorthy T.V. and Shanmugam, "Machine Design", Khanna Publishers, 2003.
2. Sen G. C. and Bhattacharyya A, "Principles of Machine Tools", New Central Book Agency (P) Ltd., 2006.
3. Md.Jallaudeen, "A Text book of Machine Design", Anuradha Publications, 2006.
4. Bernard J. Hamrock, "Fundamentals of Machine Elements", 3rd Edition McGraw-Hill Companies, May 2004.
5. Hall A.S. Holowenko A.R. and Laughlin H.G., "Theory and Problems in Machine Design", Schaum Series, 2000.
6. Hall and Allen, "Machine Design", Schaum Series, 1st Edition, 2001.

Hand Book

1. Design Data - Data Book for Engineers, PSG College of Technology, Coimbatore, Kalaikathir Achchagam, 2012.

14ME2029 DESIGN OF MACHINE ELEMENTS
(Use of approved data books is permitted)

Credits: 3:1:0 **(Version 1.1)**

Course Objectives:
To impart knowledge on
- applying elementary design principles and basic design procedures for design of machine elements.
- handling and interpreting design data for the design of mechanical elements.

Course Outcome:
Ability to
- analyze stresses acting on components and determine the size based on theories of failure.
- design machine components for a given load condition using design data hand books.
- follow standards as per design data hand books and select standard components to improve interchangeability.

Design process - factors influencing the machine design, selection of materials based on its properties. Direct and combined stress equations, impact and shock loading. Criteria of failure, stress concentration factor, size factor, surface finish factor - factor of safety, design stress, theories of failures. Variable and cyclic loads - fatigue strength and fatigue limit - S-N- curve, combined cyclic stress, Soderberg and Goodman equations. Design of springs, Design and drawing of shafts, keys, couplings, riveted joints, pressure vessels and structures, screw joints, cotter joints knuckle joints and pipe joints. Design and drawing of engine components- piston, connecting rod, crankshaft, and flywheel

References:

1. Joseph Edward Shighley, "Mechanical Engineering Design", McGraw Hill, 2007.
2. S. Md. Jalaludeen, "Machine Design", Anuradha Publications, Chennai 2011.
3. Sundarrajamoorthy T.V. and Shanmugam, "Machine Design", Khanna Publishers, 2003.
4. Bernard Hamrock, "Fundamentals of Machine Elements", McGraw Hill, 2007.
5. Dobrovolsky.V, "Machine Elements", MIR Publications, 2000.
6. Hall and Allen, "Machine Design", Schaum Series, 2001.

14ME2031 COMPUTER AIDED DESIGN AND ENGINEERING LABORATORY

Credits: 0:0:2 **(Version 1.1)**

Course Objectives:
To impart knowledge on
- the application and use of the analysis software.
- constructing models, selecting appropriate elements and meshing them.
- solving structural, thermal and fluid problems.

Course Outcomes:
Ability to
- model 3D mechanical components such as knuckle joint, Plummer block using appropriate modelling/assembling commands.
- identify the domain of the problem and select element, boundary condition, solvers for 2D structural and thermal problems.

LIST OF EXPERIMENTS

The faculty member conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2032 MACHINE DRAWING

Credits: 0:0:2 **(Version 1.1)**

Course Objectives:

To impart knowledge on

- representing engineering components with the help of professional drawings.
- Orthographic views and cross sections of machine parts.
- Combine parts to develop assembly drawings.

Course Outcomes:

Ability to

- prepare part drawings according to drafting standards and specify appropriate tolerances for machine design applications.
- develop sectional views of machine components and construct assembly drawings.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

References:

1. Gopalakrishnan, "Machine Drawing", Subash Publishers, 2000.
2. Bhatt N.D., "Machine Drawing", Charotar Publishing House, Anand, 2003.
3. Siddheswar, N. P.Kanniah, and V.V.S. Satry, "Machine Drawing", Tata McGraw Hill, 2005.
4. Revised IS codes; 10711, 10713, 10714, 9609, 1165, 10712, 10715, 10716, 10717, 11663, 11668, 10968, 11669, 8043, 8000.
5. Ajeet Singh, "Machine Drawing", Tata McGraw Hill Edition, 2008.

14ME2036 MECHANICAL VIBRATIONS

Credits: 3:0:0 **(Version 1.1)**

Prerequisite: Dynamics of Machinery [14ME2027]

Course Objectives:

To impart knowledge on

- modeling a vibratory system to find its response.
- analyzing the vibration behavior of mechanical systems under different types of loading.
- importance of vibration and methods of reducing unwanted vibration.

Course Outcome:

Ability to

- formulate mathematical models of problems in vibrations using Newton's second law or energy principles.
- solve for the motion and the natural frequency for free, forced vibration of un-damped motion and damped motion.
- recognize and apply vibration and Noise control strategies.

Relevance and need of vibrational analysis - Mathematical modelling of vibrating systems -Types of vibrations - single degree of freedom systems for free and forced vibration. Damped free vibration -

Forced vibration of undamped system - Dynamic vibration absorber. Free and forced vibrations of multi-degree of freedom systems in longitudinal torsional and lateral modes -Matrix methods of solution - Orthogonality principle. Vibration of continuous system like beams, strings and rods - Torsional vibration. Vibration measuring devices - vibration exciters -Vibration Tests.

References

1. Singiresu.S.Rao, "Mechanical Vibrations", 5th Edition, Pearson, 2011.
2. Benson H Tongue, "Principles of vibration", 2nd Edition, Oxford University Press, 2002.
3. Kelly, "Fundamentals of Mechanical Vibrations", McGraw Hill Publications, 2000.
4. Thomson W.T., "Theory of Vibration with Applications" CBS Publishers and Distributers, New Delhi, 2002.
5. Rao V. Dukkipati, J. Srinivas., "Vibrations: Problem Solving Companion", Narosa Publishers, 2007.

14ME2038 TRIBOLOGY IN DESIGN

Credits: 3:1:0 **(Version 1.1)**

Prerequisite: Design of Machine Elements [14ME2029],

Course Objectives:

To impart knowledge on

- the application of basic theories of friction, wear, and lubrication.
- frictional behavior of commonly encountered sliding interfaces.

Course Outcomes:

Ability to

- interpret tribological characteristics.
- classify types of wear of metals, ceramic and polymers.
- improve the performance of mechanical components using lubricants, coatings and surface modification.

Introduction, surface topography, Hertzian contact, friction - stick slip motion - measurement of friction, wear - simple theory of sliding wear mechanism of sliding wear of metals - abrasive wear - materials for adhesive and abrasive wear situations - corrosive wear - surface fatigue wear situations, hydrodynamic lubrication hydrostatic lubrication, elasto-hydrodynamic lubrication, boundary lubrication, lubricants - study of types of oils and grease used in automobiles and general mechanical industry - surface modification, latest technologies in surface modification. Mechanical dynamic tribology and testing methods - simple tribological mechanical dynamic test machines and test methods, dry sand - rubber wheel test, wet sand rubber wheel test, slurry abrasivity test, solid particle erosion test, pin-on-disk wear test, rolling wear test, drum wear test, drill wear test.

References:

1. Prasanta Sahoo, "Engineering Tribology", Prentice Hall of India, 2005.
2. Sushil Kumar Srivastava, "Tribology in Industries", S. Chand Publishers, 2005.
3. J. A. Williams, "Engineering Tribology", Cambridge University Press, 2005.
4. Mang, Kirsten Bobzin and Thorsen Bartels, "Industrial Tribology: Tribosystems, Friction, Wear and Surface Engineering, Lubrication-Theory", Wiley-VCH Verlag and Co., 2011.
5. Stachowiak and Batchelor, "Engineering Tribology" 3rd Edition, Elsevier, 2005.
6. S.K. Basu, S.N. Sengupta, B.B. Ahuja, "Fundamentals of Tribology", Prentice Hall of India, 2005.
7. I.V. Kragelsky, V. V. Alisin "Tribology: Lubrication, Friction and Wear", Wiley 2001.

LIST OF SUBJECTS

Sub. Code	Name of the Subjects	Credit
14ME3043	Instrumentation and Error Analysis	3:0:0
15ME3001	Vibration Laboratory I	0:0:1
15ME3002	Rotor Dynamics	3:0:0
15ME3003	Modal Analysis of Mechanical Systems	3:0:0
15ME3004	Nuclear Power Engineering	3:0:0
15ME3005	Solar Energy Utilization	3:0:0
15ME3006	Design of Fluid Power Systems	3:0:0
15ME3007	Advanced Tool Design	3:0:0
15ME3008	Advanced Instrumentation in Thermal Engineering	3:0:0
15ME3009	Advanced Refrigeration and Air-Conditioning Systems	3:0:0
15ME3010	Design and Analysis of Heat Exchangers	3:0:0
15ME3011	Advanced Turbo Machinery	3:0:0
15ME3012	Two Phase Flow and Heat Transfer	3:0:0

REVISED VERSION SUBJECTS			
Sub. Code	**Version**	**Name of the Subjects**	
14ME3001	1.1	Combustion in Engines	3:0:0
14ME3002	1.1	Advanced Thermodynamics	3:0:0
14ME3003	1.1	Advanced Fluid Mechanics	3:0:0
14ME3004	1.1	Design of Thermal Power Equipments	3:0:0
14ME3005	1.1	Computer Integrated Manufacturing Systems	3:0:0
14ME3006	1.1	Computer Applications in Design	3:0:0
14ME3007	1.1	Engineering Materials and Applications	3:0:0
14ME3008	1.1	Advanced Strength of Materials	3:0:0
14ME3011	1.1	Computer Aided Engineering Laboratory	0:0:2
14ME3016	1.1	Advanced Metrology	3:0:0
14ME3017	1.1	Advanced Heat Transfer Laboratory	0:0:1
14ME3018	1.1	Automation and Robotics Laboratory	0:0:2
14ME3022	1.1	Advanced Heat Transfer	3:0:0
14ME3023	1.1	Design of Mechanical System Elements	3:0:0
14ME3024	1.1	Design for Manufacturing and Assembly	3:0:0
14ME3025	1.1	Manufacturing System and Simulation	3:0:0
14ME3026	1.1	Advanced Mechanism Design	3:0:0
14ME3027	1.1	Industrial Tribology	3:0:0
14ME3028	1.1	Advanced Mechanical Vibrations	3:0:0
14ME3030	1.1	Industrial Robotics	3:0:0
14ME3033	1.1	Engineering Product Design and Development Strategies	3:0:0
14ME3034	1.1	Control of CNC Machine Tools	3:0:0
14ME3036	1.1	Biomass Energy	3:0:0
14ME3037	1.1	Quality Concepts in Design	3:0:0
14ME3039	1.1	Experimental Stress Analysis	3:0:0
14ME3040	1.1	Engineering Fracture Mechanics	3:0:0

14ME3043 INSTRUMENTATION AND ERROR ANALYSIS

Credits 3:0:0

Course Objectives

To import knowledge on

- kinds of errors and uncertainty
- types of fluid flow and flow measuring devices
- temperature measuring devices and calibration methods
- solar radiation measuring instruments and solar collectors
- data acquisition and processing systems

Course Outcome

Ability to

- describe the kinds of errors and uncertainty
- analyze the types of fluid flow
- explain the temperature measuring instruments
- choose the solar collector for a particular application
- make use of data acquisition and processing systems

Review of static and dynamic measurements, kinds of errors and uncertainty analysis, planning the experiments from error analysis, flow Measurements - pitot tubes , rotameter, orifice meter, venturimeter, magnetic flow meter, flow visualization methods, holographic flow motors, NMR flow meter, temperature measurements - thermocouples, transient response of thermal systems, calibration methods, temperature controller, gas composition analysis - gas chromatography, thermal conductivity detector, mass spectrometer, pressure measurements- manometers, pressure gauges, data acquisition and processing , analysis of experimental data, solar radiation measurements, solar collectors, pH meter, elemental analyzer, gas calorimeter.

Reference Books

1. Doebelin O.E., 'Measurement Systems and Design', McGraw Hill Co., 2001.
2. Holman J.P., 'Experimental Methods for Engineers', McGraw Hill, 2004.
3. Beckwith T.G. and Buck M.L., 'Mechanical Measurements', Addition Wesley, 2003. Rangan, C.S., Sharma G.S. and Mani V.S., 'Instrumentation Devices and Systems', Tata McGraw Hill Pub. Co., 2005.
4. Johnson C.D., 'Process Central Instrumentation Technology', John Willey & Sons Inc., 2006.

15ME3001 VIBRATION LABORATORY - I

Credits: 0:0:1

Course Objectives:

To impart knowledge on

- Fundamentals of mechanical vibrations
- Use of vibration measurement equipments

Course Outcomes:

Ability to

- Determine the parameters of free, forced and torsional vibrations
- Measure vibration characteristics using instruments

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15ME3002 ROTOR DYNAMICS

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Rotor dynamics phenomena with the help of simple rotor models
- Behavior of fluid film lubrication and rotor bearing system in rotor system
- Performance of bearings under dynamic conditions

Course Outcomes:

Ability to

- Apply the principles of rotor dynamics in design and analysis of mechanical components
- Diagnose vibration of bearings considering rotor dynamics
- Measure vibration and conduct dynamic analysis in rotating machine elements

Description:

Single mass rotors – bending critical speeds of unbalanced elastic rotor – Equivalent discrete systems – Torsional vibrations in rotating machinery – Gyroscopic effects – Rotor – bearing interactions – Effects of anisotropic bearings – Steady state characteristics of fluid film bearings – Stability and dynamic response for hydrodynamic journal bearing, Two lobe journal bearings – Stiffness calculations of Rolling element bearings – Instability in rotors – Unbalanced response of an asymmetric shaft – Rigid and flexible rotors balancing – Bearing dynamic parameters estimation – Measurement and digital processing techniques – Condition monitoring of rotating machineries – Finite Element Analysis of rotors.

References:

1. Rao J.S., 'Rotor Dynamics', New Age International, New Delhi, 2007
2. Genta G., 'Dynamics of Rotating Systems', Springer, New York, 2005.
3. Muszynska A., 'Rotor dynamics', Series: Dekker Mechanical Engineering, Vol. 188, CRC Press, 2005
4. Robert B.M., 'Rotating Machinery: Practical Solutions to Unbalance and Misalignment', CRC Press, 2003.
5. Rao J.S., 'Vibratory Condition Monitoring of Machines', Narosa Publishing House, New Delhi, 2000.
6. Chen W.J., and Gunter E.J., 'Introduction to Dynamics of Rotor-Bearing Systems', Trafford Publications, Canada, 2005.

15ME3003 MODAL ANALYSIS OF MECHANICAL SYSTEMS

Credits: 3:0:0

Course Objectives:

To impart knowledge

- Modal testing and modal analysis of single-degree of freedom systems
- Modal testing and modal analysis of multi-degree of freedom systems
- Techniques used for estimation of modal parameters.

Course Outcomes:

Ability to

- Perform modal analysis of single and multi-degree of freedom systems
- Excite and measure vibration parameters of structural members
- Extract modal parameters of components using different techniques

Description:

Modal Testing – Single Degree of Freedom (SDOF) System Theory – Presentation and Properties of FRF Data for SDOF System – Undamped Multi–degree of freedom (MDOF) system – Characteristics and presentation of MDOF – Nonsinusoidal vibration and FRF Properties – Analysis of Weakly Nonlinear Structures – Basic Measurement System – Excitation of the Structure – Rotational Mobility Measurement – Measurement on Non linear structures – Multi point excitation methods. Modal Parameter extraction methods like Circle Fit, Inverse Method for SDOF – MDOF curve fitting procedures in the Time Domain – Modal Models – Display of Modal Model – Response Models – Spatial Models – Mobility Skeletons and System Models.

References:

1. Ewins D. J., 'Modal Testing, Theory, Practice, and Application', John Wiley and Sons Ltd., 2000.
2. Sujatha C., 'Vibration and Acoustics', Tata McGraw Hill, New Delhi, 2010.
3. Gaetan Kerschen, 'Modal Analysis of Nonlinear Mechanical Systems', Springer, 2014.
4. Zhi-Fang Fu and Jimin He, 'Modal Analysis', Butterworth-Heinemann Publisher, 2001.
5. Maia N. M. M and Silva J. M. M., 'Theoretical and Experimental Modal Analysis', John Wiley and sons Ltd., 1998.
6. Ward Heylen, Stefan Lammens and Paul Sas, 'Modal Analysis, Theory and Testing', Katholieke Universiteit Leuven, Belgium, 1998.

15ME3004 NUCLEAR POWER ENGINEERING

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Principles and methods in designing, constructing and operating a safe nuclear power plant.
- Fundamental concepts of nuclear power engineering.
- Safety of nuclear power plants.

Course Outcomes:

Ability to

- Apply the concepts of nuclear physics for power generation
- Design power plants and reactor systems
- Suggest safety systems and shielding methods in nuclear power plant

Description:

Review of Nuclear Physics, Nuclear Equations, Energy from Nuclear Reactions and Fission, Thermal Reaction Equation, Reactor Heat generation and Removal, Heat flow in and out of solid fuel element, Temperature variations across Fuel elements. Heat removal in solids subjected to radiation, Thermal Shield quality and void fractions in flow and non-flow systems Types of Reactors, Simple and Dual Pressure Cycle, Corrosion and Erosion Characteristics. Energy from Nuclear fusion, Thermonuclear Fusion, D-T Reaction, P-P Reaction, Fuel Cycle. Safety of Nuclear Plants: Nuclear plant safety, safety systems, changes and consequences of accident criteria for Safety.

References:

1. M. M. Ei. Wakil, ‘Nuclear power Engineering’, McGraw Hill book Company, New York, 1987.
2. Samuel Glasstone and Alexander Setonske, ‘Nuclear Reactors Engineering’, 3rd Edition, CBS Publishers and Distributors, 1992.
3. Thomas J. Cannoly, ‘Fundamentals of Nuclear Engineering’, John Wiley, 1992.
4. Suresh S. ‘Physics of Nuclear Reactors’ Tata McGraw Hill Publishing Company Limited, 1985.
5. J. Kenneth Shultis, Richard E. Faw, ‘Fundamentals of Nuclear Science and Engineering’, Marcel Dekker, 2002.
6. R. L. Murray, ‘Nuclear Energy: an Introduction to the Concepts, Systems, and Applications of Nuclear Processes’, 5/e, Butterworth Heinemann, 2000.

15ME3005 SOLAR ENERGY UTILIZATION

Credits: 3:0:0

Course Objectives:
To impart knowledge on
- Solar radiation and its measurement.
- Classification and analysis of solar collectors.
- Applications of solar energy.

Course Outcomes:
Ability to
- Estimate solar radiation flux using different techniques.
- Analyze the performance of solar collectors.
- Design solar energy storage systems.
- Suggest methods for using solar energy for various applications.

Description:
Solar energy – radiation – solar constant – extra terrestrial radiation – clear sky irradiation – solar radiation measurement – estimation of average solar radiation – solar radiation on tilted surface. solar collectors – types – flat plate collector – collectors efficiency – collector performance – thermal analysis of flat plate collector and useful heat gained by the fluid – parabolic concentrators, non–imaging concentrators, other forms of concentrating collectors – performance analysis. Solar energy storage – stratified storage – well mixed storage – solar ponds – types. applications of solar energy.

References:

1. John. A. Duffie and Willam A. Beckman., 'Solar Engineering of Thermal Processes', Wiley, 2006.
2. Suhatme, S.P., 'Solar Energy Principle of Thermal Collection and Storage', Tata McGraw Hill, 1996.
3. Kriender, J. M., 'Principles of Solar Engineering', McGraw Hill, 1999.
4. Mangal, V. S., 'Solar Engineering', Tata McGraw Hill, 1992.
5. Bansal, N. K., 'Renewable Energy Source and Conversion Technology', Tata McGraw Hill, 1989.
6. Peter J. Lunde., 'Solar Thermal Engineering', John Willey and Sons, New York, 1985.

15ME3006 DESIGN OF FLUID POWER SYSTEMS

Credits: 3:0:0

Course Objectives:
To impart knowledge on:
- Laws and governing equations for hydraulics and pneumatics with ISO symbolic representations.
- Working principles of hydraulic and pneumatic drives and develop circuits for engineering applications.
- Trouble shooting the hydraulic and pneumatic systems.

Course Outcomes:
Ability to
- Identify the components and apply symbolic notation in a fluid power system.
- Select and suggest hydraulic and pneumatic drives for an engineering application.
- Design and develop pneumatic, hydraulic and PLC circuits for automation

Description:
Introduction to fluid power systems – Industrial Prime movers – Pneumatic fundamentals – symbols – control elements – Actuators – position and pressure sensing – logic circuits – switching circuits – fringe condition, modules and integration – sequential circuits – cascade methods – electro–pneumatic circuits – PLC based control pneumatic circuits – Hydraulics symbols – system components –industrial circuit design, Piping design for fluid power systems and bulk fluids, Trouble shooting in fluid power systems.

References Books:

1. Antony Esposito, 'Fluid Power with Applications', Prentice Hall, 2006.
2. Joji P, 'Pneumatic Control', Wiley India P. Ltd., 2011.
3. Ilango, P, Soundarajan, V, 'Introduction to Hydraulic and Pneumatics', Prentice Hall India, 2011.
4. Andrew Parr, 'Hydraulic and Pneumatics' (HB), Jaico Publishing House, 2008.
5. Shanmuga Sundaram, 'Hydraulic and Pneumatic Controls: Understanding made Easy' S. Chand and Co Book publishers, New Delhi, 2009.
6. Dudley, A. Pease and John J. Pippenger, 'Basic fluid power', Prentice Hall, 1987.
7. Peter Rohner, 'Fluid Power Logic Circuit Design: Analysis, Design Methods, and worked Examples', Wiley Publications, 1979.

15ME3007 ADVANCED TOOL DESIGN
(Use of Design Data Book is permitted)

Credits: 3:0:0

Course Objectives:
To impart knowledge on

- Concepts, procedures to design cutting tools, work holding and tool holding devices.
- Standard parts in design.
- Tooling requirements for CNC machine tools

Course Outcomes:
Ability to

- Select suitable materials, components and standards for the design of jigs, fixtures and tools.
- Design jigs, fixtures, gages and tools using data books
- Design tooling for CNC machine tools.

Description:
Introduction tool design: Challenges and requirements – Tooling standards and materials. Design of single and multi–point cutting tools – Design of gear and thread milling cutters. Design of jigs and fixtures: Gages and gauge design – Types and materials – Gage Tolerances – Principles of location and clamping – Locating methods and devices – design of drill jigs – Drill bushings –Types of fixtures – Design of milling fixture. Design of press tool dies: Design of blanking, piercing, bending and drawing dies. Tool design for CNC machine tools: Fixture design for CNC machine tools– Universal fixtures.

References:

1. Frank W. Wilson., 'Fundamentals of Tool Design', Literary Licensing, LLC, 2012.
2. Cyrill Donaldson, George H. LeCain, Joyjeet Ghose, V.C. Goold , 'Tool Design', Tata McGraw Hill, 2012.
3. Edward G. Hoffman, 'Jig and Fixture Design', Delmar Cengage Learning; 5th Revised edition, 2003.
4. Prakash Hiralal Joshi, 'Tooling data', A H Wheeler Publishing Co Ltd, 2001.
5. Venkataraman. K., 'Design of Jigs, Fixtures and Press tools', Tata McGraw Hill, 2005.
6. 'CMTI Machine Tool Design Handbook', Tata McGraw-Hill Education, 1982

15ME3008 ADVANCED INSTRUMENTATION IN THERMAL ENGINEERING

Credits 3:0:0

Course Objectives:
To impart knowledge on

- Advanced instrumentation, experimental methods and measurement techniques.
- Operation and specific functional characteristics of thermal instruments.
- Analytical calculations and their uncertainties which may arise in the various instruments and their measurement techniques.

Course Outcomes:
Ability to

- Analyze experimental data and predict correlation
- Quantify uncertainties and errors in various measurements
- Apply measurement techniques of intensive and extensive properties

Description:
Introduction to measurements, Errors in measurements, Statistical analysis of data, Regression analysis, correlation, estimation of uncertainty and presentation of data, Measurement of field quantities like temperature, pressure, velocity by intrusive and non-intrusive techniques. Measurement of derived quantities like heat flux, volume/mass flow rate, temperature in flowing fluids. Measurement of thermo-physical properties such as thermal conductivity, viscosity, surface tension, specific heat capacity, radiation properties of surfaces, Computer assisted data acquisition, analysis of experimental data presentation.

References:

1. Doebelin O.E., ‘Measurement Systems and Design’, McGraw Hill Co., 2003.
2. Holman J.P., ‘Experimental Methods for Engineers’, McGraw Hill Co, 2001.
3. Beckwit T.G. and Buck M.L., ‘Mechanical Measurements’, Addition Wesley, 2011.
4. Rangan, C.S., Sharma G.S. and Mani V.S., ‘Instrumentation Devices and Systems’, Tata McGraw Hill., Pub. Co., 1993.
5. B.C. Nakra ‘Instrumentation measurement and Analysis’, Tata McGraw-Hill Publishing Company, 2002
6. R.K. Jain, ‘Mechanical and Industrial Measurements’ Khanna Publishers, 2000.

15ME3009 ADVANCED REFRIGERATION AND AIR-CONDITIONING SYSTEMS

Credits: 3:0:0

Course Objectives:
To impart knowledge on

- Types and applications of refrigeration systems.
- Psychrometry concepts and applications of air-conditioning systems.
- Air distribution systems.

Course Outcomes:
Ability to

- Apply thermodynamic principles to various refrigeration cycles
- Design refrigeration and air-conditioning systems.
- Analyze fan and duct system

Description:
Review of thermodynamic principles of refrigeration, vapor compression cycle, cascade system, Bell Coleman cycle. Types and applications of refrigeration and air–conditioning systems. Vapor absorption system – aqua ammonia and water–lithium bromide system. Review of psychometric process, RSHF, GSHF, ESHF. Comfort air conditioning and cooling load calculations. Pressure drop in straight, rectangular ducts, fittings. Design of duct systems – velocity method – equal friction method. Centrifugal fans for HVAC System – Air distribution in rooms.

References:

1. Stocker W.F. and Jones J.W., ‘Refrigeration and Air-conditioning’, Tata McGraw Hill, 2008.
2. Manohar Prasad., ‘Refrigeration and Air Conditioning’, Willey Eastern Ltd., 2007.
3. C.P. Arora ‘Refrigeration and Air Conditioning’’, Tata McGraw-Hill Education, 2000
4. Jordan and Priester, ‘Refrigeration and Air conditioning’, Prentice Hall of India, 1974.
5. ‘ASHRAE Hand Book’, 4 Vol., 2012 Edition.
6. Carrier Air Conditioning Co., ‘Hand Book of Air Conditioning’, Prentice Hall of India, 2008.

15ME3010 DESIGN AND ANALYSIS OF HEAT EXCHANGERS

Credits: 3:0:0

Course objectives:

To impart knowledge on

- Construction of heat exchangers and applications of heat exchangers
- Design and analysis of heat exchangers
- Performance of heat exchangers

Course outcomes:

Ability to

- Select and design the heat exchanger for a particular application
- Determine the size and rating of a heat exchanger
- Design evaporator, condenser and cooling tower specific to an application

Description:

Types of heat exchanger, constructional details, fluid flow arrangements, industrial applications, modes of heat Transfer, heat transfer correlations, overall heat transfer coefficient, LMTD, effectiveness – NTU method of heat exchanger analysis, sizing and rating of heat exchangers, fouling factors, effect of turbulence, friction factor, pressure loss, stress in tubes, differential thermal expansion, types of failure, effect of baffles, heat exchanger materials, selection of heat exchangers, optimization, cost analysis, design of typical liquid–liquid, gas–gas, gas–liquid heat exchangers, design of condensers, evaporators and cooling towers.

References:

1. Kays, W.M. and London A.L., 'Compact Heat Exchangers', 3rd Ed., Krieger Publishing Company, 2008.
2. Afgan, N.H. and Schliinder, 'Heat exchangers, Design and Theory Source Books' McGraw Hill Book Company, 2004.
3. Frass, A.P. and Ozisik, M.N., 'Heat Exchanger Design', John Wiley and Sons Inc., 2005.
4. Walker G., 'Industrial Heat Exchangers', a basic guide, McGraw Hill V Book Co., 2007.
5. Donold Q Kern., 'Process Heat Transfer', McGraw Hill Book Co., 2009.
6. E.A.D. Saunders., 'Heat Exchangers', Longman Scientific and Technical, New York, 2006

15ME3011 ADVANCED TURBO MACHINERY

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Working principle of pumps, compressors, fans, and turbines
- Application of turbo machines
- Performance of pumps, compressors, fans, and turbines

Course outcomes:

Ability to

- Determine flow velocity in pumps and compressors
- Select pump and compressor for a particular application
- Analyze the performance of pumps, compressors, fans, and turbines

Description:

Classification of turbo machinery, Euler's equation, blade terminology, radial and axial flow pumps and compressors, degree of reaction, dimensionless parameters, effects of Reynolds Number and Mach number , compressor and pump efficiencies, losses in turbo machines– cavitations, pumps and compressors characteristic curves, types of fan, efficiencies, classification of steam turbine, compounding of turbine, performance of steam turbine, classification of hydraulic turbines, specific speed, governing, efficiencies, performance and characteristic curves, types of gas turbine, performance, characteristic curves.

References:

1. Lee, 'Theory and Design of Steam and Gas Turbine', McGraw Hill, 2006
2. Yahya, 'Turbines, Compressors and Fans', Tata McGraw Hill, 2009
3. Stephard, D.G., 'Principles of Turbo machines', Macmillan Co., 2011
4. A. Valan Arasu, 'Turbo Machines' Vikas Publishing House Pvt. Ltd, 2012
5. Modi, P.N., and Seth, S.M., 'A Text book of Fluid Mechanics and Hydraulic Machines', Standard Book House, New Delhi, 14th Edition, 2007
6. Bathe W.N., 'Fundamentals of Gas Turbines', Willey and Sons, 2004

15ME3012 TWO PHASE FLOW AND HEAT TRANSFER

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Two phase flow pattern maps.
- Computational modeling of two phase flow
- Thermodynamics of boiling and condensation.

Course Outcomes:

Ability to

- Analyze two phase flow patterns for horizontal and vertical systems.
- Apply analytical tools for design and performance assessment of two-phase devices
- Determine critical heat flux and burn out condition for pool and flow boiling

Description:

Introduction: Two phase flow pattern maps for horizontal and vertical systems: Governing equations for homogeneous, drift-flux, particle trajectory and two-fluid models; Analyses of two phase flow regimes; Introduction to computational modeling; Measurement of two-phase flow parameters Thermodynamics of boiling; pool, flow boiling: onset of nucleation, heat transfer coefficients, critical heat flux, effect of sub-cooling; post burnout heat transfer. Condensation.

