DEPARTMENT OF AEROSPACE ENGINEERING

Curriculum Details

B.Tech.

Aerospace Engineering

2017-21

<u>Table AE-2</u>

B.Tech. (Aerospace Engineering) – 2016 Batch

Table AE-2

B.Tech. (Aerospace Engineering) – 2017 Batch

COURSE COMPONENTS

Table 1

Sl. No.	Course Code	General – 3 credits Name of the Course	Credits
1	16VE2001	Value Education	2:0:0
2		Personality Development	0:0:1
		Course Total	3

Table 2

Sl. No.	Course Code	Basic Sciences – 12 credits Name of the Course	Credits
1	17MA2001	Vector Calculus and Complex Analysis	3:1:0
2	17MA2002	Mathematical Transforms	3:1:0
3	17MA2006	Numerical Mathematics and Computing	3:1:0
		Course Total	12

Table 3

Sl. No.	Course Code	Engineering Sciences & Technical Arts – 6 credits Name of the Course	Credits
1	17SS2001	Soft skills – I	1:0:0
2	17SS2002	Soft skills – II	1:0:0
3		General Aptitude – I	1:0:0
4		General Aptitude– II	1:0:0
5	17AE2015	Foundations of Space Engineering	3:0:0
		Course Total	**7**

Table 4

Sl. No	Course Code	Program Core – 75 Credits & a full / Part Semester Project Name of the Course	Credits
1	17AE2001	Introduction to Aerospace Engineering	3:0:0
2	17AE2002	Fundamentals of Fluid Flow	3:1:0
3	17AE2003	Fluid Mechanics Laboratory	0:0:1
4	17ME2004	Engineering Thermodynamics	3:0:0
5	17AE2004	Solid Mechanics	3:0:0
6	17AE2005	Solid Mechanics Lab	0:0:1
7	17AE2006	Aircraft Instrumentation	3:0:0
8	17AE2007	CAD/CAM Laboratory	0:0:2

9	17AE2008	Aero Thermal Engineering	3:0:0
10	17AE2009	Thermal Engineering Laboratory	0:0:1
11	17AE2010	Aerodynamics	3:0:0
12	17AE2011	Aerodynamics Laboratory	0:0:2
13	17AE2012	Aircraft Structures – I	3:0:0
14	17AE2013	Aircraft Performance	3:0:0
15	17AE2014	Elements of Avionics	3:0:0
16	17AE2016	Gas Dynamics	3:0:0
17	17AE2017	Gas Dynamics Laboratory	0:0:2
18	17AE2018	Aircraft Structures – II	3:0:0
19	17AE2019	Aircraft Structures and Composite Laboratory	0:0:2
20	17AE2020	Aircraft Stability and Control	3:0:0
21	17AE2021	Aircraft Propulsion	3:0:0
22	17AE2022	Space Dynamics	3:0:0
23	17AE2023	Computational Fluid Dynamics	3:0:0
24	17AE2024	CFD Laboratory	0:0:2
25	17AE2025	Rocket Propulsion	3:0:0
26	17AE2026	Propulsion Laboratory	0:0:2
27	17AE2027	Computational Structural Analysis Laboratory	0:0:2
28	17AE2028	Aircraft/Spacecraft Design Project	0:0:4
29	17AE2029	Instrumentation and Avionics Laboratory	0:0:2
	FSP2999/PSP2998	Full / Part Semester project	18/12
		Total Credits	**93/ 87**

Table 4

Sl. No	Course Code	Professional Electives (Minimum of 21 Credits to be Earned)	Credits
		Name of the Course	
1	17AE2030	Wind Tunnel Techniques	3:0:0
2	17AE2031	Finite Element Analysis in Aerospace Application	3:0:0
3	17AE2032	Heat Transfer	3:0:0
4	17AE2033	Experimental Stress Analysis	3:0:0
5	17AE2034	Composite Materials	3:0:0
6	17AE2035	Navigation, Guidance and Control of Aerospace	3:0:0
7	17AE2036	Cryogenic Propulsion	3:0:0
8	17AE2037	Industrial Aerodynamics	3:0:0
9	17AE2038	Introduction to Unmanned Aircraft Systems	3:0:0
10	17AE2039	Aero-elasticity	3:0:0
11	17AE2040	Analytics for Aerospace Engineers	3:0:0
12	17AE2041	Advanced space dynamics	3:0:0
13	17AE2042	Air Traffic Control and Aerodrome details	3:0:0
14	17AE2043	Introduction to Non Destructive Testing	3:0:0
15	17AE2044	Introduction to Hypersonic Flows	3:0:0
16	17AE2045	Aircraft Systems	3:0:0

17	17AE2046	Theory of Vibration	3:0:0
18	17AE3016	Boundary Layer Theory	3:0:0
19	17AE3017	Theory of Elasticity	3:0:0

Sl. No	Course Code	University Electives Name of the Course	Credits
1	17AE2047	Basics of Aerospace Engineering	3:0:0

Table AE-3

M.Tech. (Aerospace Engineering) - 2017 Batch

COURSE COMPONENTS

Table -1

Course Code	PROGRAM CORE Name of the Course	Credits
17MA30**	Advanced Calculus and Numerical Methods	3:0:0
17AE3001	Vibration and Aero-Elasticity	3:0:0
17AE3002	Advanced Aerodynamics	3:0:0
17AE3003	Advanced Aerodynamics Laboratory	0:0:2
17AE3004	Aerospace Propulsion	3:0:0
17AE3005	Aero Propulsion Laboratory	0:0:2
17AE3006	Advanced Computational Fluid Dynamics	3:0:0
17AE3007	Computational Heat Transfer	3:0:0
17AE3008	Advanced Computational Fluid Dynamics Laboratory	0:0:1
17AE3009	Flight Performance and Dynamics	3:0:0
17AE3010	Aerospace Structural Analysis	3:0:0
17AE3011	Aerospace Structure and composite Laboratory	0:0:2
17AE3012	Advanced Avionics (V-1.1)	3:0:0
17AE3013	Aircraft Modelling Laboratory	0:0:1
17AE3014	Advanced Avionics Laboratory	0:0:1
	Total Course Credits	**36**
17VE30**	Value Education	2:0:0
PSP3998	Part Semester Project	12
FSP3999	Full Semester Project	20
	TOTAL	**70**

Table -2

Course Code	PROFESSIONAL ELECTIVES Name of the Course	Credits
17AE3015	Orbital Space Dynamics	3:0:0
17AE3016	Boundary Layer Theory	3:0:0
17AE3017	Theory of Elasticity	3:0:0
17AE3018	Aircraft Design	3:0:0

17AE3019	Rockets and Missiles	3:0:0
17AE3020	Unmanned Aerial Systems	3:0:0
17AE3021	Finite Element Analysis for Aerospace Structural Application	3:0:0

Course Code	BRIDGE COURSES	Credits
	Name of the Course	
17AE3022	Elements of Aerospace Engineering	3:0:0