References:

1. Collier and J. R. Thome, 'Convective Boiling and Condensation', 3rd ed., Oxford University, 2001
2. C. Kleinstreuer, 'Two-Phase Flow: Theory and Applications', Taylor and Francis, 2003.
3. G. B. Wallis, 'One-Dimensional Two-Phase Flow', McGraw-Hill, 1979.
4. P. B. Whalley, 'Boiling, Condensation and Gas-Liquid Flow'. Oxford University Press, 1990.
5. Tong, L.S., and Tang. Y. S., 'Boiling Heat Transfer and Two-Phase Flow', 2nd ed., Taylor and Francis, 1997.
6. Ishii, M and Hibiki, T., 'Thermo-Fluid Dynamics of Two-Phase Flow', Springer, 2006.

14ME3001 COMBUSTION IN ENGINES (V-1.1)

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Combustion principles and chemical kinetics.
- Combustion in SI and CI engines.
- Combustion in gas turbine.

Course Outcomes:

Ability to

- Interpret the concept of combustion and recognize their applications in IC engines and gas turbines.
- Recommend appropriate measures for minimizing combustion generated environment pollution.
- Build energy efficient combustion equipment/ gadgets which satisfy the prevailing emission standards

Description:

Principles and Thermodynamics concepts of combustion, Combustion calculations, Chemical equilibrium and dissociation, Chemical kinetics, Theories of combustion, types of flames, combustion generated pollutants, Combustion in SI and CI engines, Knock, Delay period, Ignition lag, Heat balance, Combustion chamber design, Combustion in gas turbines, Various configurations of gas turbine combustion chambers.

References:

1. John B. Heywood., 'Internal Combustion Engine Fundamentals', McGraw Hill, International Edition, 2001.
2. Pulkrabek, W.W., 'Engineering Fundamentals of the Internal Combustion Engine'. Pearson Prentice Hall, 2003.
3. Edward E. Obert., 'Internal Combustion Engines and Air Pollution', Internal Educational Publishers,New York, 2005.
4. Cohen H. Rogers, GEC and Saravanamutto, H.I.H., 'Gas Turbine Theory', Longman Group Ltd., 2007.
5. Treager, 'Air Craft Gas Turbine Engine Technology', Tata McGraw Hill, 3rd Ed., 2006.
6. J.K. Jain, 'Gas Dynamics and Jet Propulsion', Khanna Publishers, 2004
7. Mathur M.L. and Sharma. 'A Course in Internal Combustion Engines', R.P. Dhanpat Rai Publications, 2009.
8. Paul W. Gill, James H. Smith., 'Fundamentals of Internal Combustion Engines', Oxford and IBH Publishing Co., 2002.
9. V. Ganesan., 'Internal Combustion Engines', Tata McGraw Hill Publishing Company Ltd., 2010.

14ME3002 ADVANCED THERMODYNAMICS (V-1.1)

Credits 3:0:0

Course Objectives:

To impart knowledge on

- Entropy, availability, thermodynamic relations
- Combustion process
- Kinetic theory of gases

Course Outcomes:

Ability to

- Apply first and second laws of thermodynamics to thermal systems.
- Analyze the behavior of ideal and real gas mixture
- Apply chemical thermodynamics for reacting mixtures

Description:

First and second law analysis – concept of entropy – availability –Helmholtz function – Gibb's function – On Sager reciprocity relation. Thermodynamic relations, Criteria for Equilibrium –Conditions for stability. Compressibility factor, fugacity and activity. Phase rule – ideal and real solution of gases, liquids, equilibrium system. Combustion. First and second law of thermodynamics applied to combustion process – heat of combustion – Adiabatic flame temperature – stoichiometry and excess air – chemical equilibrium and dissociation. Kinetic Theory of Gases, Perfect gas model, Distribution of translational velocities distribution function, molecular collisions and mean free path, equi-partition of energy.

References:

1. A. Bejan, 'Advanced Engineering Thermodynamics', 3rd edition, John Wiley and sons, 2006.
2. I. K. Puri and K. Annamalai, 'Advanced Engineering Thermodynamics', CRC Press, 2001.
3. D.P. Mishra, 'Engineering Thermodynamics', Cengage Learning, 2012.
4. P.K. Nag., 'Engineering Thermodynamics', 4th Edition. McGraw Hill, 2008.
5. G.J. Van Wylen and R.E. Sonntag., 'Fundamentals of Thermodynamics', Willy Eastern Ltd., 2012.

14ME3003 ADVANCED FLUID MECHANICS (V-1.1)

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Continuity, momentum and energy equations of fluid flow.
- Irrotational flows, flow past cylinders and rankine body.
- Concepts of boundary layer, prandtl mixing length, turbulent theory, universal velocity profile

Course Outcomes:

Ability to

- Apply continuity equation to solve numerical flow problems
- Apply momentum equation to determine velocity distribution in the fluid flow
- Apply energy equation to determine the temperature distribution in the fluid flow
- Analyze flow using boundary layer theory

Description:

Methods of describing fluid motion, time rates of change, acceleration, Eulerian and Lagrangian equation of continuity, Bernoulli's Equation. Forces and stresses acting on a fluid particle, momentum equation, Navier stokes Equations in rectangular, Energy equation. Irrotational motion in two dimensions, source and sink, complex potential due to source, due to doublet. Vortex motion, Helmholtz's vorticity theorem, velocity potential and stream function. Flow past cylinder with and without circulation, flow past Rankine body. Boundary layer principles, Prandtl mixing length, turbulent theory, universal velocity profile.

References:

1. Streeter, 'Fluid Dynamics' 3rd Ed., McGraw Hill, 2006.
2. Raisinghania M.D,' Fluid Dynamics', 4th Ed., S. Chand and company Ltd, 2002.
3. Fox R N and McDonald A T., 'Fluid Mechanics', John Wiley and Sons, 1999.
4. J.K. Goyal and K.P. Gupta., 'Fluid Dynamics', 3rd revised Ed., Pragathiprakasam, Meerut, 1999.
5. Schlichting H., 'Boundary Layer Theory'. 8th Ed., McGraw Hill New York, 2001.
6. Robertson., 'Hydrodynamics Theory and Application', Prentice Hall of India, 1965

14ME3004 DESIGN OF THERMAL POWER EQUIPMENTS

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Design of boiler, furnace, condenser and cooling tower
- Boiler performance and their accessories
- Water and steam purification methods and equipments

Course Outcomes:

Ability to

- Design boilers, furnaces, condensers and cooling towers
- Design economizer, super heater, reheater and analyse their performance
- Design air preheater, draft system and chimney

Description:

Boiler and furnace design–IBR Code Furnace Design: Heat Transfer in Furnace – heat balance – types of refractory walls, Water wall arrangements. Heat release rates – furnace bottoms – Slag removal – Cold primary air system – wind box assembly, Different types of furnaces for solids and liquids. Water Side Design – Circulation. Design of condensers, cooling tower–Types and design for power plant application. Performance of boiler – Equivalent evaporation–Boiler efficiency–boiler trail–heat losses in boiler. Economizer–types, design. Super Heater –Design, Super heat temperature control. Desuperheater – design. Design of Reheater. Water and Steam purification washing typical arrangements of boiler drum internal in H.P. boilers. Air Pre–Heaters: Types of Air heater, recuperative and regenerative – Design considerations – Higher temperature and low temperature applications. Draft system design, Ash separators by ESP Electrostatic precipitators.

References:

1. P.K. Nag., ‘Power Plant Engineering ’, Tata McGraw Hill, 2002.
2. C.D. Shields., ‘Boilers’, McGraw Hill, 1982.
3. Homi, P. Serval., ‘Boilers and Pressure Vessels’, Multitech Publishing Company, Bombay, 1989.
4. Skrotzki and W.A. Vepot., ‘Power Station Engineering Economy’, Tata McGraw Hill, New Delhi, 1987.
5. Morse, T.F., ‘Power Plant Engineering’, Van Nostrand East West Press, revised Edn., 1983.
6. David Sunn, Robert Houston. ‘Industrial Boilers’, Longman Science and Technology, 1986.
7. ‘Modern Power Station Practice’, Vol. 8, Central Electricity Generating Board, UK, Pergamon Press, 1971.

14ME3005 COMPUTER INTEGRATED MANUFACTURING SYSTEMS (V-1.1)

Credits: 3:0:0

Course Objectives:
To impart knowledge on

- Application of computers in manufacturing.
- Computer assisted materials requirement planning and production monitoring systems.
- Automatic material handling systems and flexible manufacturing systems.

Course Outcomes:
Ability to

- Integrate planning, scheduling and monitoring the manufacturing activities of a plant
- Apply computer assisted techniques for carrying-out process planning, inventory and quality control.
- Suggest modern manufacturing systems for automated production

Description:
Manufacturing system: Introduction, Objectives, types, features and applications, Computer Integrated Manufacturing: Components of CIM, Data base, Planning, Scheduling and Analysis of CIM systems, Material requirements planning, ERP. Shop floor control – Factory data collection system – Automatic identification system. Computer assisted production monitoring systems: Types, Automated Inspection systems: contact and non–contact inspection methods – machine tools– Automatic Material Handling and Storage systems, DNC systems, Group Technology, Cell Design, Cellular Manufacturing Systems Flexible manufacturing systems (FMS) – Rapid prototyping – Artificial Intelligence and Expert system.

References:

1. Groover, M.P., 'Automation, Production System and CIM', Prentice-Hall of India, 2005.
2. David Bedworth, 'Computer Integrated Design and Manufacturing', Tata McGraw Hill, New Delhi, Edition 1999
3. Yorem Koren, 'Computer control of Manufacturing Systems', McGraw Hill, 2005.
4. Ranky, Paul G., 'Computer Integrated Manufacturing', Prentice Hall International 1999.
5. Vikram Sharma, 'Fundamentals of computer Integrated Manufacturing, S. K. Kataraia and sons, 2009.
6. R.K. Kundra, 'Computer Aided Manufacturing', Tata McGraw Hill Education, 2008.
7. R.K. Rajput, 'Robotics and Industrial Automation', S. Chand and Company, 2008.

14ME3006 COMPUTER APPLICATIONS IN DESIGN (V1.1)

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Use of computer in mechanical engineering design.
- Surface and solid modeling techniques.
- Advanced modeling concepts.

Course Outcomes:

Ability to

- Represent geometric entities mathematically.
- Apply algorithms to perform operations such as transformations on geometric entities
- Use advanced modeling techniques in product design.

Description:

Hardware and software for CAD, Geometric modeling, Transformations, Types and representation of curves, surfaces and solids– Solid removal algorithms shading– coloring–rendering. Parametric and variation geometry based on software, Creation of prismatic and lofted parts. CAD/CAM Exchange formats, Mechanical tolerances, Mass property calculations and Mechanical Assembly, Advanced Modeling Concepts, Conceptual, Top Down and collaborative Design, Mechanism simulation, Rapid prototyping.

References:

1. Ibrahim Zeid, CAD/CAM- Theory and Practice, Tata McGraw Hill, Edition,2013
2. Mikell. P. Groover and W. Zimmers Jr. 'CAD/CAM Computer aided Design and Manufacturing', Prentice Hall of Inc., 2002
3. Donald Hearn and M Pauline Baker 'Computer Graphics', Prentice Hall Inc. III Edition2006.
4. Jean Gallier., 'Curves and Surfaces in Geometric Modeling: Theory and Algorithms', Morgan Kaufmann; 1st edition, 1999.
5. Michael Mortenson, ' Geometric Modelling', Industrial Press, 3rd edition,2006
6. David Salomon, 'Computer Graphics and Geometric modelling', Springer; 1st edition 1999.
7. Martti Mantyla, 'An Introduction to Solid Modelling' W.H. Freeman and Company, 1988.

14ME3007 ENGINEERING MATERIALS AND APPLICATIONS (V-1.1)

Credits: 3:0:0

Course Objectives:
To impart knowledge on

- Structure and composition and behavior of Metals
- Principles of design, selection and processing of materials

Course Outcomes:
Ability to

- Select materials based on specific properties.
- Interpret material properties used in various applications
- Identify the failure behavior of materials.

Description:
Elastic and Plastic Behavior – atomic model of Elastic behavior – Rubber like Elasticity an elastic behavior – plastic deformation– slip– shear strength of perfect and real crystals– movement of dislocation. Fracture Behavior: Ductile and Brittle fracture – Energy and stress intensity approach, fracture toughness– Ductile Brittle Transition Fatigue– Creep in Materials. Modern Metallic Materials: Patented Steel wire – Steel martensite – micro alloyed steels– precipitation hardened aluminium alloys– Maraging steels – metallic glasses – shape memory alloys smart Materials– TRIP Steel. Ceramics and glasses: Properties, applications, Ceramic Structures– silicate ceramics– carbon –diamond– imperfections and impurities in ceramics –applications

References:

1. V. Raghavan, 'Materials Science and Engineering – Prentice Hall of India (P) Ltd., New Delhi.2004.
2. Raymond A. Higgin's 'Properties of Engineering Materials, English Language Book Society, 2000
3. Thomas H. Courtney 'Mechanical Behavior of Materials' McGraw Hill International Edition, 2005.
4. Williams D, Callister 'Material Science and Engineering' John Wiley and sons inc. 2009.
5. Joshua Pelleg, 'Mechanical Properties Materials', Springer, 2013
6. Kenneth. G, Michael, K. Budinski, 'Engineering Materials', Properties and selection, Prentice Hall, 2010.
7. C. P. Sharma, 'Engineering Materials: Properties and applications of metals and alloys', Prentice Hall India, 2004.

14ME3008 ADVANCED STRENGTH OF MATERIALS (V1.1)

Credits: 3:0:0

Course Objectives:
To impart knowledge on

- Potential applications of strength of materials.
- Material behavior under various stress conditions.
- Development of stresses depending upon material shape and wall thickness.
- Development of stresses under various loading conditions.

Course Outcomes:
Ability to

- Determine stress conditions of engineering structures and components
- Analyze structural members subjected to torsion and bending loads
- Analyze cylinders subjected to static and cyclic loading

Description:
Introduction to potential applications of strength of materials, methods of analysis. Introduction to theory of elasticity, concept of stress, and their relationships. Material behaviour under various stress conditions. Torsion in circular, non–circular, rectangular cross sections and in thin–wall sections.. Bending behaviour of beams depending upon their cross sections, curvature and elasticity of foundations. Energy methods– Castigliano's Theorem, Methods of virtual work, Stress and strain in cylinders depending upon their wall thickness. Materials under static and cyclic loading.

References:

1. Richard G. Budynas, 'Advanced Strength and Applied Stress Analysis' (2nd Edition) by, McGraw-Hill International Editions, 1999.
2. Boresi, Arthur P. and Schmidt, Richard J., Advanced Mechanics of Materials, 6th Ed., John Wiley and Sons, 2003.
3. Young, Warren C. and Budynas, Richard G., Roark's Formulas for Stress and Strain, 7th Ed., McGraw-Hill, 2002.
4. Beer, Ferdinand P., Johnston, E. Russell and DeWolf, John T., Mechanics of Materials, 3rd Ed., McGraw-Hill, 2002.
5. L S Srinath. Advanced Mechanics of Solids, 3rd edition, McGraw-Hill, 2008.
6. A. C. and S. K. Fenster, Advanced Mechanics of Materials and Applied Elasticity', Prentice Hall, 5th Edition 2012.
7. J. P. Den Hartog, Advanced Strength of Materials, McGraw Hill, 2012.

14ME3011 COMPUTER AIDED ENGINEERING LABORATORY (V-1.1)

Credits: 0:0:2

Course objectives:
To impart knowledge on

- Software tools like NASTRAN and ANSYS for Engineering Simulation.
- Application of the tools in various fields of engineering.

Course outcome:
Ability to

- Create geometries and mesh using software packages
- Apply knowledge of engineering (structural, thermal and fluids) to solve engineering problems
- Analyze and document results

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME3016 ADVANCED METROLOGY (V1.1)

Credit 3:0:0

Course Objectives:
To impart knowledge on

- Science of measurement and measuring machines commonly used.
- Limits, fits and tolerances, geometric dimensioning aspects
- Methods of acceptance test for conventional machine tools.
- Concepts of Laser metrology and surface roughness.

Course Outcomes:
Ability to

- Use measuring instruments.
- Perform acceptance test for machine tools using conventional and modern techniques
- Represent part features using standards, geometrical dimensioning and tolerancing symbols.

Description:
Science of measurement: Mechanical measurement – types, measurement standards– terms used in rating instrument performance. Measuring machines: Study of Measuring Machines, gear tooth measurement– measurement of gear profile, Isometric Viewing of Surface Defects, Image Shearing Microscope for Vertical Dimensions. Laser metrology and microscopy: Laser Metrology – Vision systems– Principles and applications, Principles of Scanning and Transmission Electron Microscopy and its applications. Acceptance tests for machine tools and surface finish measurements, calibration of machine tools, introduction to ball bar measurement, Measurement of surface roughness. Introduction to Tolerancing and Dimensioning: Introduction; Indian Standard System of Limits and Fits (IS: 919–2709); Designation of Holes, Shafts and Fits. Meaning of GD and T, Various Geometric symbols used in GD and T, Datum feature, Material Conditions.

References:

1. Ernest O Doeblin, 'Measurement systems', McGraw Hill Publishers, 2003.
2. R. K. Jain, 'Engineering Metrology', Khanna Publishers, New Delhi, 2009.
3. Gene R. Cogorno, Geometric Dimensioning` and Tolerancing for Mechanical Design McGraw Hill, 2006.
4. I.C Gupta, 'Engineering Metrology', Dhanpat Rai and Co., 2004.
5. Beckwith Thomas G, 'Mechanical Measurements', Pearson Education, 2008.
6. M. Mahajan,'A Text Book of Metrology', Dhanpat Rai and Co,. 2010
7. The Metrology Handbook, Jay L. Bucher, American Society for Quality, 2004.

14ME3017 ADVANCED HEAT TRANSFER LABORATORY (V-1.1)

Credits: 0:0:1

Course Objective:

To impart practical skills in conducting and analyzing heat transfer experiments

Course Outcomes:

Ability to

- Analyze heat transfer systems
- Measure heat transfer parameters using measurement techniques
- Predict uncertainties in the heat transfer systems.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME3018 AUTOMATION AND ROBOTICS LABORATORY (V-1.1)

Credits: 0:0:2

Course Objectives:

To impart knowledge on

- Designing pneumatic and electro pneumatic components for automation.
- Components, ladder logic design, programming for plc/microcontroller and robot
- Configuration of robot and reconfigure them for a custom application

Course Outcomes:

Ability to

- Select fluid power control components and design circuits for automating applications.
- Write PLC programs for industrial automation
- Configure and operate robots for practical applications.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME3022 ADVANCED HEAT TRANSFER (V-1.1)

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Conduction, convection, radiation, heat transfer during boiling and condensation.
- Design of heat exchangers.
- Principles of mass transfer.

Course Outcomes:

Ability to

- Apply the principles of conduction, convection and radiation to thermal systems
- Analyze heat transfer performance of thermal systems
- Determine flow patterns for two phase flow.

Description:

Conduction: heat diffusion equation, plane wall, Radial system. Heat Transfer from extended surfaces, Insulation, Analytical method for two dimensional heat equation, Finite difference method, Transient conduction. Convection: Energy equation, thermal boundary layer. Forced convection: flow over surfaces, internal flow. Natural convection, combined forced and free convection, combined convection and radiation in flows. Radiation: Radiative heat exchange between surfaces, Radiation exchange with emitting and absorbing gases. Boiling: Pool and flow boiling, Nucleate boiling correlations. Condensation, modes and mechanisms, correlations. Heat exchanger: types – LMTD method and the effectiveness – NTU method. Mass Transfer: types, Fick's law of diffusion – mass diffusion equation, Transient Mass Diffusion – Diffusion in moving medium. Convective mass transfer. Simultaneous Heat and Mass transfer.

References:

1. Yunus.A Cengel., 'Heat Transfer a Practical Approach', Tata McGraw Hill, 2nd Ed.,2003
2. Holman J.P., 'Heat and Mass Transfer', Tata McGraw Hill, 10th Ed., 2009.
3. Allen D.Kraus., 'Extended Surface Heat Transfer', Wiley-Interscience., 2001.
4. Frank P. Incropera and David P. Dewit T., 'Fundamentals of Heat and Mass Transfer',5 th Ed., John Wiley and Sons, 2001.
5. C.P. Kothandaraman., 'Fundamentals of Heat and Mass Transfer', 3rd Ed., New Age International, 2006.
6. Kays, W.M., Crawford W and Bernhard Weigand., 'Convective Heat and Mass Transfer', McGraw Hill Inc., 2004.
7. Burmister L.C., 'Convective Heat Transfer', John Wiley and Sons, 1993.

14ME3023 DESIGN OF MECHANICAL SYSTEM ELEMENTS (V-1.1)

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Working principles, operation and applications of various mechanical transmissions systems and pressure vessels.
- Design of mechanical elements.

Course Outcomes:

Ability to

- Analyze the behavior of material handling equipment under dynamic load conditions.
- Apply engineering principles and procedures to design pressure vessels.
- Design automotive transmission systems and material handling elements based on the requirements.

Description:

Material Handling Equipment Types, Selection and applications. Method for determining stresses–Terminology and ligament efficiency–Applications. Stresses in Pressure Vessels and Introduction: Stresses in a circular ring, cylinder – Membrane stress analysis of vessels shell components–Cylinder shells, spherical heads, conical heads. Thermal stresses – Discontinuity stresses in pressure vessels. Design of Vessels: Design of tall cylinder, self–supporting process columns Supports for short vertical vessels–Stress concentration at a variable thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of reinforcement. Pressure vessel design. Design of automotive transmission system – clutches – power transmitted brake – cams – gear box. Design of hoisting elements, Load handling attachments. Design of forged hooks and eye hooks – crane grabs – lifting magnets – Grabbing attachments – Design of arresting gear and Brakes. Conveyors –Types, description, design and applications. Escalators.

References:

1. John. F. Harvey, ‘Theory and Design of Pressure Vessels’, ‘CBS Distributors’, 1991.
2. Rudenko. N, ‘Materials Handling Equipment’, Elnvee Publishers, 1970.
3. Alexandrov. M. ‘Materials Handling Equipment’, MIR publishers, 1981.
4. Henry.H.Bedner ‘Pressure Vessels’, Design Hand Book, CBS Publishers and Distributors, 1986.
5. Joseph Edward Sighley, ‘Mechanical Engineering Design’, McGraw Hill, 2011.
6. R. C. Mishra, Simant, ‘Mechanical System Design’, Prentice Hall of India, 2009.

14ME3024 DESIGN FOR MANUFACTURING AND ASSEMBLY (V-1.1)

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Product functionality, product design, product planning and assembly.
- Developing quality products by incorporating the reliability, safety functions and robustness.

Course Outcomes:

Ability to

- Represent part features according to geometrical dimensioning and tolerancing principles
- Design components considering constraints of manufacturing processes
- Apply principles of DFA to increase manufacturing efficiency in assembly processes.

Description:

Design principles for manufacturing: mechanisms and selection, Process capability – Feature and geometric tolerances, assembly limits and Datum Features. Form design: Principle, Factors, Material and manufacture design, Design for machining consideration: drills, milling cutters, keyways and counter sunk screws, simplification by separation and amalgamation– Design for machinability, economy, clampability, accessibility and assembly. Design for casting and welding considerations: Redesign of castings based on parting line, core requirements and machined holes, Redesign of weld members based on different factors and considerations. Redesign for manufacture and case studies: Design for Assembly Automation, group technology –Design for reliability and safety, Robust and quality design.

References:

1. Geoffrey Boothroyd, Petre Dewhurst, Winston A Knight, 'Product Design for Manufacture and Assembly', CRC Press, Taylor and Francis Group, 2010
2. Harry Peck, 'Designing for Manufacture', Pitman Publications, 1983.
3. George E.Dieter, 'Engineering Design: A Materials and Processing Approach', 3rd ed., McGraw-Hill, 2000.
4. James G, Bralla, 'Hand Book of Product design for Manufacturing', McGraw Hill Publications, 1999.
5. C. Poli, 'Design for Manufacturing', Butterworth-Heinemann, Reed Elsevier Group, 2001
6. A.K. Chitale, R. C. Gupta, Product Design and Manufacturing Prentice Hall of India, 2007.
7. Robert Matousek, 'Engineering Design- A Systematic Approach' Blackie and Son Ltd., London. 1972.

14ME3025 MANUFACTURING SYSTEM AND SIMULATION (V-1.1)

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Various modeling techniques and assembly lines.
- Manual and computer assisted simulation techniques.

Course Outcomes:

Ability to

- Represent manufacturing systems by models
- Design and evaluate different manufacturing systems using simulation.
- Simulate job shop system and queuing system

Description:

Manufacturing systems: Types and principles, manufacturing models – Types and uses, model building. Assembly lines – approaches to line balancing, sequencing, Transfer lines – paced and unpaced lines, Shop scheduling. Flexible manufacturing systems: components, planning and control. Group technology and facility layout. Random numbers generation– methods and techniques. Random variable generation – techniques. Distributions**:** types, Simulation experiments, Verification and validation of simulation models. Concepts in discrete event simulation: Concept, Manual simulation using event scheduling, single and two server queue simulation of inventory problems. Programming for discrete event systems in GPSS–Case studies

References:

1. Ronald G Askin, ‘Modeling and Analysis of Manufacturing Systems’, John Wiley and Sons, Inc, 1993.
2. Jerry Banks and John S. Carson, ‘Discrete–Event System Simulation’, Prentice Hall Inc,2009
3. Gordon G, ‘System Simulation’, Prentice Hall of India Ltd, 2009.
4. Mengchu Zhou, ‘Modeling, Simulation, and Control of Flexible Manufacturing Systems: A Petri Net Approach’, World scientific Publishing Company Pvt Ltd., 2000
5. D. S. Hira, ‘System Simulation’, S. Chand and Company Ltd, 2010.
6. Law. M. Kelton, ‘Simulation Modeling and Analysis’, McGraw Hill, NY, 2000
7. Behrokh, Khoshnevis, ‘Discrete systems Simulation’, McGraw Hill Inc. 1994.

14ME3026 ADVANCED MECHANISM DESIGN (V-1.1)

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Understand the fundamentals of kinematics
- Analyze four-bar mechanisms.
- Synthesize mechanisms and manipulators

Course Outcomes:

Ability to

- Determine degrees of freedom of multi-loop kinematic chains.
- Derive position, velocity and acceleration equations of four bar mechanisms.
- Determine forces at joints and supports of simple mechanisms.
- Analyze mechanisms by applying Denavit-Hartenbarg parameters.

Description:

Fundamentals of Kinematics– mobility analysis– Degrees of Freedom of multiloop kinematic chains– Grashoff Criterions– Kinematic Analysis– Vector loop equations – Analytical methods for four bar slider crank and crank rocker mechanisms– position velocity and acceleration. Fixed and moving centrodes–Inflection points and inflection circle. Euler Savary Equation. Synthesis of Mechanisms–types–path generation–function generation–motion generation–Application of instant centre in linkage design. Cam Mechanisms– Dynamics of Mechanisms–Static force analysis with friction – inertia force analysis– combined static and inertia force analysis. Shaking force–balancing of linkages Spatial Mechanism and Robotics–Kinematic Analysis of spatial RSSR mechanism– Denavait–Hartenberg parameters–forward kinematics of Robotic manipulators.

References:

1. Singhley, J. E. and Uicker J.J., 'Theory of Mechanics and Mechanism', McGraw Hill , 2003.
2. Kenneth J. Waldron, Gary L Kinzel, 'Kinematics, Dynamics and Design of Machinery', John wiley- sons 2004.
3. Sandor G. N. and Erdman. A. G., 'Advanced mechanism Design analysis and synthesis', Prentice Hall, 2001.
4. Norton R. L. 'Design of Machinery', McGraw Hill, 2008.
5. Amitabha Ghosh and Ahsok Kumar Mallik, 'Theory of mechanism and Machines', EWLP, Delhi, 1999.
6. J. S. Rao and R. V. Dukkipati, Mechanism and Machine Theory, New age International Publisher, 2006
7. McGrathy. M. J, Geometry Design of linkages, Springer, New York, 2000.

14ME3027 INDUSTRIAL TRIBOLOGY (V-1.1)

Credits 3:0:0

Course Objectives:

To impart knowledge on

Application of basic theories of friction, wear, and lubrication to predictions about the frictional behavior of commonly encountered sliding interfaces.

Course Outcomes:

Ability to

- Apply the principles of friction, wear and lubrication for engineering applications.
- Identify and analyze friction and wear-related problems
- Suggest methods to solve friction and wear related problems

Description:

Introduction, surface topography, Hertzian contact, friction - stick slip motion – measurement of friction, wear - simple theory of sliding wear mechanism of sliding wear of metals - abrasive wear – materials for adhesive and abrasive wear situations - corrosive wear - surface fatigue wear situations, hydrodynamic lubrication hydrostatic lubrication, elasto-hydrodynamic lubrication, boundary lubrication, lubricants, surface modification. Mechanical dynamic tribology and testing methods - simple tribological mechanical dynamic test machines and test methods. dry sand-rubber wheel test, wet sand rubber wheel test, slurry abrasivity test, solid particle erosion test, pin-on-disk wear test, rolling wear test, drum wear test, drill wear test. tribology of IC engines.

References:

1. Prasanta Sahoo. , ‘Engineering Tribology’, Prentice Hall of India, 2005.
2. Sushil Kumar Srivastava, ‘Tribology in Industries’, S. Chand Publishers, 2005.
3. J. A. Williams, Engineering Tribology, Cambridge University Press, 2005
4. Mang, Kirsten Bobzin and Thorsen Bartels, Industrial Tribology: Tribosystems, Friction, Wear and Surface Engineering, Lubrication-Theory. Wiley-VCH Verlag and Co., 2011.
5. Engineering Tribology, Stachowiak and Batchelor, Butterworth-Heinmann, 2005.
6. S.K. Basu, S.N. Sengupta, B.B. Ahuja, Fundamentals Of Tribology, Prentice Hall of India, 2005
7. Cameron, A. ‘Basic Lubricaton Theory’, Ellis Horward Ltd., UK, 2005.
8. Kragelsky, ‘ Friction Wear and Lubrication’, Mir Publications, 2005

14ME3028 ADVANCED MECHANICAL VIBRATIONS (V-1.1)

Credits: 3:0:0

Course objectives:

To impart knowledge on

- Formulating mathematical model for vibration problems
- Skills in analyzing the vibration behavior of mechanical systems subjected to loading
- Vibration control and the equipment used for collecting response data.

Course outcomes:

Ability to

- Formulate equations of motion of vibratory systems.
- Solve vibration problems with multiple degrees of freedom.
- Suggest methods to regulate vibration
- Acquire data from vibration measuring instruments

Description:

Overview of Mechanical vibrations – Types of vibrations – Damping models – Solutions of problems for one degree of freedom systems for static, transient and harmonic response using Newton's method, Energy method and Rayleigh's method – isolation of vibrations and transmissibility – Vibration of two and Multi degree of freedom systems–semi definite systems –vibration absorber – Vibration of continuous system like strings, beams and rods – Identifying natural frequencies for vibration problems using numerical methods like matrix iteration, Stodola, Holzer and mechanical impedance – Vibration measuring instruments – Vibration Tests –Data acquisition – FFT analysis.

References:

1. Singiresu S. Rao, 'Mechanical Vibrations', Addison Wesley Longman, 2003.
2. Benson H Tongue, 'Principles of Vibration' (2nd edition), Oxford University Press, 2002.
3. Thomson, W.T., 'Theory of Vibration with Applications' CBS Publishers and Distributers,NewDelhi,2002
4. Kelly, 'Fundamentals of Mechanical Vibrations', McGraw Hill Publications, 2000.
5. Rao, J. S., and Gupta K. 'Ind. Course on Theory and Practice Mechanical Vibration', NewAge International (P) Ltd., 2005.
6. Rao V. Dukkipati, J. Srinivas., Vibrations: problem solving companion, Narosa Publishers, 2007.
7. Daniel J. Inman, 'Engineering Vibration', Prentice Hall,4th Edition, 2013

14ME3030 INDUSTRIAL ROBOTICS (V-1.1)

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Components, sensing elements used programming techniques and Applications of robots.
- Fundamentals of Robotics and primary actuating systems, sensors and transducers.

Course Outcomes:

Ability to

- Design feedback systems for control of robots
- Apply forward and reverse kinematics to determine position of manipulators
- Select end effectors and sensing systems for robots employed in industrial applications.

Description:

Robot – Definition – Basic Concepts – configurations – Types of drives – Basic motions – Point to point control – Continuous path control. Basic control system concepts and analysis – robot actuation and feedback, Manipulators – director and inverse kinematics, Coordinate transformation – Brief Robot dynamics. Types of Robot end effectors – Grippers, Tools, End – effecter interface. Sensing – Range, Proximity, Touch, Force and Torque. Introduction to Machine vision – Sensing and digitizing – Image processing and analysis. Methods – languages – Capabilities and limitation – Artificial intelligence – Knowledge representation – Search techniques – AI and Robotics. Application of robots in machining – Welding – Assembly – Material handling – Loading and unloading – CIM – Hostile and remote environments.

References:

1. Criag John, 'Introduction to Robotics- Mechanics and Control', Pearson, 3rd Edition,2008
2. Reza N Jazzar, 'Theory of Applied Robotics', Springer, 2010.
3. Mikell P. Groover, Mitchell Weiss, 'Industrial Robotics, Technology, Programming and Applications. 'McGraw Hill International Editions, 1st Edition, 2000.
4. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, 'Robotic Engineering - An Integrated Approach', Prentice Hall India, 2002
5. K.S. Fu., R.C. Gonalez, C. S. G. Lee, 'Robotics Control sensing ', Vision and Intelligence, McGraw Hill International Edition, 1987.
6. Deb. S.R, 'Robotics Technology and Flexible Automation', Tata McGraw Hill, 2009.

14ME3033 ENGINEERING PRODUCT DESIGN AND DEVELOPMENT STRATEGIES (V-1.1)

Credits: 3:0:0

Course Objectives:
To impart knowledge on
- Important practices followed during designing and developing a product in industries.
- Product life cycle right from its conceptual stage to its development stage.
- Various concepts like modelling, simulation, material selection and GD & T.

Course Outcomes:
Ability to
- Follow appropriate methodology to design components.
- Make use of technologies like CAD, CAM and CAE in designing and developing a product
- Improve the quality of the design of the final product.

Description:
Importance of product design – Design Constraints – Consideration of a Good Design – Detailed description of Design process – The role of different Models in Engineering Design – Relation of Materials Selection to Design – Performance Characteristics of materials, The Materials Selection process – Material selection in Embodiment design – Economics of materials – Selection with Computer–Aided database – Weighted Property Index – Value analysis – Functional and production design – Form design – Influence of basic design, Mechanical loading and material on Form design – Form design of castings – Dimensioning and Tolerancing a product – Functional production and inspection datum – Tolerance analysis. Dimensioning systems – Dimensioning Rules – Geometric tolerancing – introduction to statistical tolerancing.

References:

1. Dieter. G. E, ‘Engineering Design’, McGraw Hill, 2000.
2. David A. Madsen, ‘Engineering Drawing and Design’, Delmar Thomson Learning Inc. 2002,
3. Jones J.C., ‘Design Methods’, Interscience, 2008
4. Kevin Otto and Kristin Wood, ‘Product Design’, Pearson Educational Inc. 2004.
5. Karl T Ulrich, Steven D Eppinger, ‘Product Design and Development’, Irwin Homeward Boston Publishers, 2004.

14ME3034 CONTROL OF CNC MACHINE TOOLS (V-1.1)

Credits: 3:0:0

Course Objectives:

To familiarize the students about functioning of CNC machine tool from the control point of view.

Course Outcomes:

Ability to

- Recognize functions of the CNC control systems.
- Design control systems for CNC machines.
- Design and implement interpolators for CNC systems

Description:

Introduction to CNC systems, Coordinate systems of CNC machines, Economics. CNC programming – Interpolation, feed, tool and spindle functions (G–codes). CNC drives – Hydraulic systems, servo and stepping motors, response analysis, Feedback devices and coutner. CNC Interpolation – Hardware interpolators – DDA integrator, linear, circular, complete interpolators, Software interpolators, Tustin method, NURBS and polynomial interpolators, Acceleration and deceleration control techniques. CNC control loops, PID control, servo controller, gain tuning, feed forward control, Mathematical analysis of control loops. CNC Architecture – Numerical control kernel – types, PLC, programming, languages, Human–Machine Interface – functions, structure, Introduction to Open CNC architecture.

References:

1. Suk-Hwan Suh and Ian Stroud, Cloud 'Theory and Design of CNC Systems', Springer, 2008
2. Yoram Koren and Joseph Ben Uri, 'Numerical Control of Machine Tools', Khanna Publishers, 2000.
3. Yoram Koren, 'Computer Control of Manufacturing Systems' McGraw Hill, 1985.
4. Bollinger, 'Computer Control of Machines and Processes', Addison Wesley, 1989.
5. Yusuf Altintas, 'Manufacturing Automation Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design', Second edition, Cambridge University Press, 2012.
6. Gene F. Franklin, J. David Powell, Abbas Emami-Naeini, 'Feedback Control of Dynamic Systems', 6th Edition, Pearson Education, 2009.

14ME3036 BIOMASS ENERGY (V-1.1)

Credits 3:0:0

Course Objectives:

To impart knowledge on

- Thermal biomass conversion and biological pathways.
- Power generation techniques.
- Design, selection, construction and operation of biogas plants.

Course Outcomes:

Ability to

- Analyze biomass conversion process for better yield
- Design of bio-mass systems considering economic and environmental aspects.
- Apply biomass energy systems for practical applications.

Description:

Biomass – resources, classification, properties. Thermo chemical conversion, Biological Conversion – alcohol Production – Fermentation – Anaerobic Digestion Biodegradation and Biodegradability of Substrate – Hydrogen Generation from Algae – Biological Pathways – Biogas Production from different Organic Wastes – Effect of Additives on Biogas, Industrial Application – Wood Gasifier System, Operation of Spark Ignition and Compression Ignition with Wood Gas – Energy Effectiveness and Cost Effectiveness – History of Energy Consumption – Environmental Aspects of Bio energy Conversion – Economic analysis of bio energy options – Design of the digester – scaling of biogas plants – Electricity Production from biomass.

References:

1. Mital K.M, 'Biogas Systems: Policies, Progress and Prospects', 1st Edition, New Age International Private Ltd, New Delhi, 2006.
2. N. H. Ravindranath, Hall D.O., 'Biomass, Energy and Environment', Reprinted Edition, Oxford University Press, Oxford, 2002.
3. Chawla O.P., 'Advances in biogas technology', Publications and Information Division, Indian Council of Agricultural Research, New Delhi, 2009.
4. Nijaguna, B.T, 'Biogas Technology', 1st Edition, New Age International Private Ltd, New Delhi , 2009.
5. Mital, K.M, 'Biogas Systems: Principles and Applications', 1st Edition, New Age International Private Ltd, New Delhi, 2009.

14ME3037 QUALITY CONCEPTS IN DESIGN (V-1.1)

Credits 3:0:0

Course Objectives:

To impart knowledge on

- Basic concepts in Total quality Management
- Taguchi methods for robust design

Course Outcomes:

Ability to

- Practice the concepts of six sigma, TQM and SPC in work place.
- Design and conduct experiments for optimizing processes and products.
- Improve quality and reliability of systems

Description:

Basic concepts in quality engineering and management, TQM, Cost of quality, quality engineering and Six Sigma. Review of Probability and Statistics, Frequency distributions and Histograms, Test of Hypothesis. DMAIC process for process and design improvement, Acceptance Sampling, SPC (Statistical Process Control), Process Capability, Gage Reproducibility and Repeatability, Quality Function Deployment. Failure mode effect analysis, APQP, Embodiment checklist – Advanced methods: systems modeling, mechanical embodiment principles. Design of Experiments, ANOVA, EVOP; Fractional, Full and Orthogonal Experiments, Regression model building, Taguchi methods for robust design. Six Sigma sustainability, Six Sigma and lean production. Reliability – Survival and Failure–Series and parallel systems – Mean time between failure – Weibull distributions

References:

1. Evans, J R and W M Lindsay, 'An Introduction to Six Sigma and Process Improvement', 2nd Edition CENGAGE, 2005.
2. Pyzdek, Thomas, 'The Six Sigma Handbook-Revised and Expanded', McGraw-Hill, 2003.
3. Montgomery, D C, 'Design and Analysis of Experiments', 5th Edition., Wiley.2007
4. Mitra, Amitava, 'Fundamentals of Quality Control and Improvement', 3rd Edition, John Wiley and Sons, 2008.
5. L S Srinath, Reliability Engineering, East West Press, 2005.

14ME3039 EXPERIMENTAL STRESS ANALYSIS (V-1.1)

Credits: 3:0:0

Course Objectives:

- To impart knowledge on applied stress and strain involved in solid mechanics.
- To impart knowledge on the relation between theory of mechanics and experimental stress and strain analysis

Course Outcomes:

Ability to

- Analyse stress and strain in machine elements.
- Apply appropriate techniques to measure stress and strain.
- Make use of devices to find stress and strain experimentally.

Description:

Elementary Elasticity, Strain Measurement Methods, Photo Elasticity – plane and circular polarization – stress optic law – photo elastic materials – casting and modeling techniques – calibration methods – Reflection polariscope – sensitivity of the method – separation, Comparison of brittle coating and bi–refrigerant coating techniques – Brittle Coating Method. Crack detection techniques – calibration of brittle coating materials – Moire Methods. Digital image processing – Image processing systems for digital photoelasticity – Image acquisition.

References:

1. Shukla and Dally, 'Experimental Stress Analysis'**,** 3rd. Edition, McGraw Hill, 2010.
2. J.W. Dally and W.F. Riley, Experimental Stress Analysis, 4th Edition, College House Enterprises, 2005.
3. Sadhu Singh, Experimental stress analysis, Khanna publishers, 2009
4. LS Srinath, MR Raghavan, K Lingaiah, G Gargesha, B Pant, K Ramachandra, Experimental Stress Analysis, Tata McGraw-Hill, 1984.
5. U.C. Jindal, Experimental Stress Analysis, Pearson Education, 2012.
6. James F. Doyle, 'Modern Experimental Stress Analysis: Completing the Solution of Partially Specified Problems, Wiley-Blackwell,2004
7. Dove and Adams, 'Experimental Stress Analysis and Motion Measurement', Prentice Hall of India, 1964.

14ME3040 ENGINEERING FRACTURE MECHANICS (V-1.1)

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- Stress and strain field around a crack in a body for different fracture modes
- Factors governing crack, crack arrest and fatigue.
- The applications of fracture mechanics.

Course Outcomes:

Ability to

- Analyze the distribution of stress and strain field near a crack.
- Determine fracture toughness value of a material for various fracture modes.
- Apply the principles of fracture mechanics to prevent crack growth and fatigue failures

Description:

Elements of Solid Mechanics, deformation, limit analysis – Airy's function – field equation for stress intensity factor. Stationary Crack Under Static Loading: Two dimensional elastic fields –Analytical solutions yielding near a crack front – Irwin's approximation – plastic zone size –Dugdale model – determination of J integral and its relation to crack opening displacement. Energy Balance and Crack Growth: Griffith analysis – stable and unstable crack growth –Dynamic energy balance – crack arrest mechanism – K_{1c} test methods – R curves – determination of collapse load. Fatigue Crack Growth Curve: Empirical relation describing crack growth law –life calculations for a given load amplitude – effects of changing the load spectrum – rain flow method – external factors affecting the K_{1c} values – leak before break analysis. Applications of Fracture Mechanics.

References:

1. Preshant Kumar, 'Elements of Fracture Mechanics', Tata McGraw Hill Education Private Limited, 2009.
2. Ted L. Anderson, 'Fracture Mechanics: Fundamentals and Applications', 3rd Edition, Taylor and Francis, CRC, 2004.
3. David Broek, 'Elementary Engineering Fracture Mechanics', Kluwer Academic Publisher, 4th Edition, 1986.
4. Kare Hellan, 'Introduction of Fracture Mechanics', McGraw-Hill Book Company, 1985.
5. Kundu, Fundamentals of Fracture Mechanics, Taylor and Francis Group,2008
6. John M. Barson and Stanely T. Rolfe, Fatigue and fracture control in structures, Prentice Hall Inc. Englewood Cliffs. 1977.

LIST OF SUBJECTS

Subject Code	Name of the Subject	Credit
13ME301	Ergonomics for Special Groups	4:0:0
13ME302	Design and use of Assistive Technology	4:0:0
13ME303	Composite Materials Technology	4:0:0
14ME1001	Geometric Drawing	0:0:2
14ME1002	Workshop Practice	0:0:2
14ME1003	Basic Mechanical Engineering	3:0:0
14ME2001	Engineering Mechanics	3:0:0
14ME2002	Metallurgy Laboratory	0:0:1
14ME2003	Material Science and Engineering	3:0:0
14ME2004	Manufacturing Processes	3:0:0
14ME2005	Machining Processes	3:0:0
14ME2006	Metrology and Measurement Systems	3:0:0
14ME2007	Fluid Power Control Engineering	3:0:0
14ME2008	Foundry, Smithy, Welding and Sheet Metal Laboratory	0:0:2
14ME2009	Metrology Laboratory	0:0:1
14ME2010	Fluid Power Control and Mechatronics Laboratory	0:0:2
14ME2011	CAM Laboratory	0:0:1
14ME2012	Lathe Shop	0:0:1
14ME2013	Special Machines Laboratory	0:0:1
14ME2014	Engineering Thermodynamics	3:0:0
14ME2015	Thermal Engineering I	3:0:0
14ME2016	Thermal Engineering II	3:0:0
14ME2017	Basic Automobile Engineering	3:0:0
14ME2018	Power Plant Engineering	3:0:0
14ME2019	Heat and Mass Transfer	3:1:0
14ME2020	Thermal Engineering Laboratory	0:0:1
14ME2021	Modern Vehicle Technology	3:0:0
14ME2022	Heat Transfer Laboratory	0:0:1
14ME2023	Internal Combustion Engines Laboratory	0:0:1
14ME2024	Mechatronics	3:0:0
14ME2025	Computer Aided Design and Manufacturing	3:0:0
14ME2026	Mechanics of Machines	3:1:0
14ME2027	Dynamics of Machinery	3:1:0
14ME2028	Design of Transmission Systems	3:0:0
14ME2029	Design of Machine Elements	3:1:0
14ME2030	Design of Heat Exchangers	3:0:0
14ME2031	Computer Aided Design and Engineering Laboratory	0:0:2
14ME2032	Machine Drawing	0:0:2
14ME2033	Dynamics Laboratory	0:0:2
14ME2034	Design of Jigs, Fixtures and Press Tools	3:0:0
14ME2035	Industrial Safety Engineering	3:0:0
14ME2036	Mechanical Vibrations	3:0:0
14ME2037	Product Design and Development Strategies	3:0:0
14ME2038	Tribology in Design	3:1:0
14ME2039	Composite Materials	3:0:0
14ME2040	Design for manufacture	3:0:0
14ME2041	Turbomachinery	3:0:0
14ME2042	Mechatronics and Control systems	3:0:0
14ME2043	Industrial Engineering	3:1:0
14ME2044	Industrial Design	3:0:0

14ME2045	Rapid Prototyping and Tooling	3:0:0
14ME2046	Metal Cutting Theory and Practice	3:1:0
14ME2047	Welding Technology	3:0:0
14ME2048	Foundry Technology	3:0:0
14ME2049	Renewable Energy Sources	3:0:0
14ME2050	Advanced Internal Combustion Engines	3:1:0
14ME2051	Refrigeration and Air Conditioning	3:1:0
14ME2052	Biomass Energy systems	3:0:0
14ME2053	Alternative fuels for I.C Engines	3:0:0
14ME2054	Principles of Resource and Quality Management	3:1:0
14ME3001	Combustion in Engines	3:0:0
14ME3002	Advanced Thermodynamics	3:0:0
14ME3003	Advanced Fluid Mechanics	3:0:0
14ME3004	Design of Thermal Power Equipments	3:0:0
14ME3005	Computer Integrated Manufacturing Systems	3:0:0
14ME3006	Computer Applications in Design	3:0:0
14ME3007	Engineering Materials and Applications	3:0:0
14ME3008	Advanced Strength of Materials	3:0:0
14ME3009	Principles of Mechanical Measurements and Instrumentation	3:0:0
14ME3010	Mechatronics and Machine Controls	3:0:0
14ME3011	Computer Aided Engineering Laboratory	0:0:2
14ME3012	CAD/CAM Laboratory	0:0:2
14ME3013	Solar Refrigeration and Air Conditioning	3:0:0
14ME3014	Refrigeration Machinery and components	3:0:0
14ME3015	Theory of Metal Cutting	3:0:0
14ME3016	Advanced Metrology	3:0:0
14ME3017	Advanced Heat Transfer Laboratory	0:0:1
14ME3018	Automation and Robotics Laboratory	0:0:2
14ME3019	Energy Conservation and Management	3:0:0
14ME3020	Advanced Manufacturing Processes	3:0:0
14ME3021	Composite Materials	3:0:0
14ME3022	Advanced Heat Transfer	3:0:0
14ME3023	Design of Mechanical System Elements	3:0:0
14ME3024	Design for Manufacturing and Assembly	3:0:0
14ME3025	Manufacturing System and Simulation	3:0:0
14ME3026	Advanced Mechanism Design	3:0:0
14ME3027	Industrial Tribology	3:0:0
14ME3028	Advanced Mechanical Vibrations	3:0:0
14ME3029	Vibration Laboratory	0:0:2
14ME3030	Industrial Robotics	3:0:0
14ME3031	Cogeneration and Waste heat Recovery	3:0:0
14ME3032	Drives and Control Systems for Robot	3:0:0
14ME3033	Engineering Product Design and Development Strategies	3:0:0
14ME3034	Control of CNC Machine Tools	3:0:0
14ME3035	Solar Thermal Energy Conversion	3:0:0
14ME3036	Biomass Energy	3:0:0
14ME3037	Quality Concepts in Design	3:0:0
14ME3038	Renewable Energy Sources	3:0:0
14ME3039	Experimental Stress Analysis	3:0:0
14ME3040	Engineering Fracture Mechanics	3:0:0
14ME3041	Applied Mechatronics	3:0:0
14ME3042	Automation in Manufacturing	3:0:0
14ME4001	Friction Stir Welding and Processing Technology	3:1:0

14ME4002	Applied Thermal Engineering and Experimental Methods	3:1:0
14ME4003	Smart Materials and Vibration Control	3:1:0
14ME4004	Control System Engineering	3:1:0

13ME301 ERGONOMICS FOR SPECIAL GROUPS

Credits: 4:0:0

Objective:

- To understand the Ergonomics for Disabled and Elderly peoples.
- To provide the knowledge about Ergonomic Assessment Methods and Techniques.
- To learn about the principles of Human Factors and Engineering.
- To give skills on special solutions for people with lower back problems and Bed ridden

Outcome:

- Knowledge in techniques to assess elderly and disabled persons.
- Ability to design of assistive devices for elderly and disabled persons.
- Ability to design for persons with disabilities
- knowledgeable on human factors engineering

Unit I

EXTRA-ORDINARY INDIVIDUALS AND GROUPS OF PEOPLE: Introduction - Defining Ergonomics-Defining "Extra-Ordinary" Individuals and Population Groups - A Day in the Life of My Mother - Differing From the Norm -Capabilities of the Mind - Sensing the Environment.

Unit II

ASSESSMENT METHODS AND TECHNIQUES: Overview- Measurement Teams -Anthropometric Techniques-Assessing Energetic Capabilities, Muscle Strength, Mental Workload, Vision Capabilities, Auditory Capabilities, Smelling and Tasting Capabilities, Taction Senses, Assessing Response, Complex Capabilities-Systematic Gathering of Information.

Unit III

PRINCIPLES OF HUMAN FACTORS ENGINEERING: Overview-Striving for Better Designs-Proper Design Procedures -Designing for Body Strength, "Signal Loop", Groups of People and for Individuals.

Unit IV

DESIGN FOR MOVEMENT: Special solutions for the very small and big, for those with lower back problems and for bedridden persons, Overview-Design for Motion Instead of Posture- Design to Fit Body Dimensions-Design for Very Small and Very Big People-Design to Avoid Harm and Injury.

Unit V

DESIGN FOR PERSONS WITH DISABILITIES: Overview-Defining and Measuring Disabilities-Ergonomics for One-Locomotion Aids –Use of Computers-Ergonomic Design of Tele-support Systems-Consumer Products-Selection of Assistive Technology-Sources of Information and Advice

Text Books:

1. Karl H.E. Kroemer, 'Extra-Ordinary' Ergonomics: How to Accommodate Small and Big Persons, The Disabled and Elderly, Expectant Mothers, and Children (Hfes Issues in Human Factors and Ergonomics), CRC Press; 1st Edition, 2005, ISBN-10: 0849336686 ISBN-13: 978-0849336683

Reference Books:

1. Arthur D. Fisk and Wendy A. Rogers, Handbook of Human Factors and the Older Adult, Academic Press Inc; 51st edition, 1996. ISBN-10: 0122576802 and ISBN-13: 978-0122576805.

2. Abdelsalam Helal, Mounir Mokhtari and Bessam Abdulrazak, “The Engineering Handbook of Smart Technology for Aging, Disability and Independence”, Wiley-Blackwell, 2008, ISBN-10: 0471711551 and ISBN-13: 978-0471711551.
3. Ergonomic Checkpoints-Practical and easy-to-implement solutions for improving safety, health and working conditions- International Labour Organization, Second edition 2010, International Labour Office,Geneva,2010, ISBN 978-92-2-122666-6,www.ilo.org/publns

13ME302 DESIGN AND USE OF ASSISTIVE TECHNOLOGY

Credits: 4:0:0

Objective:

- To familiarize student with Human Body and it’s functioning.
- To give knowledge about Ethics in design of Assistive Device Technologies.
- To give exposure to Myths of Natural Technology.
- To equip students with skills on Need and Task Based Design

Outcome:

- Knowledgeable on Human Body and its functioning.
- Ability to design of Assistive Device Technologies, Ethics and Surveys.
- Knowledgeable on Evaluate Assistive Technology

Unit I

The Human Body: Body Sizes-Mobility, Muscular work, Body Strength and load handling- The human mind, How we see, How we hear, How we sense objects and Energy, How we experience indoor and outside climates.

Unit II

The User’s Experience and Case Study: Better Than New Ethics for Assistive Technologists- Introduction-Fear of Technology and Disability Discrimination-Sources of Assistive Technology Ethics-The Standard of Normality-Justice. Case Study: An Assistive Technology Ethics Survey Peter A. Danielson, Holly Longstaff, Rana Ahmad, H.F. Machiel Van der Loos, Ian M. Mitchell, and Meeko M.K. Oishi-Survey Design -Survey Questions

Unit III

The Myth of Natural Technology: Source of the Data- Key Ideas Related to Meaning and Assistive Technology-Implications for AT Design and Selection-Accessible Technology and Models of Disability-Assistive Technology-Models of Disability-Accessible Technology-Concepts from Human–Computer Interaction

Unit IV

Need and Task-Based Design and Evaluation: Introduction-Assistive Technology Abandonment-HAAT Model-Case Stories: Applying the HAAT Model. Research and Academic Outreach - Challenges to Effective Evaluation of Assistive Technology - Evaluating Technology in the Lab, Clinic and the world.

Unit V

Providing Innovative Engineering Solutions: Academia and Industry**-** Project Criteria- Logistics. Projects: Innovative Engineering Solutions to be provided for real time problems through mini-projects.

Text Books:

1. Karl H E Kroemer, Fitting the Human, Introduction to Ergonomics, 6th Edition, 2008, CRC Press ISBN-10: 1420055399 and ISBN-13: 978-1420055399
2. Meeko Mitsuko K. Oishi, Ian M. Mitchell, H. F. Machiel Van der Loos, Design and Use of Assistive Technology, 2010, Springer, ISBN: 978-1-4419-7030-5 (Print) 978-1-4419-7031-2

Reference Books:

1. Ergonomics: A Practical Guide and Companion CD, 2nd Edition by National Safety Council, 1993, National Safety Council; 2nd edition, 1993, ISBN-10: 0879121688 and ISBN-13: 978-0879121686.

2. Rory Cooper, Wheelchair Selection and Configuration, Demos Medical, 1st Edition , 1998. ISBN-10: 1888799188 and ISBN-13: 978-1888799187.

13ME303 COMPOSITE MATERIALS

Credits 4:0:0

Objective:

- To provide a basic understanding of composite materials and to understand how composite materials are obtained and discuss the nature of the various forms of reinforcement and matrix.
- To learn about various types of composites including processing.
- To Understand the various testing of composite materials and its constituents.

Outcome:

- Ability to understand the basics of Composite materials and its properties and applications.
- Ability to know the processing methods of MMCs and their properties and applications
- Knowledge about Processing of Polymer and Ceramic Metal matrix composites and curing methods of Polymer Metal matrix composites
- Ability to understand the various testing methods of Composite materials and its constituents.

Unit I

INTRODUCTION: Definition –Classification of Composite materials based on structure – based on matrix - Matrices – Polymer, Graphite, Ceramic and Metal Matrices - Advantages of composites – application of composites – functional requirements of reinforcement and matrix . Reinforcement types – Fibres – Glass, Carbon, Ceramic and Aramid fibers - continuous, particulate and whisker reinforcements – Properties - Applications – Comparison of fiber strengths – Matrix materials – Properties. Wettability fibre with matrix – Effect of surface roughness – Interfacial bonding

Unit II

MECHANICS OF COMPOSITES: Rule of mixture - volume and mass fractions – density - void content, Evaluation of four elastic moduli based on strength of materials approach and Semi - Empirical model - Longitudinal Young's modulus - transverse Young's modulus – major Poisson's ratio – In - plane shear modulus, Ultimate strengths of a unidirectional lamina. Characteristics of Fiber - reinforced lamina – laminates – lamination theory, Interlaminar stresses.

Unit III

POLYMER MATRIX COMPOSITES: Polymer matrix resins – Thermosetting resins, thermoplastic resins – Reinforcement fibres – Rovings – Woven fabrics – Non woven random mats – various types of fibres. PMC processes - Hand lay up processes – Spray up processes – Compression moulding – Reinforced reaction injection moulding - Resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fibre reinforced plastics (FRP), Glass fibre reinforced plastics (GRP).

Unit IV

METAL MATRIX COMPOSITES: Characteristics of MMC, Various types of Metal matrix composites Alloy vs. MMC, Advantages of MMC, Limitations of MMC, Metal Matrix, Reinforcements – particles – fibres. Effect of reinforcement - Volume fraction – Rule of mixtures. Processing of MMC – Powder metallurgy process - diffusion bonding – stir casting – squeeze casting.

Unit V

COMPOSITE STRUCTURES: Fatigue –S-N curves – Fatigue behaviors of CMCs – Fatigue of particle and whisker reinforced composites – Hybrid composites – Thermal fatigue. Introduction to structures - selection of material, manufacturing and laminate configuration - design of joints - bonded joints - bolted joints - bonded and bolted

Text Books:

1. 1 Mallick, P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", Third Edition, Marcel Dekker Inc, 2007.
2. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, 2006.
3. Mathews F.L. and Rawlings R.D., Composite materials: Engineering and Science, Chapman and Hall, London, England, 1st edition, 1994.

Reference Books:

1. Robert M. Jones, "Mechanics of Composite Materials" Taylor and Francis, 1999
2. Chawla K.K Composite Materials: Science and Engineering ., Springer – Verlag, 2008
3. Ronald Gibson, "Principles of Composite Material Mechanics", Tata McGraw Hill, 2007.
4. Strong A.B., Fundamentals of Composite Manufacturing, SME, 1989.
5. Sharma S.C., Composite materials, Narosa Publications, 2000.

14ME1001 GEOMETRIC DRAWING

Credits: 0:0:2

Course Objective:

- To impart and inculcate proper understanding of the theory of projection.
- To improve visualization skills.
- To enable students to understand various concepts like dimensioning, conventions and standards related to working drawings in order to become professionally efficient.
- To understand the usage of various line types, arcs, and methods to draw using AutoCAD.
- To understand standard, modify, draw, layers and properties tool bars and use it to draw 2D drawings and plotting
- To understand suitable hatching methods, dimensioning, and apply orthographic and isometric views

Course Outcome:

Ability to

- Understand theory of projection and conventions to graphically represent the details of engineering components
- Visualize the objects from the drawings
- Represent engineering components in terms of orthographic and isometric drawings with different line types, arcs and circles using CAD software
- Reconstruct the drawings with modify, layers and properties tool bars using CAD software
- Describe simple building drawings with suitable hatching methods

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

Reference Books:

1. Basant Agrawal, C.M. Agrawal, 'Engineering Drawing', Tata McGraw Hill Private Ltd., 2010.
2. Shyam Tickoo, 'AUTOCAD 2012 ' Pearson Publications, 2012.
3. Bhatt N.D., "Elementary Engineering Drawing", 26th Edition. Chartor Publishing House, Anand, 2009.
4. Venugopal K. "Engineering Graphics", 9th Edn. (Revised), New Age International Publishers, 2009.
5. Natarajan K.V. "A Text Book of Engineering Drawing", 16th Edition, 2006.
6. Shyam Tickoo, 'AUTOCAD 2007 for Engineers and Designers ' Dreamtech India (P) Ltd., 2007.

14ME1002 WORKSHOP PRACTICE

Credits: 0:0:2

Course Objective:

- To enable students to practice soldering techniques
- To facilitate students to practice characterization of electronic devices.
- To familiarize wiring of tube lights and lights used in stair case
- To train students in the assembly of PC and trouble shooting of the same.
- To give basic training on fitting joints and Carpentry joints as well as on plumping practices.

Course Outcome:

Ability to

- Apply the acquired skills for their mini project works as well as end semester project work.
- Asses the practical difficulties encountered in industries during any assembly work and solve the same
- Formulate methods and means for fitting works, carpentry works and pipe fittings
- Design and develop electronic and electrical circuits throughout their career
- Make use of their computer literacy to solve core engineering problems

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

Reference Books:

1. S.Suyambazhahan, "Engineering Practices", PHI, Second Edition 2012.
2. S.Bawa, "Engineering workshop practice", Tata McGraw Hill, 2013.
3. Prof.Vee Ess Workshop manual, V S Publications, Bangalore,2013.