Total Credits requirement: 82

Table AE-4

LIST OF COURSES

Sl. No	Course Code	Name of the Course	Credits
1	17AE2001	Introduction to Aerospace Engineering	3:0:0
2	17AE2002	Fundamentals of Fluid Flow	3:1:0
3	17AE2003	Fluid Mechanics Laboratory	0:0:1
4	17AE2004	Solid Mechanics	3:0:0
5	17AE2005	Solid Mechanics Lab	0:0:1
6	17AE2006	Aircraft Instrumentation	3:0:0
7	17AE2007	CAD/CAM Laboratory	0:0:2
8	17AE2008	Aero Thermal Engineering	3:0:0
9	17AE2009	Thermal Engineering Laboratory	0:0:1
10	17AE2010	Aerodynamics	3:0:0
11	17AE2011	Aerodynamics Laboratory	0:0:2
12	17AE2012	Aircraft Structures – I	3:0:0
13	17AE2013	Aircraft Performance	3:0:0
14	17AE2014	Elements of Avionics	3:0:0
15	17AE2015	Foundations of Space Engineering	3:0:0
16	17AE2016	Gas Dynamics	3:0:0
17	17AE2017	Gas Dynamics Laboratory	0:0:2
18	17AE2018	Aircraft Structures – II	3:0:0
19	17AE2019	Aircraft Structures and Composite Laboratory	0:0:2
20	17AE2020	Aircraft Stability and Control	3:0:0
21	17AE2021	Aircraft Propulsion	3:0:0
22	17AE2022	Space Dynamics	3:0:0
23	17AE2023	Computational Fluid Dynamics	3:0:0
24	17AE2024	CFD Laboratory	0:0:2
25	17AE2025	Rocket Propulsion	3:0:0
26	17AE2026	Propulsion Laboratory	0:0:2
27	17AE2027	Computational Structural Analysis Laboratory	0:0:2
28	17AE2028	Aircraft/Spacecraft Design Project	0:0:4
29	17AE2029	Instrumentation and Avionics Laboratory	0:0:2
30	17AE2030	Wind Tunnel Techniques	3:0:0

31	17AE2031	Finite Element Analysis in Aerospace Application	3:0:0
32	17AE2032	Heat Transfer	3:0:0
33	17AE2033	Experimental Stress Analysis	3:0:0
34	17AE2034	Composite Materials	3:0:0
35	17AE2035	Navigation, Guidance and Control of Aerospace Vehicles	3:0:0
36	17AE2036	Cryogenic Propulsion	3:0:0
37	17AE2037	Industrial Aerodynamics	3:0:0
38	17AE2038	Introduction to Unmanned Aircraft Systems	3:0:0
39	17AE2039	Aero-elasticity	3:0:0
40	17AE2040	Analytics for Aerospace Engineers	3:0:0
41	17AE2041	Advanced space dynamics	3:0:0
42	17AE2042	Air Traffic Control and Aerodrome details	3:0:0
42	17AE2043	Introduction to Non Destructive Testing	3:0:0
44	17AE2044	Introduction to Hypersonic Flows	3:0:0
44	17AE2045	Aircraft Systems	3:0:0
45	17AE2046	Theory of Vibration	3:0:0
46	17AE2047	Basics of Aerospace Engineering	3:0:0
47	17AE3001	Vibration and Aero-Elasticity	3:0:0
48	17AE3002	Advanced Aerodynamics	3:0:0
49	17AE3003	Advanced Aerodynamics Laboratory	0:0:2
50	17AE3004	Aerospace Propulsion	3:0:0
51	17AE3005	Aero Propulsion Laboratory	0:0:2
52	17AE3006	Advanced Computational Fluid Dynamics	3:0:0
53	17AE3007	Computational Heat Transfer	3:0:0
54	17AE3008	Advanced Computational Fluid Dynamics Laboratory	0:0:1
55	17AE3009	Flight Performance and Dynamics	3:0:0
56	17AE3010	Aerospace Structural Analysis	3:0:0
57	17AE3011	Aerospace Structure and Composite Laboratory	0:0:2
58	17AE3012	Advanced Avionics	3:0:0
59	17AE3013	Aircraft Modelling Laboratory	0:0:1
60	17AE3014	Advanced Avionics Laboratory	0:0:1
61	17AE3015	Orbital Space Dynamics	3:0:0
62	17AE3016	Boundary Layer Theory	3:0:0
63	17AE3017	Theory of Elasticity	3:0:0
64	17AE3018	Aircraft Design	3:0:0
65	17AE3019	Rockets and Missiles	3:0:0
66	17AE3020	Unmanned Aerial Systems	3:0:0
67	17AE3021	Finite Element Analysis for Aerospace Structural Application	3:0:0
68	17AE3022	Elements of Aerospace Engineering	3:0:0

17AE2001 INTRODUCTION TO AEROSPACE ENGINEERING

Credits: 3:0:0

Course Objective:

- To introduce the basic concepts of aircrafts, rockets and their functions.

- To provide knowledge about the basic parts and their function and construction details of aerospace vehicles.
- To provide information about the national and international aerospace agencies.

Course Outcome:

Students will be able to

- Understand the nature of aerospace technologies.
- Assess the forces and moments due to flow over the aircraft components.
- Identify the various types of structural components and their functions.
- Evaluate the performance of propulsion system.
- Apply the knowledge of gravitational law, Kepler's law and Newton's law to the space vehicle.
- Knowledge in various types of aerospace vehicles and their applications.

Historical Evolution: History of aviation, Different types of flight vehicles and Classifications, Components of an airplane and their functions, Standard atmosphere-Isothermal layer and gradient layer.

Principles Of Flight: Basic aerodynamics, Airfoils, wings and their nomenclature; lift, drag and pitching moment coefficients, center of pressure and aerodynamic center, NACA airfoil nomenclature.

Introduction to Aircraft Structures: General types of construction, Types of structure, Typical wing and fuselage structure, Honeycomb and Sandwich structure, Aircraft materials, Aircraft instruments.

Propulsion Systems: Principles of Thrust generation, Reciprocating engine, propeller, turboprop engine, Basic ideas about jet propulsion, Types of jet engines - turbofan and turbojet engines.

Rockets and Orbital Dynamics: Principles of operation of rocket, Rocket engine-specific impulse, Rocket equation, Chemical rockets: Solid and liquid propellants, Introduction to orbital dynamics, Aerospace industries and institutions worldwide.

Text Books:

1. Anderson, J.D., "Introduction to Flight", Tata McGraw-Hill, sixth Edition, 2011
2. Sutton, G.P. "Rocket Propulsion Elements", John Wiley, 2009.