14ME1003 BASIC MECHANICAL ENGINEERING

Credits: 3:0:0

Course Objective:

- To provide knowledge about IC Engines, External combustion Engines, boilers, power plants, metal forming, metal joining, machining process and materials.

Course Outcome:

Ability to

- summarise thermal energy systems.
- summarise materials and manufacturing processes

External combustion engine – Working of Steam Engine – Steam Turbine Boilers, petrol and Diesel Engine. conventional, non conventional power plants. Load – Types, stress and strain —Stress strain curve of ductile and brittle materials. Metal Casting and Forming Process –various steps in moulding process- patterns – melting of cast iron –cupola furnace- principles of forging, extrusion and Rolling. Arc welding, gas welding. Metal Machining**:** Working Principles and specifications of Lathe, drilling and milling machine. Properties of materials – ferrous metals and alloys –Nonferrous metals and alloys, Introduction to composites.

Reference Books:

1. K.Venugopal,V.Prabhuraja," Basic Mechanical Engineering", Anuradha Agencies,2013
2. S.R.J.Shantha Kumar, "Basic Mechanical Engineering", HiTech Publications,2001.
3. I.E. Paul Degarmo, J.T. Black, Ronald A. Kosher, "Material and Processes in Manufacturing", 8th Edition, John Wiley and sons, inc., 1999.
4. S S Rattan ," Strength of materials", Tata McGraw-Hill,2008
5. G. Shunmagam, "Basic Mechanical Engineering", Tata McGraw Hill, 2001.

14ME2001 ENGINEERING MECHANICS

Credits: 3:0:0

Course Objective:
To impart knowledge on
- forces acting on particle and rigid bodies.
- free body diagrams for solving problems with structural members.
- geometrical properties of surfaces and solids
- concepts of kinematics, kinetics of particle and rigid bodies

Course Outcome:
Ability to
- Classify the system of forces and resolve the components of force system in space
- Determine centroid and moment of inertia of solids and understand their application in mechanics.
- Analyse the motion of connected bodies
- Apply D-Alembert's principle on motion of bodies

Statics of particle : Concurrent forces in space:- Components of force in space, Equilibrium of a Particle in space – Application of statics of particle. **Equilibrium of rigid bodies:** - Free body diagram. Moment of a force about a point – Varignon's theorem – Moment of a couple – Resolution of a given force in to force and couple system. Applications of statics of rigid bodies. **Properties of surfaces and solids:-** CG, Centroid and Moment of inertia **Dynamics of particle**: Kinematics , mass moment of inertia of simple solids **Kinetics:** Newton's second law of motion – D-Alembert's principle – Motion on connected bodies, Work – Energy method Motion of connected bodies – Impulse and momentum Equation. Dynamic Equilibrium, Impact of elastic bodies: Types of impact – Method of analysis .

References Books:

1. Beer, F.P and Johnston Jr. E.R. "Vectors Mechanics of Engineers", Vol. 1 Statics and Vol. 2 Dynamics, McGraw-Hill International Edition, 2005.
2. Hibbeler, R.C., "Engineering Mechanics", Vol. 1 Statics, vol .2 Dynamics ,Pearson Education Asia Pvt. Ltd.,2000
3. Irving H. shames, "Engineering Mechanics – Statics and Dynamics", IV Edition – Pearson Education Asia Pvt. Ltd., 2003.
4. Rajasekaran, S, Sankarasubramanian, G., "Fundamentals of Engineering Mechanics", Vikas Publishing House Pvt. Ltd.,2007
5. Palanichamy, M.S.,Nagan, S., "Engineering Mechanics – statics and dynamics", Tata McGraw-Hill,2002

14ME2002 METALLURGY LABORATORY

Credit: 0:0:1

Course Objective:
- To impart knowledge on metallographic techniques for studying the microstructures of alloys.

Course Outcome:
Ability to
- Understand the working principle of optical microscope (upright type and inverted type)
- Prepare samples for metallurgical studies following appropriate metallographic procedure
- Identify the microstructures of different types of steels, aluminum and copper
- Demonstrate skills to extract metallographic images from samples
- Conduct experiments to determine the properties of foundry sand

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2003 MATERIAL SCIENCE AND ENGINEERING

Credits: 3:0:0

Course Objective:

- To impart knowledge on materials science, the structure of alloys, crystal defects, mechanical properties, phase diagrams, and heat treatments with their effects on properties.

Course Outcome:

Ability to

- Understand crystal structures of common engineering materials
- Summarize various types of defects in crystal and identify the different strengthening mechanisms
- Analyse different types of failures and predict service behavior of materials for various applications
- Determine the right compositions of metals, heat treatment procedures for different mechanical engineering applications.

Structure of solid metals, polymorphism- Miller indices. Metallographic analysis- Optical microscope, SEM, TEM. Defects in crystals– diffusion - Fick's, Laws of diffusion – plastic deformation- slip and twinning – recovery re-crystallization and grain growth.- strengthening mechanisms-Fracture – ductile and brittle fracture - Griffith's theory of crack propagation-Creep- Fatigue failure, Solid solution, Phases- phase diagrams- Gibbs phase rule- cooling curves, types of Equilibrium diagrams, lever rule –Iron –Iron Carbide equilibrium diagram -heat treatment of steel. Properties and applications: Non-ferrous alloys, polymers and ceramics. Mechanical Testing.

References Books:

1. Raghavan. V, "Material Science and Engineering, Prentice Hall of India Pvt. Ltd, New Delhi, 2004.
2. Williams D. Callister " Material Science and Engineering" John Wiley & sons inc. 2013.
3. Reza Abbaschian, Lara Abbaschian, Robert E. Reed-Hill, "Physical Metallurgy Principles", Cengage Learning, 2010.
4. Raymond A Higgins "Engineering Materials (Applied Physical Metallurgy) English Language book society, 2003.
5. Sidney Avner, " Introduction to Physical Metallurgy", Tata McGraw Hill, 1997.

14ME2004 MANUFACTURING PROCESSES

Credits: 3:0:0

Course Objective:

To impart knowledge on

- principle, procedure and applications of casting and welding processes
- principle, procedure and applications of bulk metal forming, sheet metal forming and powder metallurgy process

Course Outcome:

Ability to

- Apply cutting mechanics to metal machining based on cutting force and power consumption.
- Learn the basic operation of various traditional and non-traditional manufacturing processes.
- Learn how various products are made using traditional and non-traditional manufacturing processes.
- Justify the most appropriate manufacturing process and material for a given product.
- Select/Suggest process for producing gear.

Casting Processes and Machines: Types, Moulding Tools, Casting defects, Special casting processes. **Bulk Forming Processes and Machines:** Rolling, Forging-Extrusion, Drawing-Defects- -Force calculations, Processing of Plastics. **Sheet Forming Processes:** Types, Clearance and shear on punch and die, Types of sheet metal dies. **Welding Processes:** Types**,** consumables, Weld defects and remedies. **Powder Metallurgy:** Production of metal powder-characteristics – equipment, shaping processes, Secondary and finishing processes.

Reference Books

1. P.N. Rao, Manufacturing Technology Foundry, Forming and Welding, TMH-2003; 2nd Edition, 2003
2. Kalpakjian, S., "Manufacturing Engineering and Technology", Pearson Education India Edition, 2006.
3. Roy. A. Lindberg, Processes and Materials of Manufacture, PHI / Pearson Education, 2006
4. Nagpal G.R. "Metal forming processes", Khanna publishers, New Delhi, 2004
5. Heine, Richard, Carl R Loper and Philip Rosenthal, 'Principles of Metal Casting', Tata McGraw Hill Publishing Ltd., 2000.
6. George E Dieter., Mechanical Metallurgy, Tata Mcgraw Hill; 3 Ed 3rd edition, 2013

14ME2005 MACHINING PROCESSES

Credits: 3:0:0

Course Objective:

To impart knowledge on

- concept and basic mechanics of metal cutting,
- working of machine tools such as lathe, shaping, milling, drilling, grinding and broaching.
- methods of gear manufacturing and to know the working concepts of Non-conventional machining processes

Course Outcome

- Ability to select and apply appropriate machining processes to develop products

Chip Types, formation Mechanism, orthogonal cutting - Merchant and Lee and Shaffer theory -cutting force - Temperature in metal cutting-Tool life and tool wear-cutting tool materials- cutting fluids. **Lathe**: Construction, Types, Operations, special attachments, machining time and power estimation- capstan and turret lathes. **Reciprocating machine tools:** shaper, planer, slotter. **Milling**: Types, cutters, operations, indexing. **Drilling**: reaming, boring, tapping, machining time calculations - Broaching machines. **Grinding**: wheel designation and selection, types of machines, types of finishing Processes. Gear cutting methods. Non-conventional machining.

Reference Books

1. Rao. P.N "Manufacturing Technology", Metal Cutting and Machine Tools, Tata Mc Graw– Hill, New Delhi, 2004.
2. Kalpakjian, S., "Manufacturing Engineering and Technology", Pearson Education India Edition, 2006.
3. HMT – Production Technology, Tata Mc Graw Hill, 2008.
4. S.K.Hajra Choudhray, S.K. Bose, 'Elements of Workshop Technology, Vol. II, Machine Tools', Media promoters & Publishers (P) Ltd, 2000.
5. Gary F Benedict, 'Non traditional Manufacturing Processes', Marcel Dekker Inc,2005

14ME2006 METROLOGY AND MEASUREMENT SYSTEMS

Credits: 3:0:0

Course Objective:

To impart knowledge on

- concept of Measurements,
- various measurement systems.

Course Outcome:

- Ability to select and employ suitable instruments for measurement .
- Ability to demonstrate the use of advanced measurement techniques.

Definition-Standards of measurement-Errors in measurement-Accuracy, precision, sensitivity and readability. Length standard-Line and end standard – Slip gauges, micrometers, verniers, dial gauges comparators: various types-principle and applications, angular measuring instruments-bevel protractor, levels, sine bar and sine center, Straightness, flatness, surface texture, run out-various measuring instruments, Tool maker's microscope. Measurement of threads - errors. Coordinate measuring machine, Interferometry-applications.

Reference books:

1. R.K.Jain, "Engineering Metrology", Khanna Publishers ,2009.
2. I.C.Gupta, "A Text Book of Engineering Metrology", Dhanpat Rai and Sons, 2000.
3. John Frederick Wise Galyer, Charles Reginald Shotbolt, " Metrology for Engineers ", ELBS, 1990.
4. Thomas G. Beckwith, Roy D. Marangoni and John H. Lienhard V " Mechanical Measurements, 6th Edition, 2006
5. Manohar Mahajan, A text book of metrology , Dhanpat Rai & CO..2006

14ME2007 FLUID POWER CONTROL ENGINEERING

Credits: 3:0:0

Course Objective:

To impart the knowledge on

- components of pneumatic and hydraulic circuits.

Course Outcome:

Ability to

- Apply boolean algebra for logic design of FPC circuits.
- Interpret the standard symbols used in FPC Systems.
- Demonstrate the working principles and constructional details of Fluid Power Control System components and drives.
- Design and develop low cost automation circuits for industrial problems.

Introduction, application and design of pneumatic, hydraulic, electro pneumatic, electro hydraulic systems - Circuit and graphic symbols – Actuators –valves Cylinders - Energy transfer and preparation - Measuring instruments-Equipment combinations - Electrical circuit symbols - Electro-hydraulic control - Hydraulic circuit diagram - Electrical circuit diagram - Function diagram - Procedure for the construction of an electro-hydraulic system - Actuation of a single-acting cylinder - Direct solenoid valve actuation - Indirect solenoid valve actuation - Boolean basic logic functions - Actuation of a double-acting cylinder - **Hydraulic Drives** - Constant and Variable delivery types, gears, vane and piston pumps - linear motor cylinder and piston drives - Hydraulic and pneumatic Circuits – Reciprocation - quick return - sequencing – synchronizing - clamping and accumulator circuits - press circuits - fluidic elements – Fluidic sensors

Reference books:

1. R. Srinivasan "Hydraulic and Pneumatic Controls" 2nd Edition ,Tata McGraw - Hill Education 2008.
2. Anthony Esposito, " Fluid power with applications", Prentice Hall,2008.
3. Steward H.L. " Hydraulic and pneumatic power for production, Industrial press", NewYork, 1997.
4. D.Merkle,K.Rupp, "Electro Hydraulics" FESTO didactic KG, D- 73734 Esslingen1994.
5. Ramakrishnan M. "Industrial Automation", Swathi Publications, 1999.

14ME2008 FOUNDRY, SMITHY, WELDING AND SHEET METAL LABORATORY

Credits: 0:0:2

Course Objective:

- To impart knowledge on principles and procedure of casting, welding, forming processes.
- To provide hands on training in all manufacturing processes such as casting, welding and forming

Course Outcome:

Ability to

- Apply the acquired skills for their mini project works as well as end semester project work.
- Asses the practical difficulties encountered in industries during any manufacturing processes with hand tools and solve the same
- Formulate methods and means for casting, welding forming and sheet metal processes
- Design process planning for production processes

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2009 METROLOGY LABORATORY

Credits: 0:0:1

Course Objective:

To impart knowledge on

- working principles of linear and angular measuring instruments
- measurement of linear and angular dimensions of a typical work piece specimen using the measuring instruments
- methods of form measurements

Course outcome:

Ability to

- Carry out- measurements with linear and angular measuring instruments
- measure linear and angular dimensions of a typical work piece specimen using the measuring instruments

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2010 FLUID POWER CONTROL AND MECHATRONICS LABORATORY

Credits: 0:0:2

Course Objectives:

To impart knowledge on

- fundamentals of fluid power and Mechatronics systems and primary actuating systems.
- programming skills in Programmable logic controllers.
- principles of pneumatics and hydraulics and apply them to real life problems.

Course Outcome

Ability to

- Apply boolean algebra for logic design of FPC circuits.
- Design and demonstrate low cost automation circuits with PLC for industrial problems.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2011 CAM LABORATORY

Credits: 0:0:1

Prerequisite: Lathe Shop [14ME2012], Special Machines Laboratory [14ME2013]

Course Objective:

To impart knowledge on

- NC programming for CNC turning and milling operation and execution.
- Selection of tool for a machining operation.
- simulation and verifying machining processes.

Course Outcome:

Ability to

- Understand features and applications of CNC turning and machining centers.
- Write CNC Programming for different mechanical components using G codes and M codes
- Implement the communication procedure for transmitting the CNC part program from an external computer to the control of the CNC machine tool.
- Operate a modern industrial CNC machine tool for actual machining of simple and complex mechanical parts.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2012 LATHE SHOP

Credit: 0:0:1

Course Objective:

- To impart knowledge on various operations on Lathe.

Course Outcome:

Ability to

- Demonstrate skills to machine components in lathe
- Select appropriate cutting tools for a given operation
- Interpret component drawing and compare the dimensions of the components using vernier caliper

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2013 SPECIAL MACHINES LABORATORY

Credits: 0:0:1

Prerequisite: Lathe Shop [14ME2012]

Course Objective:

To impart knowledge on

- basic knowledge about Metal cutting operation and execute it.
- selection of tools for machining operations.

Course Outcome:

- Ability to perform various metal machining operations using special machines

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2014 ENGINEERING THERMODYNAMICS

(Use of standard thermodynamic tables, Mollier diagram, Psychrometric chart are permitted.)

Credits: 3:0:0

Course Objective:

To impart knowledge on

- basic concepts of engineering thermodynamics.
- first and second law of thermodynamics, properties of pure substances, gas mixtures and psychrometry.

Course Outcome:

Ability to

- Analyse a given system applying laws of thermodynamics.
- Apply concept of entropy to design effective thermal systems.
- Determine steam quality using steam tables and Mollier chart.
- Understand and analyse psychrometric processes

Microscopic and macroscopic approach, modes of work, zeroth law of thermodynamics – First law of thermodynamics – application to closed and open systems. Kelvin's and Clausius statements of second law, reversibility and irreversibility, Carnot cycle, concept of entropy, availability. Thermodynamic properties of pure substances in solid liquid and vapour phases.Properties of ideal and real gases, Vander Wall's equation of states compressibility. Sensible and Latent heat exchange processes. Adiabatic mixing, evaporative cooling.

Reference Books:

1. Nag P.K., Engineering Thermodynamics, Tata McGraw Hill, New Delhi, 2002.
2. Yunus Cengel 'Thermodynamics', Tata McGraw Hill, 2000
3. Holman. J.P., Thermodynamics, 4th edition, McGraw Hill, 2002
4. Roy Choudhury T., Basic Engineering Thermodynamics, Tata McGraw Hill, 2000
5. Vanwylen and Sontag,, Fundamentals of Classical thermodynamics, Wiley Eastern, 2005

14ME2015 THERMAL ENGINEERING I

Credits 3:0:0

Prerequisite: Engineering Thermodynamics [14ME2014]

Course Objective

To impart knowledge on

- steam generators, nozzle, turbine.
- air compressors, refrigeration systems.

Course Outcome

Ability to

- Estimate the performance of a steam generator
- Explain the flow through steam nozzles
- Determine the efficiency of the impulse and reaction turbine using velocity triangles
- Estimate the efficiency of a reciprocating compressor

- Describe the working principle of Refrigeration systems

Steam generators - classification - boiler terms - evaporative capacity – equivalent evaporation - factor of evaporation - efficiency - heat losses - heat balance. Steam nozzle - flow through nozzles - general relation for adiabatic flow - effect of friction - critical pressure ratio - super saturated flow. Steam turbines- types and compounding - velocity diagrams for simple and multistage turbines. Air compressor - work of compression with and without clearance -efficiencies, multistage compressor - intercooling - work of multistage compressor. Refrigeration cycles.

Reference Books

1. Kothandaraman, C.P, Domkundwar S., "Thermal Engineering ", Dhanpat Rai & Sons, 2nd edition, 2003
2. Rajput, R.K., "Thermal Engineering ", Laxmi Publications (P) Ltd., 2009
3. Rudramoorthy, R., "Thermal Engineering", Tata McGraw-Hill, New Delhi, 2010
4. Nag, P.K., "Engineering Thermodynamics", Tata McGraw-Hill, New Delhi, 2002
5. Mahesh M Rathore., "Thermal Engineering", Tata McGraw-Hill, New Delhi, 2010
6. Cengel, Y.A., Boles, M. A., "Thermodynamics, an Engineering Approach", Tata McGraw Hill, 2003
7. Arora, C.P., "Refrigeration and Air conditioning", TMH, 2nd edition, 2002.

14ME2016 THERMAL ENGINEERING II

(Use of standard thermodynamic tables, Mollier diagram, Psychometric chart and Refrigerant, property tables are permitted.)

Credits: 3:0:0

Prerequisite: Engineering Thermodynamics [14ME2014]

Course Objective:

To impart knowledge on

- testing and performance of IC Engines.
- various Gas Power cycles.

Course Outcome:

Ability to

- Evaluate the performance of an internal combustion engine and various gas power cycles
- Understand the computational aspects of isentropic flow through variable area
- Analyze gas turbines cycles and compare the operational aspects of jet engines.
- Estimate cooling loads in air-conditioning systems

Internal combustion engines: Classification, components and functions. valve, port timing diagram, testing and performance. Lubrication and cooling system. Gas Power cycles- calculation of mean effective pressure and air standard efficiency.Air-conditioning: cycles, equipment, cooling load estimation. Gas dynamics: Isentropic flow – Mach number variation, Impulse function, mass flow rate, flow through nozzles and diffusers. Fanno flow equation and Rayleigh flow equation. Gas Turbines & Propulsion: Classification, Jet Propulsion, Rocket Propulsion

Reference Books:

1. Kothandaraman, C.P, Domkundwar S., "Thermal Engineering", Dhanpat Rai & Sons, 2nd edition, 2003
2. Rajput.R.K ., "Thermal Engineering", Laxmi Publications(P) Ltd.,2010
3. Rudramoorthy.R., "Thermal Engineering"., Tata McGraw-Hill .,2010
4. S.M Yahya., "Fundamentals of Compressible Fluid Flow"., New Age international Publishers .,2005
5. Arora, C.P., "Refrigeration and Air conditioning", Tata McGraw-Hill, 2nd edition, 2002.

14ME2017 BASIC AUTOMOBILE ENGINEERING

Credits 3:0:0

Course objective:
To impart knowledge on

- automotive chassis structure, transmission and suspension systems
- engine and its working
- fuel supply, cooling and lubrication systems
- thermodynamic systems
- history of Automobile

Course outcome
Ability to

- Identify the importance of vehicle frame.
- Understand the thermodynamic principles behind the working of petrol and Diesel Engines.
- Understand the construction and working principles of SI and CI engines.
- Outline the functions and components of clutch and transmission systems.
- Outline the functions and components of engine cooling, lubrication and ignition systems.

Classification of vehicles, Automobile body and loads. Automotive chassis layout and Frame. Clutches-Gearboxes-brakes-Steering system, Suspension system. Introduction to first and second laws of thermodynamics, Otto and Diesel cycles-Fuels used. Working principles of two stroke and four stroke reciprocating IC Engines. Application, various terms and specification of automobile engines. Automobile Fuel tank-Fuel Filter and Spark plug. Ignition systems-carburetor- Fuel injection systems-MPFI and CRDI. Cooling systems-Lubrication systems-History of automobile, Leading manufacturers, development in automobile industry, trends and new products

Reference Books:

1. Ramalingam. K .,K, Automobile Engineering, Scitech publications,2011
2. Kirpal Singh , "Automobile Engineering Vol II"., Standard Publishers, 2011
3. Gupta RB, Automobile Engineering, Satya Parkashan, 2000
4. P L Ballaney, Thermal Engineering, Khanna Publishers, 2004
5. Crouse W.H. and Anglin D.L., "Automotive Engines", , McGraw Hill, 9^{th} Edition, 1994

14ME2018 POWER PLANT ENGINEERING

Credits 3:0:0

Course Objective
To impart knowledge on various power generating systems.

Course Outcome
Ability to

- Explain working principles of conventional and unconventional power plants
- Asses the performance of power plants.
- Predict the fixed and operating costs of power plants.
- Identify environmental hazards of various power plants.

Vapour Power Cycles. Steam power plant - high pressure boilers - combustion systems – Boiler accessories - water treatment - condenser - cooling tower - Nuclear power plant - types of reactors - radiation shielding - waste disposal -Gas turbine power plant - open and closed cycle - Diesel engine power plant - selection of engine type - Hydro electric power plant - storage and pumped storage type - selection of water turbines - environmental hazards of various power plants. Non conventional power plant. Power plant economics - load curve - fixed and operating costs - comparison of economics of various power plants - energy audit.

Reference Books:

1. Arora and Domkundwar, "Power Plant Engineering", Dhanpat Rai & Sons, 2005
2. Roy Eckart and Joel Weisman., "Modern Power Plant Engineering", PHI, 1999.
3. Wakil, M.M.E.l, "Power Plant Technology", Mc Graw Hill, 2000
4. Wakil M.M.El., "Nuclear Heat Transport, International text Book Company", London, 1990
5. R.K.Rajput, "Power Plant Engineering", Laxmi Publications (P) Ltd, New Delhi, 2002
6. P.K.Nag, "Power Plant Engineering", TMH, New Delhi, 2002.

14ME2019 HEAT AND MASS TRANSFER

(Use of standard Heat and Mass Transfer data book is permitted.)

Credits: 3:1:0

Prerequisite: Engineering Thermodynamics [14ME2014]

Course Objective:

To impart knowledge on

- conduction, convection and radiation heat transfer.
- design of heat exchangers.
- basic principles of mass transfer.

Course Outcome:

Ability to

- Understand principles of heat conduction, convection, radiation and mass diffusion and apply to solve heat transfer problems
- Design heat exchanger systems for enhanced heat transfer performance
- Analyse and predict the flow patterns in two phase flow and heat transfer

Conduction equation in Cartesian, Cylindrical and Spherical coordinates. One dimensional steady state heat conduction in plane wall and composite wall. Heat generation in plane wall, cylinder and sphere. Conduction in two dimensions, shape factor, numerical method of analysis. lumped heat capacity systems, significance of Biot and Fourier numbers. Concept of hydro dynamics and thermal boundary layers. Forced convective heat transfer over a flat plate, flow through pipes, Free Convection – heat transfer from vertical and horizontal surfaces. Types of heat exchangers, overall heat transfer coefficients, LMTD and NTU methods, fouling factor and effectiveness. Fick's law of diffusion, equi-molal counter diffusion, Convective mass transfer coefficient, black body concepts, gray body, radiation shape factor, radiation heat transfer between two surfaces and radiation Shields.

Reference Books:

1. Holman J.P., 'Heat Transfer', SI Metric 8th Ed., Mc Graw Hill, ISE, 2003.
2. Sachdeva, 'Heat and Mass Transfer', Wiley Eastern, 2nd Ed, 2005.
3. Frank.P.Incropera,David.P.DeWitt 'Heat& Mass Transfer',John Wiley,5Th Edition 2005.
4. Yunus.A.Cengal,' Heat Transfer',Tata McGraw Hill,2nd Edition 2003.
5. P.S.Ghoshdastidar, Heat Transfer, Oxford University Press, 2005.

14ME2020 THERMAL ENGINEERING LABORATORY

Credits: 0:0:1

Co/Prerequisite: Thermal Engineering I [14ME2015]

Course Objective:

- To impart knowledge on working principles of various thermal equipments like air blower, reciprocating compressors, Refrigeration & Air Conditioning Systems, Boilers

Course Outcome:

Ability to

- Understand the thermal engineering concepts and apply them to thermal systems
- Estimate the performance of different thermal equipments like air blower, reciprocating compressors, refrigeration & air conditioning systems, Boilers

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2021 MODERN VEHICLE TECHNOLOGY

Credits: 3:0:0

Course objective:
To impart knowledge on
- Modern automobile vehicle systems.
- Sensors and Fuel injection Systems

Course outcome:
Ability to
- Select a suitable vehicle chassis.
- appreciate the functions of modern vehicle systems.

Types of automobiles-Engine location – Automobile chassis layout – construction types, engine cylinder arrangements – Piston rings – Cylinder liners – Valves and Actuating mechanisms – Inlet and Exhaust manifolds. Review of Fuel, Cooling systems-Lubrication systems-Steering systems-Wheels and tyres-Suspension systems-Clutches-brakes- Gearboxes- Hydromatic transmission. Universal joint- Propeller shaft – Hotchkiss drive – Torque tube drive, Front and Rear axles Differential: need and types; Four wheel drive. Various types of Sensors & Actuators- Solenoids, Stepper-Motors, & Relay. Fuel Injection systems- MPFI- GDI- CRDI-VTI- Distributor-less Ignition-Engine Mapping-On-board Diagnostics. Transmission electronics-Multiplexing and De-multiplexing electronically controlled Automatic Transmission System.

Reference Books:

1. Crouse W.H. and Anglin D.L., “Automotive Engines”, , McGraw Hill, 9th Edition, 1994
2. William B. Riddens, “Understanding Automotive Electronics”, 5th Edition, Butterworth & Heinemann Woburn, 1998
3. Robert Bosch, “Automotive Hand Book”, SAE 5th Edition, 20006. Bechhold, “Understanding Automotive Electronics”, SAE, 1998
4. Ramalingam.K.K, “Automobile engineering”, Scitech Publications (India) Pvt Ltd , 2011
5. Kirpal Singh , “Automobile Engineering Vol II”., Standard Publishers, 2011

14ME2022 HEAT TRANSFER LABORATORY

(Use of standard Heat and Mass Transfer data book is permitted.)

Credit: 0:0:1

Prerequisite: Heat and Mass Transfer [14ME2019]

Course Objective:
- To impart knowledge on conducting the heat transfer experiments and practically learns how to find heat transfer coefficients, thermal Conductivity, emissivity and effectiveness.

Course Outcome:
Ability to
- Demonstrate skills in conducting, heat conduction, convection and radiation heat transfer experiments
- Analyse the performance of various types of heat exchangers

- Perform boiling and condensation experiments

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2023 INTERNAL COMBUSTION ENGINES LABORATORY

Credits: **0:0:1**

Co/Prerequisite: Thermal Engineering II [14ME2016]

Course Objective:

- To impart knowledge on the performance of different IC engines like air cooled, water cooled, low speed, single and twin cylinder engines

Course Outcome:

Ability to

- Conduct a variety of experiments in internal combustion engines
- Demonstrate skills in minimizing the losses by performance test
- Estimate the emission contents in the exhaust gases through emission test

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2024 MECHATRONICS

Credits: 3:0:0

Course Objective:

To impart knowledge on

- fundamentals of Mechatronics systems and primary actuating systems, sensors and transducers.
- programming skills in Programmable logic controllers
- data presentation systems and electrical drives, Microprocessor and microcontrollers and apply them to real life problems.

Course Outcome:

Ability to

- apply the knowledge in selecting suitable Sensors and transducers for real life or industrial problems
- design and develop Mechatronics systems and primary actuating systems.

Introduction to Mechatronics - Elements of Mechatronics - Measurement systems - Control systems –Open and Closed loop systems – - Pneumatic and Hydraulic actuation systems - Servo and Proportional Controls Valves - Sensors and Transducers - Performance Terminology – Sensors – types and selections – Inputting by switches- Data presentation Systems - data acquisition systems- data loggers – Digital –to-analogue and analogue-to-digital converters- Electrical actuating systems:- electrical systems - mechanical switches – solid state switches – Solenoids – DC Motors –A.C.Motors - stepper motors. General form of microprocessor – buses – the microprocessor – memory – input/output – examples of systems - Block diagram of microcontroller– Selecting a microcontroller – Programmable Logic Controllers – Ladder Programming – Latching and internal relays – sequencing – timers and counters.

Reference Books:

1. W Bolton, "Mechatronics-Electronic control systems in Mechanical and Electrical Engineering", 4th Edition, Pearson Education,2012.
2. Dan Necsulescu, "Mechatronics", Pearson Education Asia, 2002 (Indian reprint).

3. DevadasShetty, Richard Akolk,"Mechatronics System Design" First reprint 2001.
4. Andrew Parr, 'Hydraulics and Pneumatics', Jico Publishing House ,Mumbai 2006.
5. Ramachandran S., Shiva Subramanian A., "Mechatronics" 2004 Edition.

14ME2025 COMPUTER AIDED DESIGN AND MANUFACTURING

Credits: 3:0:0

Course Objective:

- To impart knowledge on the application of computer in the design and manufacturing
- To impart knowledge on graphical entities of CAD/CAM
- To impart fundamental knowledge on computer numerical programming

Course Outcome:

Ability to

- use suitable graphical entities to design a product
- use CAD software for solid and surface modeling
- program and operate CNC Machines and to identify proper tools

Introduction to CAD- Design Process-Product cycle - Sequential and concurrent engineering- Representation of curves - Bezier curves - Cubic spline curve - B-Spline curves – Rational curves – Surface Modeling techniques - surface patch - Coons patch - bi-cubic patch - Bezier and B-spline surfaces- CNC machine tools, Principle of operation of CNC, Constructional features, Work holding features, Tool holding features, Feedback system, machine control system, 2D and 3D machining on CNC. Numerical control codes-Standards-Manual Programming-Canned cycles and subroutines- Computer Assisted Programming, CAD/CAM approach to NC part programming-APT language, machining from 3D models.

References Books:

1. Ibrahim Zeid, " CAD - CAM Theory and Practice ", Tata McGraw Hill Publishing Co. Ltd., 2005.
2. Kunwoo Lee, "Principles of CAD/CAM/CAE Systems", Addison Wesley, 2005
3. Sadhu Singh, " Computer Aided Design and Manufacturing ", Khanna Publishers, New Delhi, 2003.
4. P.Radhakrishnan and C.P.Kothandaraman, " Computer Graphics and Design ", Dhanpat Rai and Sons, New Delhi, 2003.
5. Groover and Zimmers, " CAD / CAM : Computer Aided Design and Manufacturing Prentice Hall of India, New Delhi, 2002.
6. Lalit Narayan.K, Mallikarjuna Rao,Sarcar.M.M.M, " Computer Aided Design and Manufacturing", Prentice Hall of India, 2008

14ME2026 MECHANICS OF MACHINES

Credits: 3:1:0

Prerequisite: Engineering Mechanics [14ME2001]

Course Objective:

To impart knowledge on

- linkages, mechanisms and cams
- principles involved in the displacement, velocity and acceleration at any point in a link of a mechanism.
- concepts of toothed gearing and kinematics of gear trains.
- the effects of friction in motion transmission and in machine components.

Course Outcome:

Ability to

- Understand different mechanisms and calculate the mobility
- Analyse position, velocity and acceleration of links in mechanisms

- Design cam motion profiles, for different types of follower motions
- Understand gear nomenclature and analyse gear trains
- Design transmission devices considering frictional aspects.

Basics of Mechanisms - Basic kinematic concepts and definitions– Description of some common mechanisms– Design of quick return crank-rocker mechanisms **Kinematics of Linkage Mechanisms -** Displacement, velocity and acceleration analysis of simple mechanisms– Coincident points – Coriolis component of Acceleration. **Kinematics of Cam Mechanisms-** Layout of plate cam profiles – Specified contour cams – Pressure angle and undercutting – sizing of cams. **Gears and Gear Trains-** Law of toothed gearing – tooth profiles– Non-standard gear teeth –Gear trains – Epicyclic Gear Trains – Differentials – Automobile gear box. **Friction -** Basics of friction- Sliding and Rolling friction – Friction drives – Friction in screw threads –Bearings and lubrication – Friction clutches – Belt and rope drives.

References Books:

1. Ambekar A.G., "Mechanism and Machine Theory", Prentice Hall of India, New Delhi, 2007.
2. Shigley J.E., Pennock,G.R., Uicker J.J., "Theory of Machines and Mechanisms", Oxford University Press, 2003.
3. Thomas Bevan, Theory of Machines, CBS Pub.,2001
4. Ghosh A. and Mallick A.K., "Theory of Mechanisms and Machines", affiliated East-West Press Pvt. Ltd., New Delhi, 1988.
5. Khurmi R.S. "Theory of Machines" Khanna Publishers, Delhi, 2006
6. Rattan.S.S, ' Theory of Machines" , Tata McGraw Hill, 2005.

14ME2027 DYNAMICS OF MACHINERY

Credits: 3:1:0

Prerequisite: Mechanics of Machines [14ME2026]

Course Objective:

To impart knowledge on

- analysis of forces acting in mechanisms.
- effects of unbalance forces
- modeling and analyzing the vibration behavior of spring mass damper system
- the principles in mechanisms used for governing of machines.

Course Outcome:

Ability to

- determine the forces acting on various linkages when a mechanism is subjected to external forces
- identify and correct the unbalances of rotating body
- analyze the vibratory motion of SDOF systems
- reduce the magnitude of vibration and isolate vibration of dynamic systems.
- determine dimensions of Governors for speed control.

Force analysis – Static force analysis of simple mechanisms – Dynamic force analysis – Dynamic Analysis in reciprocating engines. **Flywheel** - Turning moment diagrams of reciprocating engines - fluctuation of energy - coefficient of fluctuation of energy and speed. **Balancing** - Static and dynamic balancing - partial balancing of reciprocating masses of in-line, V and radial engines. **Free vibration** - Undamped free vibration of single degree freedom systems. **Damped Vibration** - Types of Damping – Damped free vibration. **Forced vibration** of single degree freedom systems - Vibrating isolation and Transmissibility. **Transverse vibration** - Dunkerley's method - Whirling of shafts - Critical speed. **Torsional vibration** – Two rotor, three rotor and multi rotor systems. **Mechanism for Control:** Governors – Types - Characteristics – Effect of friction – Other Governor mechanisms. Gyroscopes–Gyroscopic effects in Automobiles, ships and airplanes.

References Books:
1. Ambekar A.G., ”Mechanism and Machine Theory”, Prentice Hall of India, New Delhi, 2007.
2. Shigley J.E., Pennock,G.R., Uicker J.J., “Theory of Machines and Mechanisms”, Oxford University Press, 2003.
3. Thomas Bevan, Theory of Machines, CBS Pub.,2001
4. Ghosh A. and Mallick A.K., “Theory of Mechanisms and Machines”, affiliated East-West Press Pvt. Ltd., New Delhi, 1988.
5. Khurmi R.S. “Theory of Machines” Khanna Publishers, Delhi, 2006.
6. Rattan.S.S, ‘ Theory of Machines” , Tata McGraw Hill, 2005.

14ME2028 DESIGN OF TRANSMISSION SYSTEMS
(Use of Design Data Book is permitted)

Credits: 3:0:0

Prerequisite: Design of Machine Elements [14ME2029]

Course Objective:
- To provide knowledge about the concepts, procedures and the data, to design and analyse machine elements in power transmission systems.
- To impart competency to specify, select and design the mechanical components for transmission systems.

Course Outcome:

Ability to
- Identify the working principles of mechanical components employed in mechanical transmission systems.
- Apply suitable theories and basic engineering principles and procedures to design the transmission elements.
- Select appropriate engineering design data from standard data books for the design of mechanical transmission components
- Design the transmission systems components for given conditions using Design data hand book.

Design of Journal bearings – Sliding contact and Rolling contact. Design of belts – Flat and V Belt, Design and selection of Chains, ropes drives. Design of gears- Spur, Helical, Herringbone, bevel,worm, skew gears. Design of gearbox and speed reducers. Design of Ratchet & pawl mechanism, Geneva mechanism. Design of cams – Contact stress and Torque calculation, Power screws.Design of plate clutches-axial and cone- Design of Internal and External Shoe brakes.

References Books:
1. Sundarajamoorthy T.V. and Shanmugam, ‘Machine Design’, Khanna Publishers, 2003 .
2. Sen G. C. & Bhattacharyya A, ‘Principles of Machine Tools’, New Central Book Agency (P) Ltd., 2006.
3. Md.Jallaudeen, A Text book of Machine Design, Anuradha Publications 2006.
4. Bernard J. Hamrock, ‘Fundamentals of Machine Elements’, Third edition, McGraw-Hill Companies, May 2004
5. Hall A.S. Holowenko A.R. and Laughlin H.G., ‘Theory and Problems in Machine Design’, Schaum’s Series,2000.
6. Hall and Allen, ‘Machine Design’, S.Schaum’s Series, I edition 2001

Hand Book

Design Data – Data Book for Engineers, PSG College of Technology, Coimbatore, Kalaikathir Achchagam 2012.

14ME2029 DESIGN OF MACHINE ELEMENTS
(Use of approved data books is permitted)

Credits: 3:1:0

Course Objectives:

- To impart knowledge and skills in applying elementary design principles, basic design procedures and use of design data for the design of mechanical elements.

Course Outcome:

Ability to

- Analyse stresses acting on components and determine the size based on theories of failure
- Design machine components for a given load condition using design data hand books
- Decide specifications as per standards given in design data and select standard components to improve interchangeability

Design process – factors influencing the machine design, selection of materials based on its properties. Direct and combined stress equations, impact and shock loading. Criteria of failure, stress concentration factor, size factor, surface finish factor – factor of safety, design stress, theories of failures. **Variable and cyclic loads** – fatigue strength and fatigue limit – S-N- curve, combined cyclic stress, Soderberg and Goodman equations.
Design of springs, Design and drawing of shafts, keys, couplings, riveted joints, pressure vessels and structures, screw joints, cotter joints knuckle joints and pipe joints. Design and drawing of engine components- piston, connecting rod, crankshaft, and flywheel

Reference books:

1. Joseph Edward Shighley, 'Mechanical Engineering Design', McGraw Hill, 2007.
2. S.Md .Jalaludeen , " Machine Design",Anuradha Publications, Chennai 2011.
3. Sundarrajamoorthy, T.V. and Shanmugam, 'Machine Design', Khanna Publishers, 2003.
4. Bernard Hamrock,"Fundamentals of Machine Elements",McGrawHill,2007.
5. Dobrovolsky.V, " Machine Elements", MIR Publications, 2000.
6. Hall and Allen, " Machine Design", Schaum Series, 2001

14ME2030 DESIGN OF HEAT EXCHANGERS

Credits: 3:0:0

Prerequisite: Heat and Mass transfer [14ME2019]

Course objective

To impart the

- working principle and different types of heat exchangers
- basic design methods of heat exchangers
- the applications of heat exchangers

Course outcome

Ability to

- understand the working principle and different types of heat exchangers
- understand the basic design methods of heat exchangers
- get familiarized with the applications of heat exchangers

Introduction and classification of heat exchangers - parallel flow, counter flow and cross flow; shell and tube and plate type; single pass and multi pass. Heat transfer correlations, Overall heat transfer coefficient, Design of heat exchangers - LMTD and effectiveness NTU methods - sizing of finned tube heat exchangers, U tube heat exchangers, fouling factors, pressure drop calculations. Mechanical design of shell and tube type - thickness calculations, tube sheet design using TEMA formula. Compact and Plate Heat Exchangers - types - merits and demerits. Design of Compact heat exchangers, plate heat exchangers, performance influencing parameters, limitations. Design of surface and evaporative condensers - cooling tower - performance characteristics

Reference Books

1. Sadik Kakac and Hongtan Liu, Heat Exchangers Selection, Rating and Thermal Design, CRC Press, Second Edition 2002.
2. T.Taborek, G.F. Hewitt and N.Afgan, Heat Exchangers, Theory and practice, McGraw-Hill Book Co.1983
3. Arthur, P. Frass, Heat Exchanger Design, John Wiley and Sons, 1988
4. J. P .Gupta, Fundamentals of Heat exchanger and pressure vessels technology, Hemisphere publishing corporation, springer –Verlag (outside NA), 1986
5. E.A.D. Sanders, Heat Exchangers, Selection Design and Construction Layman Scientific and Technical; co Published with John Wiley & Sons, 1988

14ME2031 COMPUTER AIDED DESIGN AND ENGINEERING LABORATORY

Credits: 0:0:2

Course Objective:

To impart knowledge on

- the application and use of the analysis software
- constructing models, selecting appropriate elements and meshing them
- solving structural, thermal and fluid problems.

Course Outcome:

Ability to

- Gain practical experience in 3D modelling/analysis software
- Model 3D mechanical components such as knuckle joint, plummer block using appropriate modelling/assembling commands
- Identify the domain of the problem and select element, boundary condition, solvers for 2D structural and thermal problems

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2032 MACHINE DRAWING

Credits: 0:0:2

Course Objective:

To impart knowledge on

- representing any matter/object with the help of picture.
- working drawings.
- orthographic drawing of different machine parts.
- developing assembly drawings.

Course Outcome:

Ability to

- Understand drafting fundamentals and standards.
- Interpret drawings and extract required information
- Create part drawings and sectional views of machine components.
- Develop assembly drawings from part drawings.
- Carry out tolerance analysis and specify appropriate tolerances for machine design applications

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

Reference books:

1. Gopalakrishnan, "Machine Drawing" , Subash Publishers,2000 .Division of Production Engineering,
2. Bhatt, N.D. "Machine Drawing", Charotar Publishing House, Anand,2003.
3. Siddheswar, N. P.Kanniah, and V.V.S. Satry, "Machine Drawing", Tata McGraw Hill,2005
4. Revised IS codes; 10711, 10713, 10714,9609, 1165, 10712, 10715, 10716, 10717, 11663, 11668, 10968, 11669, 8043, 8000.
5. Ajeet Singh, "Machine Drawing", Tata McGraw Hill Edition, 2008.

14ME2033 DYNAMICS LABORATORY

Co/Prerequisite: Dynamics of Machinery [14ME2027]

Credits: 0:0:1

Course objective:

- To supplement the principles learnt in Mechanics of Machines
- To train the students with the principle and operations of vibration based systems
- To impart knowledge of measuring devices used for dynamic testing
- To train to study the effect of forces on various equipments based on theoretical and experimental methods

Course outcome:

Ability to

- Demonstrate the effect of unbalances resulting from rotary motions
- Study the effect of dynamics on vibrations in single and multi degree of freedom system
- Understand the working principle of governor /gyroscope and demonstrate the effect of forces and moments on their motion
- Evaluate cutting forces using dynamometer

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME2034 DESIGN OF JIGS, FIXTURES AND PRESS TOOLS

Credits: 3:0:0

Course Objective:

To impart knowledge on

- The principles of designing jigs, fixtures and press tools.
- Use of standard parts in design.

Course Outcome:

Ability to

- adopt standard procedure for the design of Jigs, fixtures and press tools.
- design Jigs, fixtures and press tools according to the requirement.
- identify and use standard parts.
- be proficient in the development of jigs and fixtures.

Locating and clamping principles **-** Mechanical actuation – pneumatic and hydraulic actuation Standard parts – Drill bushes and Jig buttons – Tolerances and materials used. Design and development of jigs and fixtures - General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures –

Modular fixturing systems- Quick change fixtures. Press Working Terminologies and Elements of Cutting Dies: Design of various elements of dies - Design and preparation of views of dies. Design and development of bending, forming and drawing reverse re-drawing and combination dies. Miscellaneous Operations - bulging, swaging, embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine blanking dies.

Reference Books:

1. Joshi, P.H. “Jigs and Fixtures”, Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2004.
2. Donaldson, Lecain and Goold “Tool Design”, III rd Edition, Tata McGraw Hill, 2000.
3. K. Venkataraman, “Design of Jigs Fixtures and Press Tools”, Tata McGraw Hill, New Delhi, 2005.
4. Joshi, P.H. “Press Tools” – Design and Construction”, S. Chand Publisher, 2010.
5. Hoffman “Jigs and Fixture Design” – Thomson Delmar Learning, Singapore, 2004.

14ME2035 INDUSTRIAL SAFETY ENGINEERING

Credits: 3:0:0

Prerequisite: Machining Processes [14ME2005]

Course Objective:

To impart knowledge on

- basic Fundamentals of Safety Engineering and Management
- recognition, investigation, analysis, and control of hazards.
- management's role in safety and assess the importance.
- recognize the multiple hazards associated with welding.

Course Outcome:

Ability to

- Understanding the main safety and ethical issues that may arise from chemical industrial processes.
- communicate the difference between Hazard and Risk. Be able to express Safety in terms of Risk and to recognize unacceptable/inappropriate levels of Risk.
- Understanding hazards arising from runaway reactions, explosions and fires, and how to deal with them.

Safety in metal working machinery and wood working machines - General safety rules, principles, maintenance, Inspections of manufacturing machines, hazards. Principles of Machine Guarding - Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding of hazards - point of operation protective devices.Safety in Welding and Gas Cutting - Gas welding and oxygen cutting, resistances welding, arc welding and cutting, personal protective equipment, training, safety precautions during welding.Safety in Cold Forming and Hot Working of Metals - Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism. Safety in Finishing, Inspection and Testing - Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in inspection and testing, dynamic balancing, hydro testing. Applicable standards in Industrial safety management.

Reference books:

1. Accident Prevention Manual, National Safety Council (NSC), Chicago, 1982.
2. Occupational safety Manual, BHEL, Trichy, 1988.
3. John V. Grimaldi and Rollin H. Simonds., Safety Management, All India Travelers Book seller, New Delhi, 1989.
4. N.V. Krishnan, Safety in Industry, Jaico Publishery House, 1996.
5. Indian Boiler Acts and Regulations, Government of India.
6. Safety in the use of wood working machines, HMSO, UK 1992.
7. Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.

14ME2036 MECHANICAL VIBRATIONS

Credits: 3:0:0

Prerequisite: Dynamics of Machinery [14ME2027]

Course Objective:

- To impart knowledge on importance of vibration and its analysis
- To impart knowledge on mathematical modeling of a vibratory system and find the response
- To impart skills in analyzing the vibration behavior of mechanical systems under different types of loading.
- To impart knowledge about the methods of reducing unwanted vibration.

Course Outcome:

Ability to

- Classify vibration systems and derive equations of motion from free -body diagrams.
- Solve vibration problems with multi degrees of freedom.
- Identify modes of a system and compute its natural frequencies.
- Propose solutions to reduce vibration using Isolation
- Identify instruments used in noise and vibration control tests

Relevance and need for vibrational analysis - Mathematical modelling of vibrating systems -Types of vibrations-single degree of freedom systems for free and forced vibration. Damped free vibration-Forced vibration of undamped system- Dynamic vibration absorber. Free and forced vibrations of multi-degree of freedom systems in longitudinal torsional and lateral modes -Matrix methods of solution- Orthogonality principle. Vibration of continuous system like beams, strings and rods- Torsional vibration. Vibration measuring devices-vibration exciters-Vibration Tests.

Reference Books

1. Singiresu.S.Rao., "Mechanical Vibrations", Addison Wesley Longman ,2003.
2. Benson H Tongue, “ Principles of vibration”(2nd edition)Oxford University Press, 2002
3. Kelly, "Fundamentals of Mechanical Vibrations”, Mc Graw Hill Publications, 2000.
4. Thomson, W.T.,--"Theory of Vibration with Applications" CBS Publishers and Distributers, NewDelhi,2002
5. Rao V. Dukkipati, J. Srinivas., Vibrations :problem solving companion, Narosa Publishers, 2007.

14ME2037 PRODUCT DESIGN AND DEVELOPMENT STRATEGIES

Credits: 3:0:0

Course Objective:

- To impart knowledge on the product life cycle and its implication.
- To impart knowledge on the design consideration of a product
- To impart knowledge on design and selection of the standard mechanical elements.

Course Outcome:

Ability to:

- Select the right material for product development.
- Select the desired fabrication method for required product.

Nature and scope of product engineering - creative thinking and organizing for product innovation criteria for product success in life cycle of a product. Modeling and simulation - the role of models in product design. Material selection - performance characteristics of materials - economics of materials-cost versus performance relations-weighted property index. Functional and production design-form design-influence of basic design, mechanical loading and material on form design - form design of castings, forging and plastics. Influence of space, size, weight, etc., on form design, aesthetic and ergonomic considerations. Dimensioning and tolerancing.

References Books:

1. Dieter, G.E., "Engineering Design", McGraw Hill, 2000..
2. Kevin Otto & Kristin Wood, "Product Design", Pearson Educational Inc. 2004
3. Ali.K.Kamrani, Maryam Azimi Abdulrahman,M,Al-Ahmari, " Methods in Product Design", CRC press, Taylors Francis group, 2013
4. Karl T Ulrich, Steven D Eppinger, " Product Design & Development", Irwin Homeward Boston Publishers, 2004.
5. Imad Moustapha, " Concurrent Engineering in Product Design and Development", New Age International P Ltd publishers, 2006

14ME2038 TRIBOLOGY IN DESIGN

Credits 3:1:0

Prerequisite: Mechanics of Machines[14ME2026], Design of Machine Elements [14ME2029],

Course Objectives:

- To Impart knowledge on application of basic theories of friction ,wear , and lubrication to predictions about the frictional behavior of commonly encountered sliding interfaces.

Course Outcomes:

Ability to

- demonstrate basic understanding of friction, lubrication and wear processes.
- familiar with mathematical tools used to analyze tribological processes
- describe the detailed operation of selected anti-friction or anti-wear components.
- prepare technical project reports and technical presentations.

Introduction, surface topography, hertzian contact ,friction- stick slip motion – measurement of friction, wear - simple theory of sliding wear mechanism of sliding wear of metals -abrasive wear – materials for adhesive and abrasive wear situations - corrosive wear -surface fatigue wear situations, hydrodynamic lubrication hydrostatic lubrication ,elasto-hydrodynamic lubrication ,boundary lubrication ,lubricants – study of types of oils and grease used in automobiles and general mechanical industry -surface modification, latest technologies in surface modification. Mechanical dynamic tribology and testing methods- simple tribological mechanical dynamic test machines and test methods. dry sand-rubber wheel test, wet sand rubber wheel test, slurry abrasivity test, solid particle erosion test, pin-on-disk wear test, rolling wear test, drum wear test, drill wear test.

References Books:

1. Prasanta Sahoo. , " Engineering Tribology",Prentice Hall of India, 2005.
2. Sushil Kumar Srivastava, " Tribology in Industries" , S.Chand Publishers, 2005.
3. J. A. Williams, Engineering Tribology, Cambridge University Press, 2005
4. Mang, Kirsten Bobzin and Thorsen Bartels, Industrial Tribology: Tribosystems, Friction, Wear and Surface Engineering, Lubrication-Theory . Wiley-VCH Verlag and Co., 2011.
5. Engineering Tribology, Stachowiak and Batchelor, Butterworth-Heinmann, 2005.
6. S.K. Basu, S.N. Sengupta, B.B. Ahuja, Fundamentals Of Tribology, Prentice Hall of India, 2005
7. Cameron, A. "Basic Lubricaton Theory", Ellis Herward Ltd., UK, 2005.
8. Kragelsky, " Friction Wear & Lubrication", Mir Publications, 2005

14ME2039 COMPOSITE MATERIALS

Credits:3:0:0
Prerequisite: Material science and Engineering [14ME2003]

Course Objective:
To impart knowledge on
- the processes and behavior of composite material
- general design consideration, and failure of composites
- stiffness and strength analysis of continuous-fiber-reinforced laminated composites

Course Outcome:
Ability to
- design and analyse reinforced laminated composites
- select different manufacturing methods for composites as per design requirements
- identify the applications of different types of composites

General Characteristics, applications, Fibers- Glass, Carbon, Ceramic and Aramid fibers. Matrices- polymer, Graphite, Ceramic and Metal Matrices- Characteristics of fibers and matrices, Smart Materials- type and Characteristics. Characteristics of fiber-reinforced lamina-laminates-inter laminar stresses – Static Mechanical properties- Fatigue and Impact properties- Environmental Effects - Fracture behaviour and Damage Tolerance. Composite Manufacturing processes. Quality Inspection methods. Stress analysis of laminated Composite beams, plates, shells- vibration and stability analysis – reliability of composites- finite element method of analysis of composites. Characterization of composite products – laminate design consideration- bolted and bonded joints design examples- failure mode Predictions.

References Books:

1. Mallick, P.K., Fiber- Reinforced composites: Materials, Manufacturing and Design" Maneel Dekker inc.2006.
2. Halpin, J. C., "Primer on Composite Materials, Analysis" Techomic Publishing Co., 2006.
3. Mallick, P.K. and Newman, S., " Composite Materials Technology: Processes and Properties" Hansen Publisher, Munish, 2006.
4. Sharma.S.C. "Composite Materials", Prentice Hall of India, 2000.
5. Ronald Gibson, "Principles of Composite Material Mechanics", Tata McGraw Hill, 2007

14ME2040 DESIGN FOR MANUFACTURE

Credits: 3:0:0

Course objective:
To impart knowledge on
- design principles to be followed for different manufacturing process.
- factors influencing the manufacturability of components.
- use of tolerances in manufacturing.

Course outcome:
Ability to :
- Design the components suitable for various manufacturing process such as welding, casting, machining
- Identify and design components according to standards

Economics of Process selection – General design principles of manufacturability – Proper material selection – Strength and Mechanical factors. Casting Design and Weldment Design. Formed Metal Components and Non Metallic Parts Design - Design considerations for the manufacture of extruded, cold headed metal parts –Tube and section bends – powder metal parts – Thermo settings plastic parts -Reinforced – Plastic and Composite parts Machined Components Design for the manufacture of Turned parts-drilled parts-milled parts, Planned, shaped and slotted parts-Ground parts-parts produced by Electrical discharge machining. Design For Assembly – DFA –Index – – impact on quality.

Reference Books

1. James G. Bralla ,“Handbook of product design for manufacture”, McGraw Hill Book Co., 1999.
2. Geoffrey Boothroyd, peter Dewhurst, Winston A Knight, “ Product Design for Manufacture and Assembly, CRC Pres, Taylor and Francis group, 2010
3. Poli.C, “ Design for manufacturing”, Butter worth-Heinemann,Reed Elsevier Group, 2001
4. Chitale.A.K., Gupta.R.C., “ Product Design and Manufacturing, Prentice Hall of India, 2007.
5. David.M.Anderson, “ Design for Manufacturability and concurrent Engineering”, CIM Press, 2004.

14ME2041 TURBO MACHINERY

Credits: 3:0:0

Prerequisite: Mechanics of Fluids [14CE2003]

Course objective:

To impart knowledge on

- classification of turbo machines
- types of pump, compressor, fan, and turbine
- efficiencies and performance of turbo machines

Course outcome

Ability to understand the

- types of turbo machines
- working principles of pump, turbine, compressor, and fan
- applications of turbo machines in power stations.

Classification of turbo machinery- Incompressible fluid in turbo machines–Euler's equation- Blade terminology- Cascades of blades- blade spacing– Radial flow pumps and compressors– Axial flow pumps and compressors– Degree of reaction - dimensionless parameters– Effects of Reynolds Number and Mach number - Efficiency and utilization factor - Compressor and pump efficiencies- losses in turbo machines- Cavitations– Pumps and Compressors characteristic curves- Fan-types- efficiencies- classification of steam turbine- impulse and reaction turbine-compounding of turbine- classification of hydraulic turbines- Pelton wheel– Kaplan turbine – Francis turbine- specific speed- governing- efficiencies- characteristic curves- Gas turbine- types- performance curves

Reference Books

1. Yahya., ‘Turbines, Compressors and Fans’, Tata McGraw Hill, 2003
2. D.G. Stephard, ‘Principles of Turbo machines’, Macmillan Co., 2004
3. 1. Lee. ‘Theory and Design of Steam and Gas Turbine’, McGraw Hill, 2004
4. William J Kerten, ‘Steam Turbine Theory and Practice’, CBS Publisher and Distributors, 2006
5. Cohen Rogers., ‘Saravana Muttoo, ‘Gas Turbine Theory’, Long man, 2005
6. Bathe WN., ‘Fundamentals of Gas Turbines’, Willey & Sons, 2004.

14ME2042 MECHATRONICS AND CONTROL SYSTEMS

Credits: 3:0:0

Course Objective:

To impart knowledge on

- the fundamentals of Mechatronics and control systems.
- data presentation systems, electrical drives, microprocessor, PLCs and microcontrollers.

Course Outcome:

Ability to

- Understand measurement and mechatronics control systems
- Build pneumatic, hydraulic, electro pneumatic and electro-hydraulic circuits for automation
- Understand working principles of electromechanical devices.
- Suggest actuators for mechatronic systems.
- Design a simple mechatronics system using PLC.

Introduction to Mechatronics - Elements of Mechatronics - Measurement systems - Basic elements in Control Systems -Mathematical Models -Mechanical translational and rotational –Electrical systems -Transfer functions - Block diagrams, Stability of control systems- Routh Hurwitz criterion - Pneumatic and Hydraulic actuation systems - Servo and Proportional Controls Valves - Sensors and Transducers – Inputting by switches- Data presentation Systems - data acquisition systems- data loggers – D/A and A/D converters- Electrical actuating systems: mechanical switches – solid state switches – Solenoids – DC Motors –A.C.Motors - stepper motors. General form of microprocessor, microcontroller– Selecting a microcontroller –Programmable Logic Controllers – Ladder Programming – Latching and internal relays – sequencing – timers and counters.

Reference Books:

1. W Bolton, "Mechatronics-Electronic control systems in Mechanical and Electrical Engineering", 4thEdition, Pearson Education,2012.
2. Dan Necsulescu, "Mechatronics", Pearson Education Asia, 2002 (Indian reprint).
3. Devadas Shetty, Richard Akolk, "Mechatronics System" Design First reprint 2001.
4. Andrew Parr, "Hydraulics and Pneumatics", Jai co Publishing House ,Mumbai 2006.
5. A. Nagoor Kani, "Control Systems", RBA Publication, 2006.

14ME2043 INDUSTRIAL ENGINEERING

Credits: 3:1:0

Course Objective:

To impart knowledge on

- work study techniques towards productivity improvement
- industrial engineering concepts towards manufacturing management
- quality engineering and reliability tools

Course Outcome

Ability to

- apply various work study techniques towards productivity improvement
- apply industrial engineering concepts in real life environment
- Improve product design through quality engineering and reliability tools

Method Study- micro motion study, charts. Time study, procedure, standard time, performance rating, allowances, Methods. Measurement of productivity, productivity improvement, Productivity bargaining. Types of production. Production planning and control, Follow up, control boards, idle machine time. Plant layout, tools and techniques for plant layout, Statistical process control and charts, process capability analysis-Overview of six sigma-life testing-reliability-reliability of series parallel and mixed configuration. Management by objectives (MBO) – Strategic Management – SWOT analysis - Information technology in management – Decision support system – Business Process Re-engineering (BPR) – supply chain management (SCM). CAPP: Principles.

Reference Books:

1. T.R.Banga and Sharma, Industrial Engineering and Management, Khanna Publishers, 2002
2. M.Govindarajan and S.Natarajan, Principles of Management, Prentice Hall of India Pvt. Ltd. New Delhi 2007
3. George Kanawathi, Introduction to Work study,4th revised Edition, ILO, 1996.
4. S.Chandran, Organizational Behaviors, Vikas Publishing House Pvt., Ltd, 1994
5. David J.Sumanth, Productivity Engineering and Management ,Tata McGraw Hill,1996

6. Douglas.C.Montgomery, Introduction to Statistical Quality control, John Wiley, 2003

14ME2044 INDUSTRIAL DESIGN

Credits: 3:0:0

Course Objective:
To impart knowledge on

- team work, critical thinking, creativity and independent learning
- business practices, economic viability, environmental sustainability and social consequences of technology
- fundamental principles and concepts of human factors.

Course Outcome:
Ability to

- practice recent trends in design process and methods.
- design products and processes based on scientific methods.
- solve ergonomic problems.

Achieving creativity - Introduction to TRIZ methodology of inventive problem solving - creating and sustaining successful growth- commoditation and DE. Product life cycle, Concurrent engineering, reverse engineering, reengineering, product data management and application, knowledge based system. Economic analysis.Customer oriented design and societal considerations-product design specification-product liability-protecting intellectual property-TRIPS and its implications-legal and ethical domains –codes of ethics-future trends-patent –copyright. Industrial ergonomics-Human-Machine system, applied anthropometry, workspace design and seating, Design of repetitive task, design of manual handling task-stress-fatigue. Human factors applications-Organizational and social aspects, steps According to ISO/DIS 6385, OSHA's approach and virtual environments.