Reference Books:

1. Kermode, A.C., "Flight without Formulae", McGraw-Hill, 1997.
2. Kermode A C., "Mechanics of Flight", Pearson Education Low Price Edition, 2005.
3. E L Houghton and PW Carpenter, "Aerodynamics for Engineering students", Sixth edition, Edward Arnold publications, 2012
4. Megson, T.M.G., "Aircraft Structures for Engineering Students", 2007
5. Howard D. Curtis, "Orbital Mechanics for Engineering Students", Elsevier Butterworth-Heinemann, Third Edition, 2010

17AE2002- FUNDAMENTALS OF FLUID FLOW

Credit 3:1:0

Course Objective

- To introduce the basic concepts of fluid statics.

- To make the student understand the basic laws governing fluid motion and its application.
- To give an introduction on fluid machines and aerodynamics.

Course Outcome

Students will be able to

- Evaluate the properties of different fluids
- Understand the fundamentals of fluid flow equations
- Apply the aerodynamics concepts to fluid flow situations
- Analyse the fluid flow equations for real time aerodynamic applications
- Apply mathematical knowledge to predict the properties and characteristics in a given fluid flow situation
- Arrive at the proper non-dimensional parameters and thus devise simulation procedure

Introduction to Fluid Mechanics-Definition of a fluid – Continuum hypothesis – Fluid properties - Pressure, Temperature, Density, Viscosity - stress-strain rate relationship, Measurement of pressure –Fluid statics – Total and Centre of pressure of submerged surfaces-Stability of submerged and floating bodies.

Basic Equations-Motion of a fluid particle – Types of flow-Continuity equation-Velocity and acceleration –velocity potential and stream function- Path lines, Stream lines and Streak lines,-Fluid deformation – Rotation-Vorticity, Elementary flows- Uniform flow, Source flow, Sink flow, Doublet flow, Vortex flow, Super imposed flows- Semi-Infinite Body, Rankine Body.

Incompressible Inviscid Flow-Equations of motion-Euler's equation of motion- Energy equation-Momentum equation – Bernoulli's equation and its Applications — Flow measurement – Orifice meter – Venturi meter-Pitot tube.

Incompressible Viscous Flow-D' Alembert's Paradox, Viscous stress-strain rate relationship, Flow of viscous fluid through circular pipes – Velocity profiles – Frictional loss in pipe flow-Calculation of minor and major energy losses in pipes

Dimensional Analysis and Impact of Jets-Dimensional analysis – The Buckingham-Pi theorem – Non-dimensional numbers-Mach Number, Reynolds Number, Strouhal Number, Knudsen Number, etc., Impact of jets – Force exerted by a jet on stationary and moving vertical, horizontal and inclined plates.

Text Books

1. Rathakrishnan.E, 'Fundamentals of Fluid Mechanics', Prentice-Hall, 2007
2. White F.M., "Fluid Mechanics", 7th Edition, Tata McGraw-Hill Education, 2011

Reference Books

1. Robert W Fox & Alan T Mc.Donald, 'Introduction to fluid Mechanics', John Wiley and Sons,1995
2. Kuethe, A.M. and Chow, C.Y., Foundations of Aerodynamics, First Indian Reprint, John Wiley & Sons, 2010.
3. Yuan S W, 'Foundations of fluid Mechanics', Prentice-Hall, 1987
4. Graebel, W.P. 'Engineering Fluid Mechanics' Taylor and Francis, 2001

17AE2003FLUID MECHANICS LABORATORY

Credits: 0:0:1

Course Objective:

- To impart knowledge on the calibration of flow measurement devices
- To impart knowledge to predict losses due to friction and pipe fittings
- To provide hands on training for flow measurements

Course Outcome:

Students will be able to

- Recall the principle of instruments used in flow related measurements
- Describe the flow measurements methods
- Conduct flow measurements in pipes
- Evaluate performance of pumps and turbines
- Determine the head losses for internal flows
- Investigate influence of flow parameters

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 sudden expansion and contracting pipe
5. Determination of Minor Losses in bends and elbows of the pipe
6. Reynolds experiments

17AE2004 SOLID MECHANICS

Credits: 3:0:0

Course Objective:

- To provide an understanding the concepts of stress and strain, Shear force and Bending moment
- To provide knowledge regarding the methods of determining the deflections of beams and Torsion of shaft
- To impart basic knowledge about Joints and springs

Course Outcome:

Students will be able to

- Understand the basic material behaviour like elasticity, plasticity etc.
- Draw the shear force and bending moment diagram for different loading of beams
- Predict the deflection of beams under bending loads
- Arrive at the methods to solve torsional problems
- Analyse behaviour of a spring under different loading conditions
- Identify the structural joints for repair

Stresses and strains: Introduction, types of structures, loads and stresses , Hooke's law, stress-strain curve, Analysis of bars of varying sections, Analysis of bars of composite sections, thermal stresses, thermal stresses in composite bars, elastic constants ; Principal planes and stresses, Analytical and graphical methods for determining stresses on oblique section.
Shear force and bending moment diagram: Types of beams, important points for drawing shear force and bending moment diagram, Shear force and bending moment for different beams carrying point load, uniformly distributed load, gradually varying loads and combinations of these at different sections of the beam.
Deflection of beams: Simple bending, Theory of simple bending, Expression for bending stress, bending stress in symmetrical section, Relation between deflection, slope and radius of curvature, Methods for determining deflection- Double integration method, Macaulay's method and Moment Area method.
Torsion of shafts: Shear stress produced in a shaft subjected to torsion, torque and power transmitted by a solid and circular shaft, Strength of a shaft and Polar moment of inertia, Torque in terms of polar moment of inertia, strength of a shaft of varying sections and composite shaft, combined bending and torsion, strain energy stored in a body due to torsion.
Springs: Stiffness of a spring, Types of spring, Closely-coiled Helical Springs- Axial load-Axial twist, Open coiled helical spring, Torsion spring – Problems. Joints **-** Types of Structural joints, bonded joints, Bolted joints- Riveted Joints, Structural repair of Joints.

Text Books:

1. Bansal R K., "Strength of Materials", Laxmi Publishing Co, New Delhi, 2007
2. Ramamurtham.S., "Strength of Materials", Dhanpat Rai Publishing Co, New Delhi, 2008

References:

1. R S Khurmi," Strength of Materials", S Chand & Co Ltd, New Delhi, 2005
2. Rajput R K, "Strength of Materials", S Chand & Co Ltd, New Delhi, 2006
3. Sun C T, " Mechanics of Aircraft Structures", Wiley, India, 2010
4. Dr. Sadhu Singh," A Textbook on Strength of Materials", **Khanna Publishers Pvt. Ltd,** New Delhi , 2013

17AE2005SOLID MECHANICS LABORATORY

Credits: 0:0:1
Co-requisite:17AE2004Solid Mechanics

Course Objective

- To apply the theory of structural mechanics on real specimens
- To give hands on training on testing of real specimens
- To provide knowledge on failure of materials

Course Outcome

Students will be able to

- Determine the important mechanical properties of materials
- Identify the behaviour of materials
- Verify the Maxwell's theorem
- Understand the structural behaviour under various loads, shapes and supports
- Estimate stiffness of springs

- Choose material based on requirement

Experiments

1. Tensile Test of solid rod using Universal Testing Machine
2. Verification of Maxwell Theorem on Cantilever Beam
3. Verification of Maxwell Theorem on Simply Supported Beam
4. Torsion Test of shaft and Beam
5. Rockwell's Hardness Test
6. Brinell's Hardness Test
7. Vickers Hardness Test
8. Charpy's Impact test
9. Izod Impact Test
10. Compression of open coil helical spring

    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 the semester.