Reference Books

1. Dieter George E., " Engineering Design -A Materials and Processing Approach", McGrawHill, International Edition Mechanical Engg ., Series, 2000.
2. Karl t. Ulrich and Steven d Eppinger "Product Design and Developement " ,McGraw Hill, Edition 2004.
3. Karl Kroemer,Henrike Kroemer,katrin kroemer-Elbert,"Ergonomics'How to design for Ease and Efficency , Prentice hall international editions 2001.
4. Clayton M Christensen Michael E Raynor,"The innovators solution"Harvard Business school,Press Boston ,USA,2003.
5. Semyon D Savransky." Engineering of Creativity-TRIZ" CRC press Newyork USA. 2000.

14ME2045 RAPID PROTOTYPING AND TOOLING

Credits: 3:0:0

Course Objectives:
Impart knowledge on

- product development using rapid prototyping processes
- rapid prototyping processes

Course Outcome
Ability to

- select and employ appropriate rapid prototype methods for product development.
- develop prototypes of products.

Fundamentals of Prototyping, Product development cycle and need for speedy design, Classifications of RP, RP applications **Liquid Based Processes:** Stereo lithography Apparatus, Poly jet, Solid Creation System, Solid Object Ultraviolet–Laser Printer, Bioplotter, Rapid Freeze Prototyping, Solid Ground Curing, Microfabrication Technology. **Solid Based Processes:** Fused Deposition Modeling, Benchtop System, Laminated Object, Manufacturing, Multi-Jet Modeling System, Plastic Sheet Lamination, Invision LD Sheet Lamination, Paper

Lamination Technology, Selective Laser Sintering, Three-Dimensional Printing, Laser Engineered Net Shaping, Electron Beam Melting, Laser Cusing, Selective Laser Melting, Selective Mask Sintering, Micro Sintering and Rapid casting Technology. **Rapid Tooling and Manufacturing:** Indirect Rapid Tooling: Direct Rapid Tooling: Powder Metallurgy Tooling, Reverse Engineering using RP.

References Books:

1. C. K. Chua., K. F. Leong., C. S. Lim., “Rapid Prototyping: Principles and Applications”, World Scientific Publishing Co. Pte. Ltd., 2010.
2. Kenneth G. Cooper., “Rapid Prototyping Technology: Selection and Application”, Marcel Dekker, Inc., 2001.
3. Rafique Noorani, “Rapid Prototyping – Principles and Applications”, John Wiley and Sons Inc. New Jersey, 2005
4. Paul F Jacobs, “Stereo Lithography and other RP and M Technologies:, SME, NY, 1996
5. Andreas Gebhardt, “Rapid Prototype”, Hanser Publishers, 2003.

14ME2046 METAL CUTTING THEORY AND PRACTICE

Credits 3:1:0

Prerequisite: Machining Processes [14ME2005]

Course Objective:

To impart knowledge on

- fundamentals of metal cutting theory
- different types of tool and their nomenclature,
- measuring cutting force and cutting temperature
- mechanism of tool materials wear
- the cause of machine tool chatter

Course outcome:

Ability to

- Understand metal cutting theories.
- Interpret the nomenclature of single point and multi point cutting tools and select appropriate tool according to ISO specifications
- Explain heat distribution in work and tool during machining
- Suggest solutions to reduce tool wear and chatter and increase tool life
- Evaluate machinability of different materials using specific cutting forces and surface finish

Mechanism of chip formation-types of chips-Chip breaker-Orthogonal and Oblique cutting-Energy Consideration in machining-Merchant and Lee Shaffer theories. Nomenclature of single and multi point tools. Forces in turning, drilling and milling - specific cutting pressure- measurement of cutting forces and cutting temperature- cutting fluid-Developments in tool materials-ISO specifications for inserts and tool holders-Tool life - Concepts of machinability-Economics of machining- Types of wear-mechanisms of wear - chatter in machining

References Books:

1. David A Stephenson,John S Agapiou, Metal Cutting theory and practice, CRC Press 2005
2. Shaw .M.C., " Metal cutting Principles ",Oxford clarendon Press,2009.
3. Juneja.B.L and Sekhon.G.S- " Fundamentals of metal cutting and machine tools", New Age International(p) Ltd., 2003.
4. Bhattacharya. - " Metal Cutting Theory and Practice ", New central Book Agency pvt. Ltd., Calcutta, 2008.
5. Boothroyd.D.G. and Knight. W.A "Fundamentals of Machining and Machine tools", CRC Press, 2006.

14ME2047 WELDING TECHNOLOGY

Credits:3:0:0

Course Objectives:

To impart knowledge on

- fundamental principles of welding processes, welding metallurgy and welding of dissimilar metals.
- principles of modern welding processes followed in Industries.

Course Outcome:

Ability to

- select and employ appropriate welding process for an engineering application.

Basic Joining Processes and Equipment - gas, arc, resistance and thermit welding - Soldering, Brazing and Braze welding- welding power sources - welding electrodes - safety aspects in welding. Welding symbols-weld design - weld stress-calculations design of weld, size -estimation of weld dilution, preheat and post heat temperature- brief introduction to welding codes & standards - Weldability of cast iron, steel, stainless steel, aluminum alloys, dissimilar metals - effect of gases in welding-residual stresses-distortion-relieving of stresses - Defects in welding-causes and remedies-destructive testing methods –non destructive testing - Special welding Processes.

Reference Books

1. Khanna, O.P., "A Text book on Welding Technology", Dhanpet Rai & sons, Delhi, 2002.
2. Little, R.L, "Welding and Welding Technology", Tata McGraw Hill Publicaitons, New Delhi, 2000.
3. Rao, P.N. "Manufacturing Technology", 2nd edition , Tata McGraw Hill Publications, New Delhi,2009.
4. Parmar, R.S., "Welding Engineering and Technology", Khanna Publishers, Delhi, 2010.
5. AWS. "Welding Hand book", Vol I & II, 1996.

14ME2048 FOUNDRY TECHNOLOGY

Credits 3:0:0

Course Objective:

- To impart knowledge on various foundry processes.

Course Outcome

Ability to

- design patterns and molds for foundry process.
- make sound castings.

Introduction to moulding and casting Processes, Patterns – Cores – Core prints. Manual moulding processes – Moulding sand properties, influence of ingredients on properties – sand preparation and control – sand testing – machine moulding – types of machines, applications – core blowers – core shooters. Melting, Pouring and Testing. Furnaces – types and selection, non-ferrous melting practices, pouring equipments, Inspection of castings, destructive and non destructive, Casting defects – Occurrence, causes and remedies. Pouring, Feeding And Automation Gating system – functions-types of gating system-Gating Ratio-Riser – function –types of risers – riser design – foundry layout and automation.

References Books:

1. Jain P.L. "Principles of Foundry Technology", Tata McGraw-Hill, 2003.
2. Richard W Heine, Carl R Loper,Philip C Rosenthal "Principles of Metal Casting" Tata McGraw-Hill Publishing Company Ltd, 2008.
3. Gupta R.B "Foundry Engineering"; Satyaprakashan Publisher, 2002.
4. Lal,M and Khanna O.P "A Text Book of Foundry Technology" Dhanpat Rai and Sons, New Delhi 2011.
5. Banga T.R. and Agarwal R.L. "Foundry Engineering", Khanna Publishers, 2005.

14ME2049 RENEWABLE ENERGY SOURCES

Credits: 3:0:0

Course objective:

- To impart knowledge on the solar, wind and bio energies
- To impart knowledge on tapping the energy from oceans
- To expose the students towards the current developments in Hydrogen production and fuel cell technologies.

Course outcome:

Ability to:

- recognize the need of renewable sources for the present day energy crisis
- employ renewable energy technology in a given situation.
- work for the future development of renewable energy technologies.

Solar Energy- radiation, measurements, thermal collectors, storage, applications, fundamentals of photo voltaic cells. Wind Energy- Data, energy estimation, conversion systems, wind energy generators and its performance, hybrid systems. Biomass Energy- technology for utilization, biogas, gasification, Pyrolysis, digesters, ethanol production, biodiesel, economics. Tidal Energy, Geothermal Energy, OTEC cycles. Hydrogen- generation, storage, transport and utilization, applications. Principle of MHD power generation. Fuel cells – technologies, types – economics

Reference Books

1. G D Rai, Non Conventional Energy Sources, Khanna Publishers, New Delhi, 1999.
2. Kothari D P et.al. , Renewable Energy Sources and Technologies, prentice hall of India pvt. Ltd, 2008.
3. H P Garg, J Prakash., Solar Energy- fundamentals and applications, Tata McGraw Hill Publishing Company Ltd., New Delhi 1997.
4. S.P. Sukhatme, Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
5. John A Duffie and William A Beckmann, "Solar Engineering of Thermal Processes", Johnwiley, 2013.
6. G.N. Tiwari, solar Energy – Fundamentals Design, Modeling & applications, Narosa Publishing House, New Delhi, 2002.
7. Srivatsava, Shukla & Jha:"Technology and application of Bio Gas", Jain Brothers New Delhi, 2000.

14ME2050 ADVANCED INTERNAL COMBUSTION ENGINES

Credits: 3:1:0

Prerequisite: Thermal Engineering II [14ME2016]

Course Objective:

To impart knowledge on

- SI and CI Engines
- engine exhaust emission control and alternate fuels
- the recent developments in IC Engines

Course Outcome:

Ability to

- analyze performance of SI and CI Engines.
- recognize emission control norms.
- Use alternate fuels in IC engines.

Spark Ignition Engines: Design of carburetor, Stages of combustion-normal and abnormal combustion, Factors affecting knock, Combustion chambers. **Compression Ignition Engines:** Stages of combustion-normal and abnormal combustion – Factors affecting knock, Direct and Indirect injection systems, Combustion chambers, Turbo charging. Thermodynamic Analysis of SI and CI Engine Combustion process. **Engine Exhaust Emission Control:**

Formation of NO_X , HC/CO mechanism , Smoke and Particulate emissions, Green House Effect , Methods of controlling emissions , Emission measuring equipments, Smoke and Particulate measurement. **Alternate Fuels:** Alcohols, Vegetable oils and bio-diesel, Bio-gas, Natural Gas, Liquefied Petroleum Gas, Hydrogen and their properties. Suitability, Engine Modifications, Performance, Combustion and Emission Characteristics of SI and CI Engines using these alternate fuels.

Reference Books:

1. Ganesan V.” Internal Combustion Engines” , Third Edition, Tata Mcgraw-Hill ,2007
2. John B Heywood,” Internal Combustion Engine Fundamentals”, Tata McGraw-Hill1988.
3. Gupta H.N, “Fundamentals of Internal Combustion Engines” ,Prentice Hall of India,2006.
4. Ulrich Adler ,” Automotive Electric / Electronic Systems, Robert BoshGmbH,1995
5. Heinz Heisler, ‘Advanced Engine Technology,” SAE International Publications,USA,1998.
6. M.L.Mathur and R.P.Sharma “A course in Internal Combustion Engines”,DhanpatRai Publication,1997

14ME2051 REFRIGERATION AND AIR-CONDITIONING

Credits: 3:1:0

Prerequisite: Thermal Engineering I [14ME2015]

Course objective:

To impart knowledge on

- working principle of refrigeration and air-conditioning cycle
- fundamentals of psychrometry
- applications of refrigeration and air-conditioning

Course outcome:

Ability to

- Understand various refrigeration systems
- Demonstrate the working of refrigeration equipments
- Understand various psychrometric processes
- Design the space cooling load
- Explain the air-conditioning equipment

Review of thermodynamic principles - refrigeration. Air refrigeration - Bell-Coleman cycle - vapour compression refrigeration cycle - analysis and performance calculations - cascade system - vapour absorption refrigeration system - ammonia water and lithium bromide water systems. Compressors - reciprocating and rotary. Refrigerants - properties and selection. psychrometric processes, Cooling load estimation, requirements of comfort air conditioning - comfort charts. Applications of refrigeration and air conditioning systems.

Reference Books:

1. Arora. C.P., ‘Refrigeration and Air Conditioning’, Tata McGraw Hill, New Delhi, 2002
2. N.F. Stoecker and Jones, ‘Refrigeration and Air Conditioning’, TMH, New Delhi,2003
3. Raj. J. Dossat, ‘Principles of Refrigeration’, SI Version, Wiley Eastern Ltd., 1999.
4. Manohar Prasad, ‘Refrigeration and Air Conditioning’, Wiley Eastern Ltd Division of Mechanical Engineering, 2003 .
5. Jordon and Prister., ‘Refrigeration and Air Conditioning’, Prentice Hall of India (P) Ltd., New Delhi, 1999

14ME2052 BIOMASS ENERGY SYSTEMS

Credits: 3:0:0

Course objective:
To impart knowledge on

- thermo chemical conversion of biomass
- power generation techniques using biomass
- design, selection, construction and operation of biogas plants

Course outcome:
Ability to

- familiarize with the thermo chemical conversion process of biomass
- summarize the power generation techniques using biomass waste
- design the biogas plants
- suggest the biofuels for practical applications

Biomass - types of sources- size reduction- briquetting-drying, storage and handling of biomass- energy plantations- thermo chemical conversion of biomass - environmental impacts–alcohol production from biomass-biochemical Conversion--anaerobic digestion- operating parameters for biogas production-effect of additives on biogas yield- design, selection, construction and operation of biogas plants- types of biogas Plant- High rate digesters for industrial waste water treatment- combustion- pyrolysis – types-effect of particle size, temperature, and nitrogen gas flow rate on products yield- types of gasification - types of gasifier- industrial application of gasifier- wood gas engines-hydrogen generation from algae-electricity production from biomass

Reference Books:

1. Najaguna,B.T, "Biogas Technology", First edition, New Age International Pvt Ltd, New Delhi,2009
2. Mital K.M, "Biogas Systems: Principles and Applications", First edition, New Age International Pvt Ltd, New Delhi,2009.
3. O.P.Chawla, "Advances in biogas technology" Indian council of agricultural research, New Delhi,2009
4. N.H.Ravindranath, Hall D.O., "Biomass, Energy and Environment", Oxford University Press, Oxford 2002
5. Chakraverthy A, "Biotechnology and Alternative Technologies for Utilization of Biomass For Agricultural Wastes", Oxford and IBH publishing Co, 2006
6. Khandelwal. K.C.and Mahdi.S.S, "Biogas Technology", Tata McGraw-Hill Publishing Co. Ltd, 2006.

14ME2053 ALTERNATIVE FUELS FOR I.C. ENGINES

Credits: 3:0:0

Prerequisite: Thermal engineering II [14ME2016]

Course objective:
To impart knowledge on

- concepts of energy and its sources.
- manufacturing and performance characteristics of alternate fuels.
- emission tests procedure
- performance of dual fuel engine.

Course outcome:

- Ability to design power plant equipment such as boilers, condensers, cooling tower, economizers, etc. which contribute to increased efficiency in power generation and minimizing environmental pollution.

Fuels- Petroleum Structure- refining and products of refining process, , Properties of Petroleum products. Emulsification, alternate fuels and method of manufacturing Single fuel engines. Engine modification required-performance emission characteristics of alternative fuels in SI mode of operation v/s Gasoline operation. Introduction to dual fuel engine-use of alcohols, LPG, CNG, hydrogen, bio gas and producer gas in CI engine in dual fuel mode, performance and emission characteristics of alternative fuels in dual fuel mode of operation v/s diesel operation. Production of bio diesel, properties, performance and emission characteristics. Environmental impact, pollution control methods.

Reference Books

1. R.P.Sharma and M.L.Mathur: "A course in Internal Combustion Engines", D.Rai & sons. 2002
2. J. Heywood : Internal combustion Engines Fundamentals"", McGraw Hill International Edition, 2011
3. Osamu Hirao & Richard Pefley : "Present and future Automotive fuels", Wiley Interscience Publication. NY. 1988.
4. O.P.Gupta : "Elements of fuels, furnaces and Refractories", Khanna Publishers 2000
5. Domkundawar V.M : "Internal Combustion Engines", 1st Edition, Dhanpat Rai & Co., 1999

14ME2054 PRINCIPLES OF RESOURCE AND QUALITY MANAGEMENT

Credits: 3:1:0

Course Objectives:

To impart knowledge on

- various operations research techniques to ensure the effective utilization of resources
- network models for project planning and scheduling
- Quality and Quality Management Systems.

Course Outcome

Ability to

- Apply mathematical models for physical problems to find optimal Solutions
- Make use of appropriate operation research tools to ensure effective utilization of resources to realize maximum benefit
- Design network models for project planning, scheduling and project management
- Adopt ISO standards in industry's quality policy to assure quality of the product/service to the end users

Linear Models: Linear Programming – Graphical Method – Simplex method – Duality in simplex. Transportation Problems – Applications to problems with discrete variables. **Network Models:** Network analysis: Project Networks – Critical Path Method – Project Evaluation and Review technique – Problems on sequencing jobs through two machines and three machines. Queuing Models, Decision Models, **Quality Management:** Quality Planning – Quality Costs, Total Quality Management (TQM) – Deming's Philosophy – Quality Function Deployment – Procedures and Benefits - Benchmarking – Procedures and Benefits **Statistical Methods:** Introduction to Seven tools of quality ,Six Sigma Concepts. **Quality Management Systems:** ISO 9000 - Need for QMS – ISO 9000:2000 Quality Systems – Elements, Implementation of Quality systems, Documentation, Quality Auditing, QS 9000, ISO 14000 – Concept –Requirements and benefits.

Reference Books:

1. S.Bhaskar, Operations Research, Anuradha Agencies, 2009.
2. Dale H. Besterfied, Total Quality Management, Pearson Education India, 2011.
3. Ravindran, Operational Research, John Wiley, 2010.
4. S.C.Sharma, " Introductory operation Research", Discovery Publishing House, NewDelhi, 2006.
5. R.Pannerselvam, "Operations Research", Prentice Hall of India, NewDelhi,2006.

14ME3001 COMBUSTION IN ENGINES

Credits: 3:0:0

Course Objective:

To impart knowledge on

- the combustion principles and chemical kinetics.
- combustion in SI and CI engines.
- combustion in gas turbine.

Course Outcome:

- Ability to explain theoretical foundations of combustion
- Knowledge on the application of engineering science (thermo, fluids, heat transfer) to analyze the operation and performance of an internal combustion engine.
- Gaining an appreciation of the environmental concerns in designing combustion systems
- Exposure to standards and public policy concerning the regulation of combustion emissions.

Principles and Thermodynamic concepts of combustion, Combustion calculations, Chemical equilibrium and dissociation, Chemical kinetics, Theories of combustion, types of flames, combustion generated pollutants, Combustion in SI and CI engines, Knock, Delay period, Ignition lag, Heat balance, Combustion chamber design, Combustion in gas turbines, Various configurations of gas turbine combustion chambers.

Reference Books:

1. John B. Heywood., 'Internal Combustion Engine Fundamentals', McGraw Hill, International Edition,2001.
2. Pulkrabek, W.W., Engineering Fundamentals of the Internal Combustion Engine. Pearson Prentice Hall, 2003.
3. Edward E. Obert., 'Internal Combustion Engines and Air Pollution', Internal Educational Publishers,New York, 2005.
4. Cohen H. Rogers, GEC and Saravanamutto, H.I.H., 'Gas Turbine Theory', Longman Group Ltd.,2007.
5. Treager, 'Air Craft Gas Turbine Engine Technology', Tata McGraw Hill, 3rd Ed., 2006.
6. J.K. Jain, 'Gas Dynamics and Jet Propulsion', Khanna Publishers, 2004
7. Mathur M.L. and Sharma. 'A Course in Internal Combustion Engines', R.P. Dhanpat Rai Publications,2009 .
8. Paul W. Gill, James H. Smith., 'Fundamentals of Internal Combustion Engines', Oxford and IBH Publishing Co., 2002.
9. V. Ganesan., 'Internal Combustion Engines', Tata McGraw Hill Publishing Company Ltd., 2010.

14ME3002 ADVANCED THERMODYNAMICS

Credits 3:0:0

Course Objective:

To impart knowledge on

- entropy, availability, thermodynamic relations
- Combustion process
- Kinetic theory of gases

Course Outcome:

Ability to

- apply first and second law analysis on thermal systems.
- find the stoichiometic ratio for complete combustion of fuels.

First and Second law analysis – concept of entropy – availability –Helmholtz function – Gibb's function – On Sager reciprocity relation. Thermodynamic relations, Criteria for Equilibrium –Conditions for stability. Compressibility factor, fugacity and activity. Phase rule – ideal and real solution of gases, liquids, equilibrium system. Combustion. First and second law of thermodynamics applied to combustion process – heat of combustion – Adiabatic flame temperature – stoichiometry and excess air – chemical equilibrium and dissociation. Kinetic Theory of Gases, Perfect gas model, Distribution of translational velocities distribution function, molecular collisions and mean free path, equi partition of energy.

Reference Books:

1. Yunus A Cengel, Michael Boles, 'Thermodynamics: An Engineering Approach', The McGraw Hill Companies, 7th Edition, 2010.
2. P.K. Nag., 'Engineering Thermodynamics', 4th Edition., McGraw Hill, 2008.
3. G.J. Van Wylen & R.E. Sonntag., 'Fundamentals of Thermodynamics', Willy Eastern Ltd., 2012.
4. J.P. Holman., 'Thermodynamics', 4th Ed., McGraw Hill, 1988.
5. Jui sheng Hsieg., 'Principles of Thermodynamics', McGraw Hill, 1978.
6. Smith K. Van Ness H.C., 'Introduction to Chemical Engineering Thermodynamics' ,McGraw Hill, NY, 2005.

14ME3003 ADVANCED FLUID MECHANICS

Credits: 3:0:0

Course Objective:

To impart knowledge on

- continuity, momentum and energy equations of fluid flow.
- irrotational flows, flow past cylinders and Rankine body.
- concepts of Boundary layer, prandtl mixing length, turbulent theory, universal velocity profile

Course Outcome:

Ability to

- Analyze numerical flow problems
- Identify different types of flows and analyze them

Methods of describing fluid motion, time rates of change, acceleration, Eulerian and lagrangian equation of continuity, Bernoulli's Equation. Forces and stresses acting on a fluid particle, momentum equation, Navier stokes Equations in rectangular, Energy equation. Irrotational motion in two dimensions, source and sink, complex potential due to source, due to doublet. Vortex motion, Helmholtz's vorticity theorem, velocity potential and stream function. Flow past cylinder with and without circulation, flow past rankine body. Boundary layer principles, prandtl mixing length, turbulent theory, universal velocity profile .

Reference Books:

1. Streeter, 'Fluid Dynamics' 3rd Ed., McGraw Hill, 2006.
2. Raisinghania M.D,' Fluid Dynamics', 4th Ed., S.Chand & company Ltd, 2002.
3. Fox R N and McDonald A T., ' Fluid Mechanics', John Wiley & Sons, 1999.
4. Dr.J K Goyal and K P Gupta., 'Fluid dynamics', 3rd revised Ed., Pragathiprakasam, Meerut,`1999.
5. Schlichting H., 'Boundary Layer Theory'., 8th Ed., McGraw Hill New York, 2001.
6. Robertson., 'Hydrodynamics Theory and Application', Prentice Hall of India, 1965

14ME3004 DESIGN OF THERMAL POWER EQUIPMENT

Credits: 3:0:0

Course Objective:

To impart knowledge on

- The design of boiler, furnace, condenser and cooling tower
- boiler performance and their accessories
- water and steam purification methods and equipments

Course Outcome:

Ability to

- design boiler , furnaces, condenser and cooling tower
- design economizer, super heater, reheater and analyse their performance
- design air preheater, draft system and chimney

Boiler and furnace design–IBR Code Furnace Design: Heat Transfer in Furnace – heat balance – types of refractory walls , Water wall arrangements. Heat release rates – furnace bottoms – Slag removal – Cold primary air system – wind box assembly , Different types of furnaces for solids and liquids. Water Side Design – Circulation. Design of condensers, Cooling tower-Types and design for power plant application. Performance of boiler – Equivalent evaporation-Boiler efficiency-boiler trail-heat losses in boiler. Economiser-types, design. Super Heater –Design, Super heat temperature control. Desuperheater - design. Design of Reheater. Water & Steam purification washing typical arrangements of boiler drum internal in H.P. boilers. Air Pre-Heaters: Types of Air heater, recuperative and regenerative – Design considerations – Higher temperature and low temperature applications. Draft system design, Ash separators by ESP Electrostatic precipitators.

Reference Books:

1. P.K. Nag., ‘Power Plant Engineering ’, Tata McGraw Hill, 2002.
2. C.D. Shields., ‘Boilers’, McGraw Hill, 1982.
3. Homi, P. Serval., ‘Boilers & Pressure Vessels’, Multitech Publishing Company, Bombay, 1989.
4. Skrotzki & W.A. Vepot., Power Station Engineering Economy, Tata McGraw Hill, New Delhi, 1987.
5. Morse, T.F., ‘ Power Plant Engineering’, Van Nostrand East West Press, revised Edn., 1983.
6. David Sunn, Robert Houston., ‘Industrial Boilers’, Longman Science & Technology, 1986.
7. ‘Modern Power Station Practice’, Vol. 8, Central Electricity Generating Board, UK, Pergamon Press, 1971.

14ME3005 COMPUTER INTEGRATED MANUFACTURING SYSTEMS

Credits: 3:0:0

Course Objectives:

To impart knowledge on

- application of computers in manufacturing.
- Computer assisted materials requirement planning and production monitoring systems.
- automatic material handling systems and Flexible Manufacturing systems.

Course Outcome:

Ability to

- use computers in manufacturing to increase the productivity,
- reduce cost and time involved in planning and monitoring production systems.
- use computer assisted techniques for process planning, inventory and quality control for increased productivity.

Manufacturing system: Introduction, Objectives, types, features and applications, Computer Integrated Manufacturing: Components of CIM, Data base, Planning, Scheduling and Analysis of CIM systems, Material requirements planning, ERP. Shop floor control - Factory data collection system - Automatic identification system. Computer assisted production monitoring systems: Types, Automated Inspection systems: contact and non-contact inspection methods – machine tools- Automatic Material Handling and Storage systems, DNC systems, Group Technology, Cell Design, Cellular Manufacturing Systems Flexible manufacturing systems (FMS) - Rapid prototyping - Artificial Intelligence and Expert system.

Reference Books:

1. Groover, M.P., "Automation, Production System and CIM", Prentice-Hall of India,2005.

2. David Bedworth, "Computer Integrated Design and Manufacturing", TMH, New Delhi, I Edition 1999
3. Yorem Koren, "Computer control of Manufacturing Systems", McGraw Hill, 2005.
4. Ranky, Paul G., "Computer Integrated Manufacturing", Prentice Hall International 1999.
5. Vikram Sharma, “ Fundamentals of computer Integrated Manufacturing, S.K.Kataraia and sons, 2009.
6. R.K.Kundra, “Computer Aided Manufacturing”, Tata McGraw Hill Education, 2008.
7. R.K.Rajput, “ Robotics and Industrial Automation”, S.Chand, 2008.

14ME3006 COMPUTER APPLICATIONS IN DESIGN

Credits: 3:0:0

Course Objective:
To impart knowledge on
- use of computer in mechanical engineering design.
- surface and solid modeling techniques.
- advanced modeling concepts.

Course Outcome:
Ability to
- handle computer for solving design problems.
- Design new products using computer aided design.
- Use advanced modeling techniques in product design.

Hardware and software for CAD, Geometric modeling, Transformations, Types and representation of curves, survaces and solids- Solid removal algorithms shading- coloring-rendering . Parametric and variational geometry based on software, Creation of prismatic and lofted parts. CAD/CAM Exchange formats, Mechanical tolerances, Mass property calculations and Mechanical Assembly, Advanced Modeling Concepts, Conceptual, Top Down and collaborative Design, Mechanism simulation, Rapid prototyping.

References Books:
1. IBRAHIM ZEID,CAD/CAM- Theory and Practice, Tata McGraw Hill, Edition,2013
2. Mikell. P. Grooves and emory, W. Zimmers Jr. “CAD/CAM Computer aided Design and Manufacturing “ prentice Hall of Inc., 2002
3. Donald Hearn and M Pauline Baker “Computer Graphics Printice Hall Inc. III Edition2006.
4. Jean Gallier., “Curves and Surfaces in Geometric Modeling: Theory & Algorithms”, Morgan Kaufmann; 1st edition,1999.
5. Michael Mortenson, “ Geomentric Modelling”, Industrial Press, 3rd edition,2006
6. David Salomon, “Computer Graphics and Geomentric Modelling”, Springer; 1st edition 1999.
7. Martti Mantyla, “An Introduction to Solid Modelling” W.H. Freeman & Company,1988.

14ME3007 ENGINEERING MATERIALS AND APPLICATIONS

Credits: 3:0:0

Course Objective:
- To impart the knowledge on structure and composition and behavior of Metals
- To impart the principles of design, selection and processing of materials

Course Outcome:
- Ability to apply concepts of Materials Science for material selections.
- Ability to suggest modern metallic materials, composite materials for engineering applications.

Elastic and Plastic Behavior – atomic model of Elastic behavior – Rubber like Elasticity an elastic behavior - plastic deformation- slip- shear strength of perfect and real crystals- movement of dislocation

Fracture Behavior: Ductile and Brittle fracture – Energy and stress intensity approach, fracture toughness- Ductile Brittle Transition Fatigue- Creep in Materials.
Modern Metallic Materials: Patented Steel wire - Steel martensite - micro alloyed steels- precipitation hardened aluminium alloys- Maraging steels – metallic glasses – shape memory alloys smart Materials- TRIP Steels
Ceramics and glasses: Properties, applications, Ceramic Structures- silicate ceramics- carbon –diamond- graphite- imperfections and impurities in ceramics –applications

Reference Books:

1. V. Raghavan, " Materials Science and Engineering – Prentice Hall of India (P) Ltd., New Delhi.2004.
2. Raymond A. Higgin's " Properties of Engineering Materials, English Language Book Society,2000
3. Thomas H. Courtney "Mechanical Behaviour of Materials" McGraw Hill International Edition,2005.
4. Williams D, Callister " Material Science and Engineering" John Wiley & sons inc. 2009.
5. Joshua Pelleg, " Mechanical Properties Materials", Springer, 2013
6. Kenneth.G,Michael, K.Budinski, " Engineering Materials", Properties and selection, Prentice Hall, 2010.
7. C.P.Sharma, " Engineering Materials: Properties and applications of metals and alloys", Prentice Hall India, 2004.

14ME3008 ADVANCED STRENGTH OF MATERIALS

Credits: 3:0:0

Course Objectives:
To impart knowledge on

- Potential applications of strength of materials.
- Material behavior under various stress conditions.
- Development of stresses depending upon material shape and wall thickness.
- Development of stresses under various loading conditions.

Course Outcome:
Ability to

- Apply principles of advanced strength of materials to design engineering structures and components

Introduction to potential applications of strength of materials, methods of analysis. Introduction to theory of elasticity, concept of stress, and their relationships. Material behaviour under various stress conditions.**Torsion** in circular, non circurcular, rectangular cross sections and in thin-wall sections. **Bending** behaviour of beams depending upon their cross sections, curvature and elasticity of foundations. Energy methods- Castigliano's Theorem, Methods of virtual work, Stress and strain in cylinders depending upon their wall thickness. Materials under static and cyclic loading.

Reference Books:

1. Richard G. Budynas, "Advanced Strength and Applied Stress Analysis" (2nd Edition) by, McGraw-Hill International Editions, 1999.
2. Boresi, Arthur P. and Schmidt, Richard J., Advanced Mechanics of Materials, 6th Ed., John Wiley & Sons, 2003.
3. Young, Warren C. and Budynas, Richard G., Roark's Formulas for Stress and Strain, 7th Ed., McGraw-Hill, 2002.
4. Beer, Ferdinand P., Johnston, E. Russell and DeWolf, John T., Mechanics of Materials, 3rd Ed., McGraw-Hill, 2002.
5. L S Srinath. Advanced Mechanics of Solids, 3rd edition, McGraw-Hill, 2008.
6. A. C. and S. K. Fenster ,Advanced Mechanics of Materials and Applied Elasticity", Prentice Hall, 5th Edition 2012.
7. J.P.Den Hartog, Advanced Strength of Materials, McGraw Hill, 2012.

14ME3009 PRINCIPLES OF MECHANICAL MEASUREMENTS AND INSTRUMENTATION

Credits 3:0:0

Course Objective :
To impart knowledge on
- measurement techniques for measuring process parameters in industry and in research

Course outcome:
Ability to
- Choose measuring instruments suitable for specific application.
- Design and fabricate a system for measuring simple parameters.
- Apply the knowledge in during the measurement process

Kinds of errors and uncertainty analysis, Experimental planning , Flow measurements – Pitot tubes, magnetic flow visualization methods, shadowgraph, schlieren and interferometry, Hot wire anemometer – Laser Doppler anemometer Temperature Measurements –Measurement by Mechanical effect and by electrical effects-Thermocouples, pyrometry, transient response of thermal systems – calibration methods. Thermo electric effect instruments Thermophysical property measurements: measurement of Thermal conductivity, viscosity, specific heat and surface tension. Data Acquisition and Processing - D/A and A/D convertors. Solar Radiation Measurement and Energy Devices – Pyrhekuimeters and Pyranometers – Measurement of duration – sun shine recorder, Instrumentation for Solar systems.

Reference Books:

1. Beckwith, "Mechanical Measurement" Narosa Publishing House2003
2. R.K. Jain, "Mechanical and Industrial Measurements" Khanna Publishers, 2000
3. J.P. Holeman, "Experimental methods for Engineers" McGraw Hill Publishers, 1998
4. E.O. Doebelin, "Measurement systems : Application and Design" McGraw Hill Publishers, 2003.
5. B.C. Nakra "Instrumentation measurement and Analysis" Tata McGraw-Hill Publishing Company, 2002
6. John Bentley, " Principles of Measurement Systems", 4^{th} Ed, Pearson Edition, 2004.
7. S.P.Venketeshwar, " Mechanical Measurements", Ane Books Pvt Ltd., 2009.

14ME3010 MECHATRONICS AND MACHINE CONTROLS

Credits: 3:0:0

Course objective:
To impart
- knowledge on control systems and Programmable logic circuits
- Fluidic Controls and Process control Pneumatics

Course outcome:
Ability to
- design mechatronic systems composed of mechanical and electrical parts.
- to develop modern and smart electro-mechanical products.

Introduction - evolution and scope of Mechatronics - measurement systems - control systems – types - servomechanisms and regulators - Rouths and Hourwitz stability criteria - programmable logic controllers (PLC) – architecture - programming (ladder logic) – mnemonics -timers - shift registers - master and jump controls - selection of PLC. - Mechartonic elements - data presentation systems - hydraulic systems - feedback devices-principles of fluid logic control - Coanda effect - basic fluidic devices - fluidic logic gates and sensors - bistable - flipflop - - Process control pneumatics - signals and standards - the flapper nozzle - volume booster – air relay and force balance - pneumatic controllers - PI and IP convertors.

References Books:
1. W Boltson , 'Mechatronics', Pearson Education 4th edition 2012.
2. Andrew Parr, 'Hydraulics and Pneumatics', Jico Publishing House, Mumbai 2011.
3. Kuo, 'Automatic Control Systems', Wiley, 2009.
4. Anthony Esposito, 'Fluid Power', Pearson Education, 2005.
5. Ogata Katsuhiko , 'Modern Control Engineering', Printice Hall of India , 2010.
6. Dan Necsulescu, "Mechatronics", Pearson Education Asia, 2002.
7. Gene F.Franklin, J.David Powell and Abbas Emami-Naeini, "Feed back control and dynamic system" Prentice Hall,6th Edition, 2009.

14ME3011 COMPUTER AIDED ENGINEERING LABORATORY

Credits: 0:0:2

Course objective:

To impart

- Fundamental knowledge on using software tools like ANSYS, FLUENT, etc., for Engineering Simulation.
- Knowledge on how these tools are used in Industries for solving real time problems.
- Understanding about various fields of engineering where these tools can be effectively used to improve the output of a product.

Course outcome:

Ability to

- Appreciate the utility of the tools like ANSYS or FLUENT in solving real time problems and day to day problems.
- Become versatile in using these tools for any engineering and real time applications.
- Acquire knowledge on utilizing these tools for a better project in their curriculum
- Face the challenges in industry with confidence when it matters to use these tools in their employment.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME3012 CAD/CAM LABORATORY

Credits: 0:0:2

Course Objective:

To impart the knowledge on the

- usage of computer in design and Manufacturing.
- visualization of objects in three dimensions and producing orthographic views, sectional views and auxiliary views of it.

Course Outcome:

Ability to

- develop 2D and 3D models using software.
- write CNC Program for different components for manufacturing
- create parts, and assemble it to create a functional assembly.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME3013 SOLAR REFRIGERATION AND AIR-CONDITIONING

Credits 3:0:0

Course Objective

To impart knowledge on

- the different types of solar cooling systems
- the thermodynamic modeling
- the Economics of different cooling systems

Course Outcome:

Ability to

- apply basic thermodynamic modeling concept
- carry out design and evaluation of solar cooling systems.
- economically use the solar cooling systems

Potential and scope of solar cooling, Types of solar cooling systems, solar collectors and storage systems for solar refrigeration and air conditioning. Solar operation of vapour absorption – Lithium Bromide –Water Absorption system – Aqua Ammonia Absorption system - Intermittent Absorption Refrigeration system. Thermal modelling and computer simulation for continuous and intermittent solar refrigeration and air conditioning systems. Solar desiccant cooling systems. Open cycle absorption/ desorption solar cooling alternatives. Advanced solar cooling systems, Refrigerant storage for solar absorption cooling systems. Solar thermoelectric refrigeration and air conditioning - solar economics of cooling systems.

Reference Books:

1. Ursula Eicker, "Low Energy Cooling for Sustainable Buildings", John Wiley and Sons, 2009
2. Hans-Martin Henning, "Solar-assisted air conditioning in buildings: a handbook for planners", Springer, 2007
3. M. Santamouris, D. Asimakopoulos, "Passive cooling of buildings", Earthscan, 1996
4. A.A. M. Sayigh, J. C. McVeigh, "Solar air conditioning and refrigeration" , Pergamon press,1992

14ME3014 REFRIGERATION MACHINERY AND COMPONENTS

Credits: 3:0:0

Course Objective:

To impart knowledge on

- the working principle of various components
- the accessories and controls in refrigeration systems
- the BIS standards for appliance testing practice

Course Outcome:

- Ability to design and develop refrigeration systems.
- Ability to apply the BIS standards for appliance design and testing.

Hermetic compressors-Reciprocating, Rotary, Scroll Compressors, Open type compressors-Reciprocating, Centrifugal, Screw Compressors. Semi hermetic compressors- Construction, and Working. Capacity control, circuitry, oil return, oil separators-different types Refrigerant driers strainers, receivers, accumulators, low pressure receivers. Testing of Air conditioners, Refrigerators, Visicoolers, Cold rooms, Calorimetric tests. Refrigerant Pumps, Cooling Tower fans, Compressor Motor protection devices, Oil equalizing in multiple evaporators. Different Defrosting and capacity control methods and their implications.

Reference Books:

1. Cooper &Williams, B. "Commercial, Industrial, Institutional Refrigeration, Design, Installation and Trouble Shooting" Eagle Wood Cliffs (NT) Prentice Hall, 1989.
2. Dosset, R.J. "Principles of Refrigeration", John Wiley & Sons, 2001.

3. Hains, J.B, “Automatic Control of Heating & Air conditioning” McGraw Hill, 1981.
4. Althose, A.D. & Turnquist, C.H. “Modern Refrigeration and Air conditioning” Good Heart-Wilcox Co. Inc., 1985.
5. Recent release of BIS Code for relevant testing practice. ASHRAE Hand book (Fundamentals & Equipments), 2005

14ME3015 THEORY OF METAL CUTTING

Credits: 3:0:0

Course Objective:

To impart knowledge on

- Chip formation, tool nomenclatures and cutting forces.
- heat distribution and thermal aspects of machining
- tool materials, tool life and tool wear.
- Economics of machining

Course Outcome:

Ability to

- analyze cutting forces in turning, drilling and milling
- select the parameters to reduce cutting temperature, tool wear and tool failure.
- reduce the cost of machining by selecting proper cutting conditions.

Chip formation mechanism: types - Orthogonal Vs Oblique cutting, force and velocity relationship - shear plane angle - Modern theories in mechanics of cutting - - Nomenclature of single point and multi point tool –measurement of cutting forces. Temperature in machining - Method of measurement – Hot machining - cutting fluids - Tool materials - ISO specifications for inserts and tool holders -Tool life - Conventional and accelerated tool life tests - Concepts of machinability and machinability index - Economics of machining - Failure of cutting tools and forms of wear – Reasons, mechanisms of wear - Chatter in machining: Factors and types.

Reference Books

1. Shaw .M.C., " Metal cutting Principles ",Oxford clarendon Press, 2nd edition, 2005.
2. Juneja. B. L and Sekhon.G.S, "Fundamentals of metal cutting and machine tools", New Age International(p) Ltd., 2003.
3. Geoffrey Boothroyd and Knight. W.A "Fundamentals of Machining and Machine tools", CRC Press, New York, 2006.
4. Bhattacharya. - "Metal Cutting Theory and Practice ", New central Book Agency pvt. Ltd., Calcutta, 2008.
5. David A Stephenson, John.S, Agapiou, “ Metal cutting theory and Practice, CRC Press, 2005.
6. J.Paulo Davim, “Metal cutting: Research Advances, Nova Science publishers, 2010.
7. HMT, Production Technology, Tata McGraw Hill Education, 2004.

14ME3016 ADVANCED METROLOGY

Credit 3:0:0

Course Objective:

- To introduce the science of measurement and measuring machines commonly used.
- To impart knowledge about limits, fits and tolerances, geometric dimensioning aspects
- To introduce the methods of acceptance test for conventional machine tools.
- To familiarize students with the concepts of Laser metrology and surface roughness.

Course Outcome:

- Students will be able to work in metrology divisions in industries
- Students will be able to understand GD and T symbols and apply them.
- Students will be able to understand the advanced metrology systems.

Science of measurement: Mechanical measurement – types, measurement standards– terms used in rating instrument performance. Measuring machines: Study of Measuring Machines , gear tooth measurement- measurement of gear profile, Isometric Viewing of Surface Defects, Image Shearing Microscope for Vertical Dimensions. Laser metrology and microscopy: Laser Metrology - Vision systems- Principles and applications, Principles of Scanning and Transmission Electron Microscopy and its applications. Acceptance tests for machine tools and surface finish measurements, calibration of machine tools, introduction to ball bar measurement, Measurement of surface roughness. Introduction to Tolerancing and Dimensioning: Introduction; Indian Standard System of Limits and Fits (IS :919-2709) ; Designation of Holes ,Shafts and Fits. Meaning of GD and T, Various Geometric symbols used in GD and T , Datum feature, Material Conditions.

References Books:

1. Ernest O Doeblin, "Measurement systems", McGraw Hill Publishers, 2003.
2. R. K . Jain, "Engineering Metrology", Khanna Publishers, New Delhi, 2009.
3. Geometric Dimensioning` and Tolerancing for Mechanical Design,"Gene R. Cogorno, McGraw Hill, 2006.
4. I.C Gupta, "Engineering Metrology", Danpat Rai Publications, 2004.
5. Beckwith Thomas G, "Mechanical Measurements", Pearson Education, 2008.
6. M.Mahajan,"A Text Book of Metrology", Dhanpat Rai &Co. 2010
7. The Metrology Handbook, Jay L. Bucher ,Amer Society for Quality, 2004.

14ME3017 ADVANCED HEAT TRANSFER LABORATORY

Credits: 0:0:1

Course Objective:

- To impart the practical skills in conducting and analyzing the heat transfer experiments

Course Outcome:

- Ability to apply the practical knowledge in designing various heat transfer systems and will be conversant with measurement techniques

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME3018 AUTOMATION AND ROBOTICS LABORATORY

Credits: 0:0:2

Course Objective

To impart knowledge on

- designing pneumatic and electro pneumatic components for automation.
- components, ladder logic design, programming for PLC/Microcontroller and robot
- configuration of robot and reconfigure them for a custom application

Course Outcome

Ability to

- select components for automation.
- develop programs for different application
- configure robot for practical applications.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

References

1. Mikell P. Groover, Mitchell Weiss, "Industrial Robotics, Technology, Programming and Applications. " McGraw Hill International Editions, 1st Edition, 2000.
2. Ibrahim Zeid, "CAD/CAM Theory and Practice", McGraw Hill, 2003
3. Fanuc PLC Manual

14ME3019 ENERGY CONSERVATION AND MANAGEMENT

Credits: 3:0:0

Course Objective

To impart knowledge on

- energy auditing in engineering and process industry
- energy conservation in buildings, thermal and electrical systems

Course Outcome

Ability to

- identify areas of energy conservation in thermal and electrical systems
- apply the principles energy management for conservation.

Energy resources, energy use patterns and scope for conservation, world energy supply and demand, national energy systems, policies, Programs and decisions. Energy Auditing in engineering and process industry, identification of areas for energy conservation. Energy conservation in buildings, thermal and electrical systems. Energy management principles, need for organization and goal setting, basic discounting, life cycle costing and other methods, factors affecting economics, energy pricing and incentives for conservation, financial management.

Reference Books:

1. David H.U., Handbook of Industrial Energy Conservation,Van Nostrand Reinhold Company, 1983.
2. Raikhy P.S. and Parmindar Singh., Energy Consumption in India, Deep and Deep Publication, 1990.
3. Vogt F., Energy Conservation and use of renewable sources of Energy in the Bio - Industries, Pergamon Press, 1981.
4. Albert Thumann, Plant Engineers and Managers Guide to Energy Conservation, 10^{th} Edition., Fairmount Press, 2011.
5. Ray D.A., Industrial Energy Conservation, Pergamon Press, 1980.
6. Kreith F. and West R.E (Eds), Economics of Solar Energy Conservation Systems, Vol. I and III CRC Press, 1980.
7. Shinskey E.G., Energy Conservation through Control, Academic Press, 1980.

14ME3020 ADVANCED MANUFACTURING PROCESSES

Credits: 3:0:0

Course objective:

To impart knowledge on

- different types of non-conventional manufacturing processes.
- the mechanism and capabilities of non-conventional manufacturing processes.
- the latest manufacturing process for micro-fabrication and devices.

Course outcome:

Ability to

- evaluate and select suitable manufacturing processes for particular applications.
- apply the latest manufacturing process for micro-fabrication.
- develop new products by making use of new materials and processes.

Newer Machining Processes : Construction working principle – steps - types – process parameters – derivations – problems, merits, demerits and applications of AJM – WJM - USM – CHM – ECM – EDM - Wire cut EDM - ECM – ECG - LBM – EBM – pam – IBM.
Micro-fabrication: Semiconductors – films and film depurification – fabrication techniques – surface and bulk machining – LIGA Process – Solid free form fabrication. Wafer preparation techniques - PCB board hybrid and mcm technology – programmable devices and ASIC – electronic material and processing.– steriolithography SAW devices, Surface Mount Technology,

References:

1. Serope Kalpakjian, Steven Schmid, Manufacturing Processes for Engineering Materials (5th Edition), 2003.
2. Julian W. Gardner , Vijay K. Varadan, Osama O. Awadelkarim "Micro sensors, Mems & Smart Devices", Wiley-Blackwell, 2002
3. Richard C. Jaeger, Introduction to microelectronic fabrication Prentice Hall; 2nd edition. 2001.
4. Nario Taniguchi, " Nano Technology", Oxford University Press 1996.
5. Pandey P.C., Shan H. S, "Modern Machining Processes", Tata McGraw Hill Education Private Limited, 2013.
6. Marc J. Madou," Fundamentals of Microfabrication and Nanotechnology", Third Edition, CRC Press, 2011.

14ME3021 COMPOSITE MATERIALS

Credits: 3:0:0

Course Objective:
To impart knowledge on

- types and applications of composite materials
- nature of various forms of reinforcement and matrix.
- processing and testing of composite materials.

Course outcome:
Ability to

- process composite materials based on their properties and applications
- test composite materials for finding their suitability in industrial applications.

Composite materials: Classification, types, advantages and application. Functional requirements of reinforcement and matrix. Reinforcement types, Properties Comparison of fiber strengths – Matrix materials. Mechanics of composites**:** Rule of mixture, evaluation of four elastic moduli. Characteristics and strength of lamina. Polymer matrix composites: Resin types – PMC processes, Fibre reinforced plastics (FRP), and Glass fibre reinforced plastics (GRP). Metal Matrix Composites**:** Characteristics, types, advantages and limitations, Reinforcements and their effects, volume fraction, Rule of mixtures. Processing types. Fatigue and fracture behaviours of composites. Hybrid composites. selection of composite material and design, analysis and testing of joints.

Reference Books:

4. Mallick, P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", Third Edition, Marcel Dekker Inc, 2007.
5. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, 2006.
6. Mathews F.L. and Rawlings R.D., Composite materials: Engineering and Science, Chapman and Hall, London, England, 1st edition, 1999.
7. Chawla K.K Composite Materials: Science and Engineering ., Springer – Verlag, 2008
8. Ronald Gibson, "Principles of Composite Material Mechanics", Tata McGraw Hill, 2007.
9. Strong A.B., Fundamentals of Composite Manufacturing, Society of Manufacturing Engineers, 2007.
10. Sharma S.C., Composite materials, Narosa Publications, 2000.

14ME3022 ADVANCED HEAT TRANSFER

Credits: 3:0:0

Course Objective:

To impart knowledge on

- Conduction, convection, radiation, heat transfer during boiling and condensation.
- design of heat exchangers.
- principles of mass transfer.

Course Outcome:

- Ability to apply the knowledge in analyzing the heat transfer performance of thermal systems

Conduction: heat diffusion equation, plane wall, Radial system. Heat Transfer from extended surfaces, Insulation, Analytical method for two dimensional heat equation, Finite difference method, Transient conduction. Convection: Energy equation, thermal boundary layer. Forced convection: flow over surfaces, internal flow. Natural convection, combined forced and free convection, combined convection and radiation in flows. Radiation: Radiative heat exchange between surfaces, Radiation exchange with emitting and absorbing gases. Boiling: Pool and flow boiling, Nucleate boiling correlations. Condensation, modes and mechanisms, correlations. Heat exchanger: types – LMTD method and the effectiveness – NTU method. Mass Transfer: types, Fick's law of diffusion – mass diffusion equation, Transient Mass Diffusion – Diffusion in moving medium. Convective mass transfer. Simultaneous Heat and Mass transfer.

Reference Books:

1. Yunus.A Cengel., 'Heat Transfer a Practical Approach', Tata McGraw Hill, 2nd Ed., 2003
2. Holman J.P., 'Heat and Mass Transfer', Tata McGraw Hill, 10th Ed., 2009.
3. Allen D.Kraus., 'Extended Surface Heat Transfer', Wiley-Interscience., 2001.
4. Frank P. Incropera and David P. Dewit T., 'Fundamentals of Heat and Mass Transfer', 5 th Ed., John Wiley & Sons, 2001.
5. C.P. Kothandaraman., 'Fundamentals of Heat and Mass Transfer', 3rd Ed., New Age International, 2006.
6. Kays, W.M. ,Crawford W and Bernhard Weigand., 'Convective Heat and Mass Transfer', McGraw Hill Inc., 2004.
7. Burmister L.C., 'Convective Heat Transfer', John Wiley and Sons, 1993.

14ME3023 DESIGN OF MECHANICAL SYSTEM ELEMENTS

Credits: 3:0:0

Course Objective:

- To study the working principle, operation and applications of various mechanical transmissions systems and pressure vessels.
- To impart competency to specify and design the mechanical elements.

Course Outcome:

Ability to

- Identify the working principle of mechanical components employed in Mechanical system elements
- Applysuitable theories and engineering principles to design the mechanical elements.
- Design Mechanical system elements based on the requirements..

Material Handling Equipments Types , Selection and applications. Method for determining stresses-Terminology and ligament efficiency-Applications. Stresses In Pressure Vessels and Introduction : Stresses in a circular ring, cylinder-Membrane stress analysis of vessels shell components-Cylinder shells, spherical heads, conical heads. Thermal stresses - Discontinuity stresses in pressure vessels. Design of Vessels : Design of tall cylinder ,self supporting process columns Supports for short vertical vessels-Stress concentration at a variable thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of reinforcement. Pressure vessel design. Design of automotive transmission system – clutches – power transmitted brake – cams – gear box. Design of hoisting elements, Load handling attachments. Design of forged hooks and eye hooks - crane grabs - lifting magnets - Grabbing attachments - Design of arresting gear and Brakes. Conveyors -Types ,description , design and applications. Escalators.

Reference Books

1. John.F.Harvey, "Theory & Design of Pressure Vessels", "CBS Distributors", 1991.
2. Rudenko.N, "Materials Handling Equipments", Elnvee Publishers, 1970.
3. Alexandrov.M. "Materials Handling Equipmets", MIR publishers,1981.
4. Henry.H.Bedner "Pressure Vessels", Design Hand Book, CBS Publishers & Distributors, 1986.
5. Joseph Edward Sighley , "Mechanical Engineering Design", McGraw Hill, 2011.
6. R.C.Mishra, Simant, "Mechanical System Design", Prentice Hall of India, 2009.

14ME3024 DESIGN FOR MANUFACTURING AND ASSEMBLY

Credits: 3:0:0

Course Objective:

To impart knowledge on

- product functionality, product design, product planning and assembly.
- developing quality products by incorporating the reliability, safety functions and robustness.

Course Outcome:

Ability to

- identify and describe the integrated design, manufacturing and assembly process.
- identify the production plans for machining, casting and welding with ease of manufacturing and assembly to reduce the overall costs of the product.

Design principles for manufacturing: mechanisms and selection, Process capability – Feature and geometric tolerances, assembly limits and Datum Features. **Form design:** Principle, Factors, Material and manufacture design, **Design for machining consideration:** drills, milling cutters, keyways and counter sunk screws, simplification by separation and amalgamation– Design for machinability, economy, clampability, accessibility and assembly. **Design for casting and welding considerations:** Redesign of castings based on parting line, core requirements and machined holes, Redesign of weld members based on different factors and considerations. **Redesign for manufacture and case studies:** Design for Assembly Automation, group technology –Design for reliability and safety, Robust and quality design.

Reference Books:

1. Harry Peck, " Designing for Manufacture", Pitman Publications, 1983.
2. Robert Matousek, " Engineering Design- A Systematic Approach" Blackie and Son Ltd., London.2008
3. George E.Dieter, " Engineering Design: A Materials and Processing Approach", 3rd ed., McGraw-Hill, 2000.
4. James G,.Bralla, " Hand Book of Product design for Manufacturing", McGraw Hill publications, 1999.
5. Geoffrey Boothroyd, Petre Dewhurst, Winston A Knight, "Product Design for Manufacture and Assembly", CRC Press, Taylor & Francis Group, 2010
6. C.Poli, "Design for Manufacturing", Butterworth-Heinemann, Reed Elsevier Group, 2001
7. A.K.Chitale, R.C.Gupta, Product Design and Manufacturing Prentice Hall of India, 2007.

14ME3025 MANUFACTURING SYSTEM AND SIMULATION

Credits:3:0:0

Course Objective:

To impart knowledge on

- the various modeling techniques and assembly lines.
- Manual and computer assisted simulation techniques.

Course Outcome:

Ability to

- create model of the real manufacturing system.
- resolve practical problems in manufacturing sectors using simulation.

Manufacturing systems: Types and principles, manufacturing models - Types and uses, model building. Assembly lines - approaches to line balancing, sequencing, Transfer lines – paced and unpaced lines, Shop scheduling. Flexible manufacturing systems : components, planning and control. Group technology and facility layout. Random numbers generation- methods and techniques. Random variable generation – techniques. Distributions**:** types, Simulation experiments, Verification and validation of simulation models. Concepts in discrete event simulation: Concept, Manual simulation using event scheduling, single and two server queue simulation of inventory problems. Programming for discrete event systems in GPSS-Case studies

Reference Books:

1. Ronald G Askin, "Modeling and Analysis of Manufacturing Systems", John Wiley and Sons, Inc,1993.
2. Jerry Banks and John S. Carson, " Discrete –Event System Simulation", Prentice Hall Inc,2009
3. Gordon G, "System Simulation", Prentice Hall of India Ltd,2009.
4. Mengchu Zhou, "Modeling, Simulation, and Control of Flexible Manufacturing Systems: A Petri Net Approach", World scientific Publishing Company Pvt Ltd., 2000
5. D.S.Hira, "System Simulation", S.Chand & Company Ltd, 2010.
6. Law.M.Kelton, "simulation Modeling and Analysis", McGraw Hill, NY, 2000
7. Behrokh, Khoshnevis, " Discrete systems Simulation", McGraw Hill Inc. 1994.

14ME3026 ADVANCED MECHANISM DESIGN

Credits: 3:0:0

Course Objective

Ability to

- Understand the fundamentals of kinematics
- analyse four-bar mechanisms.
- synthesize mechansims and manipulators

Course Outcome

- capable of analysing and synthesizing mechanisms to meet industrial requirements

Fundamentals of Kinematics- mobility analysis- Degrees of Freedom of multiloop kinematic chains- Grashoff Criterions- Kinematic Analysis- Vector loop equations - Analytical methods for four bar slider crank and crank rocker mechanisms- position velocity and acceleration. Fixed and moving centrodes-Inflection points and inflection circle. Euler SavaryEquation.Synthesis of Mechanisms-types-path generation-function generation-motion generation-Application of instant centre in linkage design. Cam Mechanisms- Dynamics of Mechanisms-Static force analysis with friction – inertia force analysis- combined static and inertia force analysis. Shaking force- balancing of linkages Spatial Mechanism and Robotics-Kinematic Analysis of spatial RSSR mechanism- Denavait- Hartenberg parameters-forward kinematics of Robotic manipulators.

Reference Books

1. Singhley , J. E. and uicker J.J., " Theory of Mechanics and Mechanism", McGraw Hill , 2003.

2. Kenneth J. Waldron, Gary L Kinzel, “Kinematics, Dynamics and Design of Machinery”, John wiley- sons 2004.
3. Sandor G. N. and Erdman. A. G.,Sridharkota., “ Advanced mechanism Design analysis and synthesis”, Prentice Hall, 2001.
4. Nortorn R. L. “ Design of Machinery”, Mc Graw Hill, 2008.
5. Amitabha Ghosh and Ahsok Kumar Mallik, “Theory of mechanism and Machines”, EWLP, Delhi, 1999.
6. J.S.Rao and R.V.Dukkipati, Mechanism and Machine Theory, New age International Publisher, 2006
7. McGrathy.m.J., Geometry Design of linkages, Springer, New York, 2000.

14ME3027 INDUSTRIAL TRIBOLOGY

Credits 3:0:0

Course Objectives:

- To Impart knowledge on application of basic theories of friction ,wear , and lubrication to predictions about the frictional behavior of commonly encountered sliding interfaces.

Course Outcomes:

Ability to

- demonstrate basic understanding of friction, lubrication and wear processes.
- familiar with mathematical tools used to analyze tribological processes
- describe the detailed operation of selected anti-friction or anti-wear components.
- prepare technical project reports and technical presentations.

Introduction, surface topography ,hertzian contact ,friction- stick slip motion – measurement of friction, wear - simple theory of sliding wear mechanism of sliding wear of metals -abrasive wear – materials for adhesive and abrasive wear situations - corrosive wear -surface fatigue wear situations,hydrodynamic lubrication hydrostatic lubrication ,elasto-hydrodynamic lubrication ,boundary lubrication ,lubricants ,surface modification. Mechanical dynamic tribology and testing methods- simple tribological mechanical dynamic test machines and test methods. dry sand-rubber wheel test, wet sand rubber wheel test, slurry abrasivity test, solid particle erosion test, pin-on-disk wear test, rolling wear test, drum wear test, drill wear test. tribology of ic engines.

References Books:

1. Prasanta Sahoo. , “Engineering Tribology”,Prentice Hall of India, 2005.
2. Sushil Kumar Srivastava, “ Tribology in Industries” , S.Chand Publishers, 2005.
3. J. A. Williams, Engineering Tribology, Cambridge University Press, 2005
4. Mang, Kirsten Bobzin and Thorsen Bartels, Industrial Tribology: Tribosystems, Friction, Wear and Surface Engineering, Lubrication-Theory . Wiley-VCH Verlag and Co., 2011.
5. Engineering Tribology, Stachowiak and Batchelor, Butterworth-Heinmann, 2005.
6. S.K. Basu, S.N. Sengupta, B.B. Ahuja, Fundamentals Of Tribology, Prentice Hall of India, 2005
7. Cameron, A. "Basic Lubricaton Theory”, Ellis Herward Ltd., UK, 2005.
8. Kragelsky, “ Friction Wear & Lubrication”, Mir Publications, 2005

14ME3028 ADVANCED MECHANICAL VIBRATIONS

Credits: 3:0:0

Course objective:

To impart

- Knowledge on formulating mathematical model for vibration problems
- skills in analyzing the vibration behavior of mechanical systems subjected to loading
- Awareness on methods to reduce vibration and the equipment used for collecting response data.

Course outcome:

Ability to

- Classify the systems of vibration and construct the equation of motion from free-body diagrams.
- Solve vibration problems that contain multiple degrees of freedom.
- Reduce unwanted vibration and to handle equipment used for collecting response data.
- present the theoretical and the experimental principles of mechanical vibrations to gain practical understanding in the field of vibration

Overview of Mechanical vibrations-Types of vibrations-Damping models- Solutions of problems for one degree of freedom systems for static, transient and harmonic response using Newton's method, Energy method and Rayleigh's method - isolation of vibrations and transmissibility- Vibration of two and Multi degree of freedom systems-semi definite systems-vibration absorber-Vibration of continuous system like strings, beams and rods-Identifying natural frequencies for vibration problems using numerical methods like matrix iteration, Stodola, Holzer and mechanical impedance -Vibration measuring instruments-Vibration Tests-Data acquisition- FFT analysis.