17AE2006 AIRCRAFT INSTRUMENTATION

Credits: 3:0:0

Course Objectives:

- To provide the knowledge regarding basic concepts of flight instruments, their significance and operation.
- To impart the concepts of measurements using air data sensor, Gyroscope and engine data.
- To impart the basic concepts regarding Avionics systems and also the necessary knowledge on working of avionics system in aircraft.

Course Outcome:

Students will be able to

- Understand the basics of measurements and different parameters
- Appreciate the need for general measurements in aviation industry
- Identify the fundamental cockpit instruments and their working principles
- Select proper instrumentation requirements for aerospace vehicles
- Differentiate various sensors and transducers used in aerospace vehicles
- Apprehend the principles behind temperature, pressure, fuel flow and engine measurements

General concepts of Mechanical Instrumentation: Generalized measurement system, Classification of instruments as indicators, recorders and integrators - their working principles, Precision and accuracy: measurement error and calibration, Functional elements of an instrument system and mechanisms

Aircraft Instrumentation: Aircraft Instrumentation – Requirements and standards, Basics of aircraft instruments -Types and Cockpit Layout - Civil and Military aircraft cockpits – Cockpit instruments display – Fundamentals of helicopter instrumentation and spacecraft instrumentation, Position and displacement transducers and accelerometers.

Classification of aircraft instruments: Classification of aircraft instruments - Air data instruments – pitot static systems and instruments, gyroscopic instruments - Gyroscope and its properties, vacuum driven systems, heading instruments.
Temperature, Pressure Measurements: Temperature measurement using physical parameter, Thermocouples, Air temperature sensors – RAT sensor – TAT Probe, Ratiometer, radiation pyrometer system, Pressure measurement- elastic type pressure gauges-Bourdon tube bellows-diaphragms- Bell Gauge, Direct reading pressure gauges, pressure switches.
Engine Instruments & Fuel flow measurements: Engine Instruments - measurement of RPM, manifold pressure, torque, exhaust gas temperature, EPR, engine vibration, monitoring, Fuel Quantity measurement – float type, capacitance type, and basic gauge system, Fuel flow measurement – rotating vane type indicator, fuel flow transmitter.

Text Book

1. A.K. Sawhney, "A course in Electrical and Electronic Measurement and Instrumentation", Dhanpat Raj and Sons, New Delhi, 1999.
2. Pallet, E.H.J., "Aircraft Instruments & Integrated systems", Longman Scientific and Technical, McGraw-Hill, 1992.

References:

1. Murthy, D.V.S., "Transducers and Measurements", McGraw-Hill, 1995.
2. Doeblin.E.O., "Measurement Systems Application and Design", McGraw-Hill, New York, 1999.
3. Harry L.Stilz, "Aerospace Telemetry", Vol. I to IV, Prentice-Hall Space Technology Series.
4. Spitzer, C.R., "Avionics- Elements, Software and Functions", CRC Press, Taylor & Francis group LLC, 2007
5. Cary R .Spitzer, "The Avionics Handbook", CRC Press, 2000.
6. Collinson R.P.G., "Introduction to Avionics Systems", Springer Science + Business Media B.V, 2011.

17AE2007 CAD/CAM LABORATORY

Credits: 0:0:2

Course Objective:

- To impart the knowledge on the usage of computer in design and manufacturing
- To impart the knowledge to visualization of objects in three dimensions and producing orthographic, sectional and auxiliary views of it.
- To impart the knowledge of drafting.

Course Outcome:

Students will be able to

- Understand the CAD packages.
- Develop 2D and 3D aircraft parts using software.
- Create parts and assemble these for functional assembly
- Draft for manufacturing
- Write CNC Program for different machining process
- Get the hands-on experience of CNC manufacturing

List of Experiments:

1. 2D Sketch
2. Solid Modelling.
3. Surface modelling
4. Sheet Metal Design
5. Assembly of the Aircraft parts.
6. Drafting of Different parts.
7. Photogrammetry
8. CNC -Profile cut using Linear and circular interpolation code
9. CNC –Circular pocketing and slotting
10. CNC –step turning, taper turning,
11. CNC- Thread cutting and Drilling
12. Additive manufacturing

17AE2008AERO THERMAL ENGINEERING

Credit 3:0:0
Pre-Requisites:17ME2004 Engineering Thermodynamics

Course Objective:

- To integrate the concepts, laws and methodologies from the first course in thermodynamics into analysis of cyclic processes
- To apply the thermodynamic concepts into various thermal application like IC engines, Compressors, Turbines and Nozzle.
- To impart the knowledge on Aircraft Refrigeration and Air conditioning systems

Course Outcome:
Students will be able to

- Understand the concepts of thermodynamic cycles
- Understand the working principles of internal combustion engines
- Know the function of nozzles and turbines
- Know the working principle of air compressors
- Understand the concepts of refrigeration systems
- Apply the different gas power cycles in IC and R&AC applications.

(Use of standard refrigerant property data book, Gas Tables and Psychometric chart permitted)

Thermodynamic air cycles -Otto, Diesel, Dual combustion, Brayton cycles, Calculation of mean effective pressure, and air standard efficiency - Comparison of cycles.
Internal combustion engines-Classification - Components and their function. Valve timing diagram and port timing diagram - actual and theoretical p-V diagram of four stroke and two stroke engines. Simple and complete Carburettor- MPFI, Engine Fuel system: Fuel Metering Devices, and Ignition system and Types. Engine starting systems. Principles of Combustion and knocking in SI and CI Engines. Lubrication and Cooling systems. Performance calculation.
Air compressor-Classification and working principle of various types of compressors, work of compression with and without clearance, Volumetric efficiency, Isothermal efficiency and

Isentropic efficiency of reciprocating compressors, Multistage air compressor and inter cooling – work of multistage air compressor

Refrigeration - Refrigerants – selection of refrigerants- environmental aspects- Vapour compression refrigeration cycle- super heat, sub cooling – Performance calculations - working principle of vapour absorption system, Ammonia –Water, Lithium bromide –water systems.

Air conditioning: Air conditioning system - Processes, Types and Working Principles. Concept of RSHF, GSHF, ESHF- Cooling Load calculations. Influence of Altitude for air conditioning system.