Reference Books:

1. Singiresu.S.Rao., "Mechanical Vibrations", Addison Wesley Longman ,2003.
2. Benson H Tongue, " Principles of vibration"(2nd edition)Oxford University Press, 2002.
3. Thomson, W.T.,"Theory of Vibration with Applications" CBS Publishers and Distributers,NewDelhi,2002
4. Kelly, "Fundamentals of Mechanical Vibrations", Mc Graw Hill Publications, 2000.
5. Rao, J. S . , and Gupta K."Ind. Course on Theory and Practice Mechanical Vibration", NewAge International (P) Ltd.,2005.
6. Rao V. Dukkipati, J. Srinivas., Vibrations : problem solving companion, Narosa Publishers, 2007.
7. Daniel J.Inman, "Engineering Vibration", Prentice Hall,4th Edition, 2013

14ME3029 VIBRATION LABORATORY

Credits: 0:0:2

Course objective:

- To supplement the principles learnt in Mechanical Vibrations
- To train students with the sensors, signal conditioning and associated instrumentation for vibration measurement
- To instruct fundamentals of digital data acquisition, signal processing, data reduction and display.
- To impart knowledge on the use of vibration measurement equipments

Course outcome:

- Able to study the effect of dynamics on vibrations
- Proficient with instrumentation used in vibration control tests
- Capable to understand and adapt the way to measure vibration.

LIST OF EXPERIMENTS

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14ME3030 INDUSTRIAL ROBOTICS

Credits: 3:0:0

Course Objective:

To impart knowledge on

- components, sensing elements used programming techniques and Applications of robots.
- fundamentals of Robotics and primary actuating systems, sensors and transducers.

Course Outcome
Ability to

- design and develop Robot with basic drivers and controllers.
- select suitable Sensors and transducers for real life or industrial problems.

Robot - Definition - Basic Concepts - configurations - Types of drives -Basic motions –Point to point control - Continuous path control. Basic control system concepts and analysis - robot actuation and feedback, Manipulators – director and inverse kinematics, Coordinate transformation - Brief Robot dynamics. Types of Robot and effectors – Grippers, Tools, End - effecter interface.
Sensing – Range, Proximity, Touch, Force and Torque. Introduction to Machine vision - Sensing and digitizing - Image processing and analysis. Methods - languages - Capabilities and limitation - Artificial intelligence – Knowledge representation – Search techniques - AI and Robotics. Application of robots in machining - Welding - Assembly - Material handling - Loading and unloading - CIM –Hostile and remote environments.

Reference Books:

1. Mikell P. Groover, Mitchell Weiss, "Industrial Robotics, Technology, Programming and Applications. " McGraw Hill International Editions, 1st Edition, 2000.
2. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic Engineering - An Integrated Approach", Prentice Hall India, 2002
3. Ibrahim Zeid, "CAD/CAM Theory and Practice", McGraw Hill, 2003
4. K.S. Fu., R.C.Gonalez, C.S.G.Lee, "Robotics Control sensing ", Vision and Intelligence, McGraw Hill International Edition, 1987.
5. Klafter R.D., Chmielewski T.A. and Negin M., " Robot Engineering An Integrated approach ",Prentice Hall of India, New Delhi, 1994.

14ME3031 COGENERATION AND WASTE HEAT RECOVERY SYSTEMS

Credits: 3:0:0

Course objective:
To impart knowledge on

- the basic energy generation cycles
- the concept of cogeneration, its types and probable areas of applications
- significance of waste heat recovery systems and carryout its economic analysis

Course outcome:
Ability to

- Analyse the basic energy generation cycles
- do the economic analysis of waste heat recovery systems

Introduction –combined cycle – organic rankine cycles – performance indices of cogeneration systems – waste heat recovery – sources and types – concept of tri generation. **Cogeneration Systems, Issues and applications of Cogeneration Technologies:** Cogeneration plants electrical interconnection issues – utility and cogeneration plant interconnection issues – applications of cogeneration in utility sector – industrial sector – building sector – rural sector – impacts of cogeneration plants – fuel, electricity and environment. **Waste Heat recovery systems:** Selection criteria– recuperators – Regenerators – economizers – plate heat exchangers – thermic fluid heaters – Waste heat boilers – classification, location, service conditions, design Considerations – fluidized bed heat exchangers – heat pipe exchangers – heat pumps – sorption systems. **Economic Analysis:** Investment cost – economic concepts – measures of economic performance – procedure for economic analysis –procedure for optimized system selection and design – load curves – sensitivity analysis.

Reference Books:

1. Charles H. Butler, Cogeneration, McGraw Hill Book Co., 1984,
2. EDUCOGEN – The European Educational tool for cogeneration, Second Edition,2001
3. Horlock JH, Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford,1987.

4. Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers,London, 1963.
5. Seagate Subrata, Lee SS EDS, Waste Heat Utilization and Management,Hemisphere, Washington, 1983.
6. De Nevers, Noel., Air Pollution Control Engineering, McGrawHill, New York,1995

14ME3032 DRIVES AND CONTROL SYSTEMS FOR ROBOTS

Credits: 3:0:0

Course Objective:
To impart

- fundamental principles of various robot drives and to develop skills to recognize and analyze the problems associated with.
- skills on hydraulic, pneumatic and electric drives for development of robots in various applications.
- necessary skills, motivation and training to work and communicate with confidence in interdisciplinary areas.

Course Outcome:
Ability to

- select suitable drives for robots.
- utilize the Robots for the production of various products.

Robot drive mechanisms: motion conversions. Hydraulic drives: hydraulic fluid considerations, simple hydraulic system, hydraulic actuators, DCVS, FVCS, PCVS and servo valves and systems. Pneumatic drives: laws of gases, pneumatic valves and actuators, pneumatic proportional controller, pneumatically controlled prismatic joint. Types of electric drives. Control of robotic mechanisms - closed loop control in a position servo – no velocity feedback, linear control of manipulator and force control of manipulators.

Reference Books:

1. Richard D. Klafter, Thomas. A, Chmielewski, Michael Negin, “Robotics Engineering an Integrated Approach”, Prentice Hall of India Pvt. Ltd., 2008.
2. S R Deb, “Robotic Technology and Flexible Automation,” Tata McGraw Hill Publishing company Ltd., New Delhi, 2003.
3. P.A. Janaki Raman, Robotics and Image Processing an Introduction, Tata McGraw Hill Publishing company Ltd., 2002.
4. Mikell P. Groorer, Mitchell welss, Roger N. Nagel, Nicholas G.Odrey, Industrial Robotics, Technology programming and Applications, McGraw Hill International Edition, 2006.
5. Robert J. Schilling, Fundamentals of Robotics Analysis and Control, Prentice Hall of India Pvt. Ltd., 2001.
6. John J. Craig, “Introduction to Robotics Mechanics and Control”, 3rd Edition, Dorling Kindersley(India) Pvt. Ltd., 2009

14ME3033 ENGINEERING PRODUCT DESIGN AND DEVELOPMENT STRATEGIES

Credits: 3:0:0

Course Objective:
To impart knowledge on

- the important practices followed during designing and developing a product in industries.
- the entire product life cycle right from its conceptual stage to its development stage.
- various concepts like modelling, simulation, material selection and GD&T.

Course Outcome:
Ability to

- design and develop a product in industries.

Importance of product design-Design Constraints -Consideration of a Good Design- Detailed description of Design process.-The role of different Models in Engineering Design- Relation of Materials Selection to Design- Performance Characteristics of materials, The Materials Selection process –Material selection in Embodiment design-Economics of materials,- Selection with Computer-Aided database- Weighted Property Index- Value analysis- Functional and production design- Form design- Influence of basic design, Mechanical loading and material on Form design- Form design of castings- Dimensioning and Tolerancing a product- Functional production and inspection datum- Tolerance analysis. Dimensioning systems- Dimensioning Rules- Geometric tolerancing- introduction to statistical tolerancing.

Reference Books:

1. Dieter. G. E, “Engineering Design", McGraw Hill, 2000.
2. David A. Madsen, “Engineering Drawing and Design”, Delmar Thomson Learning Inc. 2002,
3. Jones J.C., "Design Methods", Interscience, 2008
4. Kevin Otto and Kristin Wood, “Product Design”, Pearson Educational Inc. 2004.
5. Karl T Ulrich, Steven D Eppinger, “Product Design and Development”, Irwin Homeward Boston Publishers, 2004.

14ME3034 CONTROL OF CNC MACHINE TOOLS

Credits: 3:0:0

Course Objective:

- To familiarize the students about functioning of CNC machine tool from the control point of view.

Course Outcomes:

- Ability to design control systems for CNC machine tool

Introduction to CNC systems, Coordinate systems of CNC machines, Economics. CNC programming- Interpolation, feed, tool and spindle functions (G-codes). CNC drives-
Hydraulic systems, servo and stepping motors, response analysis, Feedback devices and coutner. CNC Interpolation - Hardware interpolators- DDA integrator, linear, circular, complete interpolators, Software interpolators, Tustin method, NURBS and polynomial interpolators, Acceleration and deceleration control techniques. CNC control loops, PID control, servo controller, gain tuning, feed forward control, Mathematical analysis of control loops. CNC Architecture - Numerical control kernel- types, PLC, programming, languages, Human-Machine Interface- functions, structure, Introduction to Open CNC architecture.

Reference Books:

1. Suk-Hwan Suh and Ian Stroud, Gloud “Theory and Design of CNC Systems”, Springer, 2008
2. Yoram Koren and Joseph Ben Uri, “Numerical Control of Machine Tools”, Khanna Publishers, 2000.
3. Yoram Koren, “Computer Control of Manufacturing Systems” McGrawHill, 1985.
4. Bollinger, “Computer Control of Machines and Processes”, Addison Wesley, 1989.
5. Yusuf Altintas, “Manufacturing Automation Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design”, Second edition, Cambridge University Press, 2012.
6. Gene F. Franklin, J. David Powell, Abbas Emami-Naeini, “Feedback Control of Dynamic Systems”, 6th Edition, Peason Education, 2009.

14ME3035 SOLAR THERMAL ENERGY CONVERSION

Credits 3:0:0

Course Objective

- To impart knowledge on solar thermal systems

Course Outcome

Ability to

- estimate the solar radiation on horizontal and tilted surfaces
- analyze the performance of different solar collectors
- select the right type of solar collector for an application
- design solar heating and cooling systems.

Reflecting Surfaces and transparent materials, Selective Surfaces: Ideal coating characteristics; Anti-reflective coating, Solar radiations, Thermal analysis of Solar Collectors, Solar Energy storage - Heliostats; Solar power plant; Solar furnaces - Solar water heating systems, Solar space heating and cooling system, Solar pond, Solar applications, solar vapour absorption refrigeration system, solar desiccant cooling.

Reference Books

1. Duffie J.A., Beckman W.A., Solar Engineering of Thermal Processes, Wiley-Interscience, New York, 2006.
2. Kalogirou S. A., "Solar thermal collectors and applications," Progress in Energy and Combustion Science, Elsevier Journal, Vol. 30, pp. 231–295, 2004.
3. Yogi Goswami D., Frank Kreith, "Energy Conversion", CRC Press, New York, 2008.
4. Yogi Goswami D., Frank Kreith, "Principles of Solar Energy", Taylor and Francis, Phildelphia, 2000.

14ME3036 BIOMASS ENERGY

Credits 3:0:0

Course Objective

To impart knowledge on

- thermal biomass conversion and biological pathways.
- power generation techniques.
- Design, Selection, Construction and Operation of Biogas Plants.

Course Outcome

Ability to

- develop thermal biomass conversion systems.
- apply Pyrolysis, Gasification and Liquefaction and fermentation processes
- Communicate effectively about issues in environmental aspects for bio energy conversion and also to design the biogas plants.

Biomass – resources, classification, properties. Thermo chemical conversion, Biological Conversion - alcohol Production - Fermentation - Anaerobic Digestion Biodegradation and Biodegradability of Substrate - Hydrogen Generation from Algae – Biological Pathways - Biogas Production from different Organic Wastes - Effect of Additives on Biogas, Industrial Application - Wood Gasifier System, Operation of Spark Ignition and Compression Ignition with Wood Gas - Energy Effectiveness and Cost Effectiveness - History of Energy Consumption - Environmental Aspects of Bio energy Conversion- Economic analysis of bio energy options - Design of the digester – scaling of biogas plants –Electricity Production from biomass.

References Books

1. Mital K.M, "Biogas Systems: Policies, Progress and Prospects", 1st Edition, New Age International Private Ltd, New Delhi, 2006.
2. N.H.Ravindranath, Hall D.O., "Biomass, Energy and Environment", Reprinted Edition, Oxford University Press, Oxford, 2002.
3. Chawla O.P., "Advances in biogas technology", Publications and Information Division, Indian Council of Agricultural Research, New Delhi, 2009.
4. Nijaguna, B.T, "Biogas Technology", 1st Edition, New Age International Private Ltd, New Delhi , 2009.
5. Mital, K.M, "Biogas Systems: Principles and Applications", 1st Edition, New Age International Private Ltd, New Delhi, 2009.

14ME3037 QUALITY CONCEPTS IN DESIGN

Credits 3:0:0

Course Objective:

To impart knowledge on

- the basic concepts in Total quality Management
- the Taguchi methods for robust design

Course Outcome

- Ability to apply the six sigma concepts in industries.
- Ability to apply TQM and SPC in Industries
- Ability to conduct experiments and evolve solutions.
- Ability to improve the reliability of the systems

Basic concepts in quality engineering and management, TQM, Cost of quality, quality engineering and Six Sigma. Review of Probability and Statistics, Frequency distributions and Histograms, Test of Hypothesis. DMAIC process for process and design improvement, Acceptance Sampling, SPC (Statistical Process Control), Process Capability, Gage Reproducibility and Repeatability, Quality Function Deployment. Failure mode effect analysis, APQP, Embodiment checklist- Advanced methods: systems modeling, mechanical embodiment principles. Design of Experiments, ANOVA, EVOP; Fractional, Full and Orthogonal Experiments, Regression model building, Taguchi methods for robust design. Six Sigma sustainability, Six Sigma and lean production. Reliability-Survival and Failure-Series and parallel systems-Mean time between failure-Weibull distribution

Reference Books:

1. Evans, J R and W M Lindsay, "An Introduction to Six Sigma and Process Improvement", 2nd Edition CENGAGE, 2005.
2. Pyzdek, Thomas, "The Six Sigma Handbook-Revised and Expanded", McGraw-Hill,2003.
3. Montgomery, D C, "Design and Analysis of Experiments", 5th Edition., Wiley.2007
4. Mitra, Amitava, "Fundamentals of Quality Control and Improvement", 3rd Edition, John Wiley & Sons, 2008

14ME3038 RENEWABLE ENERGY SOURCES

Credits: 3:0:0

Course objective:

- To impart knowledge on various renewable energy sources and functioning of non-conventional power plants

Course outcome:

- Ability to design various non-conventional energy power plants
- Ability to select suitable non-conventional energy resources under specific conditions and for specific applications.

Non-conventional energy resources, Solar radiation- types of solar collectors– performance- solar applications, thermal energy storage for solar heating and cooling, solar cell power plant- Geothermal power plant- Magneto-hydrodynamics Power plant- fuel cell–Wind power plant. Biomass resources-Thermo chemical conversion of biomass-Biomass gasifier- Ocean Thermal Energy Conversion, Tidal power plant, hydrogen energy – merits and limitations of non conventional power plants- environmental impact.

Reference books:

1. Khan B.H., "Non-Conventional Energy Resources", Tata McGraw Hill, Education India Private Limited, New Delhi, 2nd Edition, 2010
2. Rai G.D, 'Non-conventional energy sources", Khanna Publishers, New Delhi, Reprint 2011
3. Rao S and Paruklekar, "Energy Technology- Non-conventional, Renewable and Conventional" Khanna Publishers, New Delhi, 3rd Edition, 2005

4. N. Chermisinogg and Thomas, C. Regin, "Principles and Application of Solar Energy" Tata McGraw Hill, 2010
5. N.G. Calvert, “Wind Power Principles” McGraw Hill, 2006
6. N.H.Ravindranath, Hall D.O., “Biomass, Energy and Environment”, Oxford University Press, Oxford 2002

14ME3039 EXPERIMENTAL STRESS ANALYSIS

Credits: 3:0:0

Course Objective:

- To impart knowledge on applied stress and strain involved in solid mechanics.
- To impart knowledge on the relation between theory of mechanics and experimental stress and strain analysis

Course Outcome:

Ability to :

- Work with devices used while carrying out experimental stress and strain analysis
- analyze experimental stress and strain data and interpret the results.

Elementary Elasticity, Strain Measurement Methods, Photo Elasticity-plane and circular polarization-stress optic law-photo elastic materials-casting and modeling techniques- calibration methods- Reflection polariscope – sensitivity of the method – separation, Comparison of brittle coating and bi-refrigerant coating techniques- Brittle Coating Method. Crack detection techniques- calibration of brittle coating materials- Moire Methods. Digital image processing -Image processing systems for digital photoelasticity- Image acquisition.

Reference Books

1. Shukla and Dally, “Experimental Stress Analysis”**,** 3rd Edition, McGraw Hill, 2010.
2. J.W. Dally and W.F. Riley, Experimental Stress Analysis, 4th Edition, College House Enterprises, 2005.
3. Sadhu singh, Experimental stress analysis, Khanna publishers, 2009
4. LS Srinath, MR Raghavan, K Lingaiah, G Gargesha, B Pant, K Ramachandra, Experimental Stress Analysis, Tata McGraw-Hill,1984.
5. U.C. Jindal, Experimental Stress Analysis, Pearson Education,2012 .
6. James F. Doyle, Modern Experimental Stress Analysis: Completing the Solution of Partially Specified Problems, Wiley-Blackwell,2004
7. Dove and Adams, Experimental Stress Analysis and Motion Measurement”, Prentice Hall of India,1964.

14ME3040 ENGINEERING FRACTURE MECHANICS

Credits: 3:0:0

Course Objective:

To impart knowledge on

- stress and strain field around a crack in a body for different fracture modes
- factors governing crack growth , crack arrest and fatigue.
- the applications of fracture mechanics.

Course Outcome:

Ability to

- estimate stress and strain field around a crack.
- estimate the fracture toughness value of a material for various fracture modes.
- provide solution to prevent crack growth and fatigue failures

Elements of Solid Mechanics, deformation, limit analysis –Airy’s function –field equation for stress intensity factor. Stationary Crack Under Static Loading: Two dimensional elastic fields –Analytical solutions yielding near a crack front –Irwin‟s approximation -plastic zone size–Dugdale model –determination of J integral and its relation to crack opening displacement. Energy Balance and Crack Growth: Griffith analysis –stable and unstable crack growth – Dynamic energy balance –crack arrest mechanism –K_{1c} test methods -R curves -determination of collapse load. Fatigue Crack Growth Curve: Empirical relation describing crack growth law –life calculations for a given load amplitude–effects of changing the load spectrum -rain flow method–external factors affecting the K_{1c} values.-leak before break analysis. Applications of Fracture Mechanics.

References:

1. David Broek, "Elementary Engineering Fracture Mechanics", Kluwar Academic Publisher, 4th Edition, 1986.
2. Ted L. Anderson , "Fracture Mechanics: Fundamentals and Applications", 3rd Edition, Taylor and Francis, CRC, 2004.
3. Preshant Kumar, "Elements of Fracture Mechanics", Tata McGraw Hill Education Private Limited, 2009 .
4. Kare Hellan, "Introduction of Fracture Mechanics", McGraw-Hill Book Company, 1985.
5. Kundu, Fundamentals of Fracture Mechanics, Taylor and Francis Group,2008
6. John M.Barson and Stanely T.Rolfe, Fatigue and fracture control in structures, Prentice hall Inc., Englewood Cliffs. 1977.

14ME3041 APPLIED MECHATRONICS

Credits 3:0:0

Course Objectives:

- To provide the students with the Mechatronics principles and applications.
- To explore architecture of intelligence machines.
- To provide students with the necessary skills, motivation and training to work and communicate with confidence in interdisciplinary areas.

Course Outcomes:

Ability to

- utilize principles of Mechatronics for design industrial and domestic applications.
- select proper sensor and actuator for a given application
- develop intelligent automated system and manufacturing data base system

Overview of Mechatronic products. Intelligent Machine vs Automatic Machine, Economic and social justification. Actuators and Motion Control. Control parameters and system objectives. Mechanical configurations. Popular control system configurations-S-curve, Motor/Load inertia matching, design with linear slides. Motion control Algorithms: significance of feed forward control loops, shortfalls, Fundamental concepts of adaptive and fuzzy control. Fuzzy logic compensatory control of transformation and deformation non-Z linearities- Introduction to Microprocessor and programmable logic controllers and identification of system, System design Classification. Motion control aspects in Design. Manufacturing Data Bases, Sensor Interfacing: Analog and Digital Sensors for Motion Measurement, Digital Transducers, Human - Machine and Machine - Machine Interfacing. Machine Vision: Feature and Pattern Recognition methods, concepts of perception and cognition in decision making.

References Books

1. Michel B. Histand and David G. Alciatore, "Introduction to Mechatronics and Measurement Systems" Tata McGraw Hill, 2011
2. C.W. De Silva, "Sensors and Actuators: Control system Instrumentation", CRC Press, 1st Edition, 2011.
3. Ogata Katsuhiko , 'Modern Control Engineering', Printice Hall of India , 2005
4. Yoram Koren, 'Computer control of Manufacturing Systems', TataMc.Graw Hill Publishers, New Delhi, 2005.
5. Mahalik,Nitaigour,Premehand, 'Mechatronics', TataMc.Graw Hill Publishers, New Delhi 2005.

14ME3042 AUTOMATION IN MANUFACTURING

Credits 3:0:0

Course Objectives:
To impart knowledge on

- basic principles of automation, tool transfer and implementation of automated flow line.
- design aspects and analysis of material handling system.
- ways of improving line balance and solving line balancing problems.

Course Outcomes:
Ability to

- implement the concepts of a productive system in automation.
- apply the knowledge of automated flow lines for industrial and other applications.
- design and analysis of material handling systems for automated assembly lines.
- balance automated assembly lines.

Production operations and automation strategies, Plant Layout, production concepts and mathematical models, Automatic loading Systems-Automated flow lines, Methods of work flow - transport transfer mechanisms, buffer storage, Control functions, Automation for machining operations, Design and fabrication considerations. Analysis of transfer lines without storage -partial automation automated flow lines with storage buffers implementing of automatic flow lines-Line balancing problems, Considerations in assemble line design-Manual assembly lines - line balancing problem - flexible manual assembly lines - automated assembly systems, Analysis of multi station assembly-Manufacturing Cells, Automated Cells, Analysis of Single Station Cells, design and analysis of material handling system, conveyor system. Automated guided vehicle system-Automated storage and Retrieval systems, Transfer lines, Design for Automated Assembly, Partial Automation, Communication Systems in Manufacturing.

Reference Books

1. Mikell P. Groover, "Automation, Production Systems and CIM", Printice Hall of India, 2008
2. P. Radha Krishnan & S. Subrahamanyarn and Raju, "CAD/CAM/CIM", New Age International Publishers, 2003.
3. Singh, "System Approach to Computer Integrated Design and Manufacturing", John Wiley 1996.
4. Yorem Koren, "Computer Integrated Manufacturing Systems", McGraw Hill, 1983.
5. Ranky, Paul G., "Computer Integrated Manufacturing", Prentice Hall International 1986.
6. R.W. Yeomamas, A. Choudry and P.J.W. Ten Hagen, "Design rules for a CIM system", North Holland Amsterdam, 1985.

14ME4001 - FRICTION STIR WELDING AND PROCESSING TECHNOLOGY

Credits: 3:1:0

Course objective:

- To help learners gain a more complete understanding of various aspects of solid state welding process and in particular Friction stir welding/processing

Course outcome:

- Ability to weld mechanical structures while minimizing negative impact to the environment

Solid state welding processes, friction stir welding – tooling and design, temperature distribution and resulting metal flow, microstructural development, mechanical and corrosive properties in friction stir welded ferrous and non-ferrous alloys. Friction stir processing. Machines for friction stir welding / processing. Application of friction stir welding and related technologies.

Reference Books:

1. Rajiv S. Mishra, Murray W. Mahoney, Yutaka Sato, Yuri Kovansti Jata, "Friction Stir Welding and Processing VI" , John Wiley & Sons, 2013.

2. Mel Schwartz “Innovations in materials manufacturing, fabrication, and environmental safety” CRC Press, Taylor & Francis Group, 2011.
3. W M Thomas, E D Nicholas and S D Smith “Friction Stir Welding – tool development” TWI Ltd. TMS Annual Meeting, New Orleans, Louisiana, USA,2011.
4. Little R. L “Welding and welding technology” (2004) Mc Graw Hill education, 2004
5. Damiela Lohwasser, Zhan Chen, “ Friction Stir Welding: from basics to applications”, CRC Press, 2010.
6. Bharat Raj Singh, “ A Hand book on friction stir welding Lap Lambert Acadmic Publishing, 2012.
7. Mohammad Kazem, Besharah-Givi, Parviz Asadi, “ Advances in friction- stir Welding and Processing”, Wood head Publishing Ltd, 2014.

14ME4002 APPLIED THERMAL ENGINEERING AND EXPERIMENTAL METHODS

Credits: 3:1:0

Course Objective:

- To impart the fundamentals of heat transfer, exergy analysis and optimization techniques for various energy systems.

Course Outcome:

- Ability to apply the knowledge in analyzing the heat transfer performance of thermal systems, also will be conversant with measurement techniques, data acquisition and processing.

First law and Second law analysis – principle of increase of entropy – Exergy analysis of thermal systems – heat pipes, heat exchanger, thermoelectric cooler. Forced convection – Mass, Momentum and Energy equations – thermal boundary layer – Laminar and Turbulent flow through mini & micro channels – Methods of development of correlations – Uncertainty analysis in experiments– Pressure, velocity, temperature and flow measurements – Velocity measurements – Measurement of Thermo physical properties – Data acquisition and processing. Regression analysis and curve fitting - modeling of thermal equipment - system simulation (successive substitution - Newton - Raphson method) - optimization - linear programming, geometric programming- Examples applied to heat transfer problems and energy systems. Nanofluid preparation and characterization – Micro level mechanisms in nanofluid flow.

Reference Books:

1. K V Wong, Thermodynamics for Engineers, First Indian Edition, 2010, CRC Press.
2. Frank P Incropera & David P De witt, Fundamentals of Heat & Mass Transfer, Fifth Edition, John Wiley& Sons.
3. Holman, J.P, Experimental methods for engineers, McGraw-Hill, 1988.
4. Kalyanamoy Deeb. “Optimization for Engineering Design algorithms and Examples”, Prentice Hall of India Pvt. Ltd.1995
5. Sarit K Das, SUS Choi, Nanofluid: Science and Technology, Wiley-Interscience, 2008.

14ME4003 SMART MATERIALS AND VIBRATION CONTROL

Credits: 3:1:0

Course Objective:

To impart

- the fundamentals of smart materials and its devices
- the development of smart structures and products
- knowledge and motivation in the design, analysis and manufacturing of smart structures
- the importance of vibration control and the methods to control it using smart materials

Course Outcome:

Ability to

- understand the physical principles underlying the behavior of smart materials

- use principles of measurement, signal processing, drive and control techniques necessary to developing smart structures and products
- Integrate smart materials and devices with signal processing and control capabilities to engineering smart structures and products.
- control vibration using smart materials

Overview of Smart Materials, Structures and Products Technologies- Piezoelectric Materials- Magneto and Electrostrictive Materials- MR and ER Fluids. Actuator materials-Sensing technologies-Microsensors- Intelligent systems- Hybrid smart materials- General engineering applications of Smart materials.
Smart Sensors- Smart Transducers- Measurement Methods- Signal Conditioning Devices- Calibration Methods- Passive, Semi-Active and Active Control- Feedback and Feed forward Control Strategies.
Design-Analysis-Manufacturing of smart materials-Application issues involved in integrating smart materials with signal processing and control capabilities.
Basics of vibration control - Dynamic Vibration Neutralizers and absorbers-Vibration Isolators.
Techniques for Vibration control- Vibration source isolation using electro/magneto rheological fluids- Distributed Control Strategy - Control of Plate Vibration.

Reference Books:

1. A.V. Srinivasan, Smart Structures: Analysis and Design, Cambridge University Press,
2. Cambridge; New York, 2001.
3. André Preumont, Vibration Control of Active Structures: An Introduction, 2nd Edition, Kluwer Academic Publishers, Dordrecht; Boston, 2002
4. A.J. Moulson and J.M. Herbert, Electroceramics: Materials, Properties, Applications, 2nd Edition, John Wiley & Sons, Chichester, West Sussex; New York, 2003
5. G. Gautschi, Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers, Springer, Berlin; New York, 2002
6. Clarence W desilva, "vibration Damping Control and design, CRC Press, Taylor and Francis Group, 2005
7. Malcolm.J.Crocker, Hand book of Noise and vibration control, John wiley & sons,2007

14ME4004 CONTROL SYSTEM ENGINEERING

Credits: 3:1:0

Course Objective:

To impart

- The basic concepts of control system and stability
- Understanding about design and specifications of control systems
- Knowledge about stability criteria

Course Outcome:

Ability to

- Represent control systems block statements..
- Be familiar with about Block diagrams, stability of control systems and stability criterion.
- Acquire ideas concerning analysis and components of control systems.

Basic elements in Control Systems -Mathematical Models -Mechanical translational and rotational –Electrical systems -Transfer functions -Block diagrams.
Time domain specifications-types of test inputs-I and II order systems-response-generalized error series-steady state error-frequency domain specifications-polar-plot-bode plot.
Stability of control systems- Routh Hurwitz criterion- root locus technique construction- Nyquist stability criterion- Jury stability test- stability analysis using bi-linear transformation.
Concepts of state variables and state model - Concepts of controllability and observability- Design of DCS with deadbeat response- sampled data control system with deadbeat response -full and reduced order observer, output feedback design.
Servomotor-stepper motor-synchro–resolver-amplidyne-planar motor-–Passive Compliances

References Books:

1. K.Ogata, :modern controls engineering " Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
2. B.C. Kuo, "Automatic Control Systems", Prentice Hall of India Pvt. Ltd., New Delhi, 2004
3. I.J.Nagrath and Gopal. "Control system engineering", new age international (P) Ltd., 2006.
4. Gene F.Franklin, J.David Powell and Abbas Emami-Naeini, "Feed back control and dynamic system" Prentice Hall,6th Edition, 2009.
5. M. Gopal, "Control Systems priniciples and Design" Tata MV Graw Hill Publishing Ltd,New Delhi , 2003.
6. U.A.Bakshi and S.C.Goyal, Feedback control systems, Technical Publications, Pune, 2008.
7. Naresh.K.Sinha, "control systems", New Age International Publishers, New Delhi, 2004.