Text Books:

1. Rajput. R. K., "Thermal Engineering" S. Chand Publishers, 2000
2. Kothandaraman.C.P., Domkundwar.S., Domkundwar. A.V., "A course in thermal Engineering", Fifth Edition, Dhanpat Rai & sons , 2002

References:

1. Sarkar, B.K,"Thermal Engineering" Tata McGraw-Hill Publishers, 2007
2. Arora.C.P, "Refrigeration and Air Conditioning ," Tata McGraw-Hill Publishers 1994
3. Ganesan V.." Internal Combustion Engines", Third Edition, Tata Mcgraw-Hill 2007
4. Rudramoorthy, R, "Thermal Engineering ", Tata McGraw-Hill, New Delhi,2003
5. Ramalingam. K.K., "Thermal Engineering", SCITECH Publications (India) Pvt. Ltd., 2009
6. Airframe and Powerplant Mechanics (EA-AC 65-12A) Powerplant handbook, Shroff Publishers and Distributors PVT.LTD, 9th Edition, 2009

17AE2009 THERMAL ENGINEERING LABORATORY

Co- requisite: 17AE2008 Aero Thermal Engineering
Credits: 0:0:1

Course Objectives:

- To impart knowledge on the performance characteristics of various thermal systems and internal combustion engines
- To impart knowledge on the design calculations of different thermal equipment
- To provide hands on training for performance measurements of different thermal system

Course Outcomes:

Students will be able to

- Evaluate the performance of refrigeration, heat pump and air–conditioning cycles
- Conduct a variety of experiments in internal combustion engines
- Analyze the efficiency and performance of two stage reciprocating air compressor
- Calculate & compare the performance parameters of air blower
- Determine the performance of 4 stroke petrol engine
- Determine the performance of four stroke single cylinder Diesel engine

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 on variable compression ratio, 4 stroke petrol engine
7. Performance test on four stroke single cylinder Diesel engine

14AE2010 AERODYNAMICS

Credits: 3:0:0
Pre-requisites: 17AE2002–Fundamentals of fluid flow

Course Objectives:

- To impart knowledge of basics of air flow
- To provide details regarding the flow over airfoils and wings
- To impart knowledge of forces and moments over an aerofoil

Course Outcome:
Students will be able to

- Understand the aerodynamic variable connected with airflow
- Apply the conservation laws for given aerodynamic situation
- Analyse the basic flows satisfying the governing equations
- Assess the flow field over the aerofoils
- Estimate the flow over aircraft wings and Fuselage
- Evaluate the forces and moments over vehicles utilizing different kinds of flows

Basics: Fundamental Aerodynamic variables, Aerodynamic forces and moments, Centre of pressure, Types of flow, Gradient of Scalar and vector fields, Line, surface and volume integrals and the relationships between them. Continuity equation. Momentum equation and drag of a two dimensional body. Energy equation.
Fluid Flow: Laplace Equation and relationship with continuity equation, Overview of Elementary flows, non-lifting and lifting flow over cylinders. Kutta – Joukowski theorem and generation of lift.
Incompressible flow over airfoil: Joukowski transformation and conformal mapping. -Airfoil characteristics. Airfoil Nomenclature. The vortex sheet. The Kutta condition. Kelvin's circulation theorem. Introduction to classical thin airfoil theory – symmetric and cambered airfoil.2-D Panel Methods.
Incompressible flow over finite wings: Down wash and induced drag. Vortex filament, Helmholtz theorems. Biot-Savart law, Introduction to Prandtl's lifting line theory and Elliptic lift distribution, Vortex Lattice Methods.
Boundary Layers: Introduction to Boundary Layers and Reynolds number effects. Development of Boundary Layer equations. Boundary layer thickness- Displacement thickness – Momentum Thickness – Energy Thickness. Momentum integral theorem and applications.

Text Books:

1. John D. Anderson, Jr., "Fundamentals of Aerodynamics", Fifth edition, McGraw-Hill publications, 2010

2. E.Rathakrishnan, “Theoretical Aerodynamics” , John Wiley & Sons, 2013

References:

1. E L Houghton and PW Carpenter, "Aerodynamics for Engineering students", Sixth edition, Edward Arnold publications, 2012
2. L.M Milne Thomson, “Theoretical Aerodynamics”, 1996
3. Jan Roskam, Chuan-Tau Edward Lan, Airplane Aerodynamics and Performance, DAR Corporation, 1997
4. John J Bertin, "Aerodynamics for Engineers", Sixth edition, Edward Arnold publications, 2012

17AE2011 AERODYNAMICS LABORATORY

Credit 0:0:2
Co-requisites: 17AE2010– Aerodynamics

Course Objective:

- To impart knowledge of basics of air flow
- To provide details regarding the flow over airfoils and wings
- To impart knowledge of forces and moments over an aerofoil

Course Outcome:

Students will be able to

- Understand the aerodynamic variable connected with airflow
- Predict pressure distribution over the various airfoils.
- Estimate lift and drag of various stream line and bluff bodies
- Visualize subsonic flow over various model
- Estimate effect of Reynolds number of low speed airfoil
- Evaluate the forces and moments over aircraft model

List of Experiments:

1. Calibration of subsonic wind tunnel.
2. The pressure distribution over a symmetric and cambered aerofoil.
3. Measurement of the Lift and drag of symmetric and cambered aerofoil.
4. The pressure distribution over a cascade aerofoil.
5. Force and moment measurements of rectangular wing by using strain gauge balance.
6. Force and moment measurements of car model by using strain gauge balance.
7. Boundary layer measurements in the test section of subsonic wind tunnel.
8. Assessment of performance of a small scale wind turbine by using Wind turbine tunnel.
9. Simulation of earth boundary layer in subsonic wind tunnel.
10. Smoke and tuft flow visualization Flow visualization over a car.
11. Flow visualization over cylinder and aircraft using Water tunnel facility.
12. Smoke and Tuft flow visualization of symmetric and cambered aerofoil.
13. Oil flow visualisation in subsonic tunnel

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 the semester.

17AE2012 AIRCRAFT STRUCTURES - I

Credits: 3:0:0
Pre-requisites: 17AE2004 Solid Mechanics

Course Objective:

- To impart the knowledge of aircraft material and its behaviour.
- To impart the knowledge on the methods of structural analysis under different types of loads.
- To provide the knowledge on basic theory of vibrations, elasticity,fatigue and failures.

Course Outcome:

Students will be able to

- Identify the suitable aircraft material and its behaviour
- Apply the methods of statically determinate and indeterminate structural analysis under different conditions
- Perceive the concept of Column buckling
- Solve the vibration problem with different DOF
- Apply the knowledge in basic theory of elasticity
- Analyse the airframe structures

Introduction to Aircraft Structures Analysis: Stress strain curve- young's modulus- Poisson's ratio, basics of elasticity: Plane stress, Plane strain, Stress-Strain Relationships, Two dimensional problems, St. Venant's Principle. Aerospace Materials, Properties and structural application of Non-ferrous; Ferrous Composites – Classification, properties and usage

Truss and Beams: Truss – Method of Joint and Space Truss Analysis, Deflection of Joints: Energy methods, Virtual Load method. Beam - Maxwell's Reciprocal theorem, Clapeyron's three moment equation, Moment Distribution Method. Castigliano's principles, Symmetrical and Unsymmetrical Bending: Stresses and deflections in beams of symmetrical and unsymmetrical sections.

Buckling of Column: Buckling of columns, Inelastic buckling, Effect of initial imperfections, Stability of beams under transverse and axial loads, Energy method for the calculation of buckling loads in columns, Flexural- torsional buckling of thin-walled columns.

Theories of failure: Introduction, Maximum principal stress theory, Maximum principal strain theory, Maximum shear stress theory, Maximum strain energy theory, Maximum shear strain energy theory; Introduction to Fatigue-Different types of Fracture Modes -SN Curve - Stress Concentration -Fatigue and Fracture of engineering Alloys.

Basic Theory of Vibration: Free and forced vibrations of undamped and damped Single DOF systems, free vibrations of undamped 2-DOF systems- Mode shape, Oscillation of beams, Approximation methods for determining natural frequencies Problems.

Text Book:

1. Megson, T.M.G., "Aircraft Structures for Engineering Students", fourth edition, Elsevier Ltd, 2010.
2. Peery, D.J., "Aircraft Structures", McGraw–Hill, N.Y., 2011.

References:

1. Donaldson B K, “Analysis of Aircraft Structures” Cambridge Aerospace Series, 2008.
2. E.F. Bruhn, “Analysis and Design of Flight Vehicle Structures”, Tristate Offset Co., 1980.
3. Rajput R K, "Strength of Materials”,S.Chand (P)LTP, 2006.
4. G Lakshmi Narasaiah “Aircraft Structures”, BS Publications.,2010
5. Sun C T, “ Mechanics of Aircraft Structures”, Wiley India,2010
6. F.S.Tse, I.E. Morse and H.T. Hinkle, “Mechanical Vibration”, Prentice Hall of India Pvt., Ltd.,New Delhi, 1988.
7. R.K. Vierck, “Vibration Analysis”, 2nd Edition, Thomas Y. Crowell & Co., Harper & Row Publishers, New York, U.S.A., 1989.

17AE2013 AIRCRAFT PERFORMANCE

Credits: 3:1:0
Pre-requisites:17AE2001 - Introduction to Aerospace Engineering

Course Objective:

- To impart knowledge about the concepts of Flight performance
- To introduce the various parameters affecting the performance
- To introduce the various theories of propeller analysis and design

Course Outcome:
Students will be able to

- Understand the preliminary design ofaircraft based on the performance.
- Differentiate performance characteristics of jet engine from propeller engine
- Estimate the performance characteristics in level Flight
- Assess the performance during turning manoeuvres of aircraft
- Realize the ground effects on performance
- Estimate the pitch angle from performance characteristics of propeller and its applications

Basics of Aerodynamics and Wing Geometry: Introduction - Aircraft Shape and Orientation Effects of the Reynolds Number– Airfoil-lift - Drag Components - Drag polar, Drag Reduction Methods.
Effects of Engine Characteristics in performance: Introduction – Performance – Variation of Power and Specific fuel consumption with Velocity and Altitude –Reciprocating Engines – Gas Turbine Engines.
Performance Characteristics of Level Flights: Steady Level Flight –Fundamental Parameters - Equation of motion, Maximum speed- Power available, Power Required - Minimum Drag Condition; Range and Endurance –Breguet formula - Effect of wind-Rate of Climb-Absolute ceiling and service ceiling - Introduction Maximum Climb Angle, Maximum Rate of Climb, Angle of climb and their variations with altitude; Hodograph, Factors Influencing the Rate of Climb - Gliding Flight Maneuvring in the Vertical Plane
Turning Characteristics: Introduction- Level Turn- Minimum Turn Radius- Maximum Turn Rate- Instantaneous turn-Pull up and Pull down manoeuvres, Cobra Maneuver.
Takeoff and Landing characteristics: Introduction to Take-off, Estimation of take-off distance-ground roll, obstacle clearing distance and height, Take off assist devices –Spoilers and landing distance–approach distance and flare distance.

Text Books:

1. J D Anderson, “Aircraft performance and Design”, McGraw-Hill, New York, 2000.
2. Roskam, Jan and Lan, Chuan-tau E, “Airplane Aerodynamics and Performance”, DAR Corporation, Lawrence, Kansas, USA, 1997.

Reference:

1. Perkins, C D and Hage, R E; “Airplane Performance Stability and Control”, Willey Toppan, 2010.
2. Houghton, E L and Carruthers, N B; “Aerodynamics for Engineering Students”, Edward Arnold Publishers, 1988.
3. Filippone, A, “Advanced Aircraft Flight Performance, Cambridge University Press, 2012.
4. David G. Hull, “Fundamentals of Airplane Flight Mechanics” Springer-Verlag Berlin Heidelberg 2007.
5. S.K. Ojha, “ Flight Performance of Aircraft”, AiAA,1995

17AE2014 ELEMENT OF AVIONICS

Credits: 3:0:0

Pre-requisites:17AE2006 Aircraft Instrumentation

Course Objectives:

- To impart knowledge about basic concepts of micro-processors and controllers, their significance and functioning.
- To provide understanding of the basic concepts and functioning of the avionic system data buses.
- To inculcate the knowledge about integrated avionics systems and the need for them.

Course Outcome:

Students will be able to

- Understand the fundamentals of processors, controllers and their applications
- Analyse the functioning of military/civil aircraft data buses and communication process between them.
- Identify display technologies and their working principles.
- Evaluate the modular avionics systems, electromagnetic interference & compatibility testing.
- Assess the working of fault tolerant systems and its applications
- Know the importance of integrated avionics systems and their build.

Introduction to Avionics: Introduction to microprocessors and controllers, Role for Avionics in Civil and Military Aircraft systems, Avionics sub-systems and design, defining avionics System/subsystem requirements-importance of ‘ilities’, Avionics system architectures.

Data Buses and Architecture: MIL-STD-1553B, ARINC-429, ARINC-629, CSDB, AFDX and its Elements, Avionics system design, Development and integration-Use of simulation tools, stand alone and integrated Verification and Validation.

Cockpit Display Systems: Trends in display technology, Alphanumeric displays, character displays etc., Civil and Military aircraft cockpits, MFDs, MFK, HUD, HDD, HMD, DVI,

HOTAS, Synthetic and enhanced vision, situation awareness, Panoramic/big picture display, virtual cockpit. Power requirements.
Modular Avionics: Packaging - Trade-off studies - ARINC and DOD types - system cooling - EMI/EMC requirements & standards.
Fault tolerant systems: Fault tolerant systems - Hardware and Software, Evaluating system design and Future architecture - Hardware assessment. Criticality, damaging modes and effects analysis - Software development process models - Software Assessment and Validation. Automatic Test Equipment - Speeds maintenance.

Textbook:

1. Spitzer, C.R., "Digital Avionics Systems", Prentice Hall, Englewood Cliffs, N.J., U.S.A., 1987.
2. Collinson R.P.G., "Introduction to Avionics", Chapman and Hall, 1996.

References:

1. Cary R .Spitzer, "The Avionics Handbook", CRC Press, 2000
2. Middleton, D.H. "Avionics Systems", Longman Scientific and Technical, Longman Group UK Ltd., England, 1989.
3. Jim Curren, "Trend in Advanced Avionics", IOWA State University, 1992
4. Harry L.Stilz, "Aerospace Telemetry", Vol. I to IV, Prentice-Hall Space Technology Series.
5. Spitzer, C.R., "Avionics- Elements, Software and Functions", CRC Press, Taylor & Francis group LLC, 2007

17AE2015 FOUNDATIONS OF SPACE ENGINEERING

Credits: 3:0:0

Course Objective:

- To impart the knowledge on coordinate systems used in astronautics
- To impart the knowledge on spacecraft trajectories
- To impart the knowledge on space environment

Course outcome:
Students will be able to

- Understand the most common coordinate systems used in astronautics: geocentric vs. helio-centric, inertial vs. body- fixed, and when each one is appropriate.
- Able to transform between these systems using rotational and translational matrices.
- Understand Keplerian orbits and Design spacecraft trajectories such as Hofmann transfers and plane changes.
- Understand the basics of rigid body rotations.
- Perceive design of trajectories in the atmosphere, and orbital maneuvers.
- Ability to comprehend the composition of the space environment

Co-ordinate systems and transformations: Types of coordinate systems, Spherical trigonometry laws and applications, Rotations and rotation matrices, Spherical polar coordinates, Proofs and applications of spherical trigonometry laws, Translations and homogeneous coordinates, Three-angle sets for specifying orientation: Roll-pitch-yaw, Euler angles, Euler parameters.

Intro to spacecraft orbits: Universal time, Julian date, Solar and sidereal days, Newtonian gravitation, circular orbits, escape velocity, Two-body motion: angular momentum; energy and velocity on orbit, Conic sections, Time since periapsis for elliptical orbits, Classical orbital elements, Derivation of Kepler's laws, Flight path angle.

Orbital Maneuver: Ground track, Oberth maneuver, Determination of orbital elements from position and velocity vectors, Hohmann transfer, Plane changes. Fast transfers, Rocket equation, Programmed turn, gravity turn, Hohmann transfer to parking orbit, Thrust vector control, Staging. Launch sites, Selection criteria for optimal launch trajectory.

Intro to attitude dynamics and control: Gravity-gradient stabilization, Thrusters and reaction wheels, Moment of inertia, Parallel axis theorem, Principal axes, Transformation of time derivatives between frames, Euler's equations of rigid body dynamics.

Intro to space environment: Sun and solar wind, Earth's atmosphere, Ionosphere and communications, geomagnetic field, Space debris, micro-meteroids.

Text Book:

1. J.R.Wertz, D.F.Everett, and J J. Puschell, “Space Mission Engineering: The New SMAD”, Microcosm Press,2011.
2. Francis J. Hale, “Introduction to Space Flight”, Pearson, 1994

References:

1. William E.Wiesel, “Spaceflight Dynamics”, Aphelion Press, USA, Third Edition, 2010
2. David.A. Vallado,”Fundamentals of Astrodynamics and Applications”, Microcosm and Kluwer , Second Edition,2004
3. Jerry Jon Sellers, Understanding Space: An Introduction to Astronautics, 3rd ed. McGraw-Hill, 2005.
4. James R. Wertz, Wiley Larson, Space Mission Analysis and Design, 3rd ed. Space Technology Library, 1999.
5. John E. Prussing, Bruce A. Conway, Orbital Mechanics, 2nd ed. Oxford University Press, 2012.
6. Alan C. Tribble, The Space Environment: Implications for Spacecraft Design, Princeton University Press, 2003.

17AE2016 GAS DYNAMICS

Credits: 3:1:0

Pre-requisites: 14AE2010 - Aerodynamics

Course Objective:

- To provide information regarding the behavior of compressible fluid flow
- To impart knowledge regarding the difference between subsonic and supersonic flow
- To Estimate flow over flying vehicles at subsonic and supersonic speeds

Course Outcome:

Students will be able to

- Understand the influence of compressibility to distinguish between the flow regime

- Apply compressibility corrections for flow in C-D passages and instrument like Pitot static tube
- Estimate the sudden changes in the flow field
- Analyse the compressible flow field over an airfoil and finite wings
- Estimate the influence of friction and heat transfer in the flow field
- Choose proper flow visualisation techniques for the given situation

One dimensional compressible flow: Compressibility, Velocity of sound, Concept of Mach Number, Isentropic relations, Normal shock and its relations, Prandtl equation and Rankine – Hugoniot relation, Flow through converging-diverging passages, Performance under various back pressures, corrections ofPitot static tube for subsonic and supersonic Mach numbers.
Oblique shocks and expansion waves: Oblique shocks and corresponding equations,Hodograph and flow turning angle, shock polar, Flow past wedges, Strong, weak and detached shocks, Expansion waves & its corresponding equations, Flow past concave & convex corners, Interaction of shocks with wall, shock wave and expansion waves, Rayleigh and Fanno Flow.
Differential equations of motion for steady compressible flows:
Potential equations, Small perturbation potential theory, solutions forsupersonic flows - flow over a wavy wall and flow over airfoil, Prandtl-Glauert correction for subsonicflows.
High speed flow over airfoil: Linearised two dimensional supersonic flow theory, Lift, drag, pitching moment and center of pressure of supersonic profiles, Lower and upper critical Mach numbers, Lift and drag divergence, shock induced separation.
High speed flow over finite wing: Finite wing, tip effects, Characteristics of sweptwings, Effects of thickness, camber and aspect ratio of wings, transonic area rule, flow visualisation Techniques.

Text Books

1. Rathakrishnan, E., “Gas Dynamics”, Third Edition, Prentice Hall of India, 2010
2. Shapiro, A.H., “Dynamics and Thermodynamics of Compressible Fluid Flow”, Ronald Press,1982

References:

1. Anderson Jr., D., – “Modern compressible flows”, McGraw-Hill Book Co., New York 1999
2. Robert D Zucker, Oscar Biblarz, Fundamental of Gas Dynamics, Second Edition, John Willey &Sons, 2002
3. Liepmann H W and Roshko A, “Elements of Gasdynamics”, John Willey & Sons, 2001.
4. Zucrow, M.J. and Joe D Hoffman , “Gas Dynamics”, John Willey & Sons, 1976.

17AE2017 GAS DYNAMICS LABORATORY

Credit 0:0:2
Co-requisites: 17AE2016 – Gas Dynamics

Course Objective:

- To impart knowledge of basics of high speed flow over the model
- To provide details regarding the supersonic flow over various model
- To impart knowledge of shock wave over various model

Course Outcome:
Students will be able to

- Calibrate of supersonic wind tunnel
- Predict pressure distribution over the various airfoils.
- Visualize supersonic flow over various model
- Visualize shock wave and Estimate shock angle over various model
- Estimate effect of Reynolds number of low speed airfoil
- Assess the effect of back pressure in C-D nozzle

List of Experiments:

1. Calibration and runtime calculation of supersonic wind tunnel.
2. Flow visualisation using Schlieren technique.
3. Flow visualisation using shadowgraph technique.
4. Oil Flow visualisation
5. Flow visualisation of - Correctly expanded, under expanded and over expanded circular jets.
6. Flow visualisation of - Correctly expanded, under expanded and over expanded elliptic jets.
7. Flow visualisation of - Correctly expanded, under expanded and over expanded rectangular jets.
8. Pressure distribution in a C-D Nozzle using OJF facility.
9. Axis switching characteristics(pressure measurements) of elliptic nozzle
10. Axis switching characteristics(pressure measurements) of rectangular nozzle
11. Jet pluming study using high altitude jet facility.
12. Multiple jet interaction studies
13. Background noise study in supersonic tunnel.

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 the semester

17AE2018 AIRCRAFT STRUCTURE-II

Credits: 3:0:0
Pre-requisites: 17AE2012 Aircraft Structures -I

Course Objective:

- To impart the knowledge on the structural behaviour of aircraft components under different types of loads
- To provide the understanding in structural design methods for aerospace vehicles
- To impart the knowledge on the force distribution of different structures in Aircraft

Course Outcome:
Students will be able to

- Predict the shear flow and shear centre in open sections with effective and ineffective wall

- Predict the shear flow and shear centre in closed sections with effective and ineffective wall
- Analyse the buckling characteristics of plates
- Choose proper methods to analyse aerospace structural members
- Assess the load and stress distribution of wing and fuselage section
- Design the fail-safe and safe-life Aircraft structures

Structural Idealization: Principle, Idealization of a panel, Effect of idealization on the analysis of open and closed section beams, Deflection of open and closed section beams.
Shear flow in open sections: Thin walled beams, Concept of shear flow, Shear center, Elastic axis, with one axis of symmetry with effective and ineffective wall in bending, Unsymmetrical beam section.
Shear flow in closed section: Bredt-Batho formula, Single and multi-cell structures, approximate methods, Shear flow in single and multi cell structures under torsion, Shear flow in single and multi cell structures under bending with effective and ineffective wall, Box Beams.
Buckling of plate: Buckling of thin plates, Inelastic buckling of plates, Local instability, Instability of stiffened panels, Failure stress in plates and stiffened panels, Crippling stresses by Needham's and Gerard's methods.
Wing and Fuselage Analysis: Shear force, bending moment and torque distribution along the span of the Wing-Tension field beam and Semi tension field beam (Wagner Bam). Fuselage Analysis - Shear and bending moment distribution along the length of the fuselage.

Text Book:

1. Donaldson B K., "Analysis of Aircraft Structures", Cambridge Aerospace Series, 2008
2. Megson, T.M.G., "Aircraft Structures for Engineering Students", Elsevier Ltd.,2010

References:

1. G Lakshmi Narasaiah, "Aircraft Structures", BS Publications, 2010
2. Sun C T, " Mechanics of Aircraft Structures", Wiley India, 2010
3. Peery, D.J., "Aircraft Structures", McGraw–Hill, N.Y., 2011.
4. Stephen P. Timoshenko & S.Woinovsky Krieger, "Theory of Plates and Shells", 2nd Edition, McGraw-Hill, Singapore, 1990.
5. Rivello, R.M., "Theory and Analysis of Flight structures", McGraw-Hill, N.Y., 1993.

17AE2019 AIRCRAFT STRUCTURES AND COMPOSITE LABORATORY

Credits: 0:0:2
Co-requisites:17AE2018 Aircraft Structure-II

Course Objective:

- To provide the basic knowledge of the testing equipment for various structural components.
- To impart the practical exposure with the measuring equipment and sensors.
- To impart the practical exposure with composite material manufacturing

Course Outcome:

Students will be able to

- Select test equipment for different types of static loading
- Conduct tests, analyse results, document and compare with analytical/theoretical results
- Analyse the different types of structural failures
- Manufacture the different Composite laminates
- Choose strain gauge for different application
- Understand the stress distribution based on cross-section shape and loading conditions

List of Experiments:

1. Deflection of simply supported and cantilever beams - Verification of Castigliano's Theorem
2. Determine the stiffness factors of an elastically supported beam
3. Determine the tensile strength of flat plates, riveted joints and bolted joints using UTM.
4. Compression test on columns, critical buckling loads – Southwell plot
5. Unsymmetrical bending of beams
6. Determination of the effective bending stiffness of a composite beam with the combination of aluminium and steel
7. Determination of the natural frequency of vibrations of a cantilever beam
8. Shear centre location for open sections
9. Torsion of a thin walled tube having closed cross section at the ends
10. Structural behaviour of a semi tension field beam (Wagner Beam)
11. Using photo elastic techniques: Calibration of circular disc in compression to find the fringe value and Determination of stress concentration factor due to compression in circular ring
12. Composite material Manufacturing and Testing- Tensile and Three point bending

17AE2020 AIRCRAFT STABILITY AND CONTROL

Credit: 3:0:0

Pre-requisites: 17AE2013Aircraft Performance

Course Objective:

- To introduce the concept of Stability and control of Aircraft
- To impart knowledge about various Aircraft motions and related stability
- To introduce the concept of dynamic stability of Aircraft

Course Outcome:

Students will be able to

- Understand the degree of freedom of aircraft system
- Analyse the static stability behaviour of the aircraft.
- Understand the dynamic longitudinal stability of aircraft
- Perform the dynamic analysis to determine stability of aircraft
- Estimate the requirement of control force and power plant
- Assess the motion of unstable aircraft and related modes of instability

Static Longitudinal Stability : Degrees of Freedom of a system, Basic equations of motion-Wing and tail contribution; Effects of Fuselage and nacelles- Stick fixed neutral points- Power effects-Jet driven airplane and Propeller driven airplane, Elevator Requirements.
Stick Fixed Static Longitudinal Stability : Basic equations of motion Elevator hinge moment, Estimation of hinge moment parameters, Stick Force gradients and Stick force per g load; Stick free Static Longitudinal Stability: Trim Taps, Stick free Neutral Point.
Static Directional Stability: Basic equations of motion- Contribution of wing –Fuselage –Vertical tail- Propeller, Directional control- Adverse yaw, One engine In-operative Conditions, Cross wind Landing, Spin recovery- Rudder effectiveness- Rudder Lock –Fins.
Static Lateral Stability: Dihedral Effect- Criterion for stabilizing dihedral effect -Selection of dihedral angle-Contribution of wing –Fuselage –Vertical tail- Propeller and Flaps- Rolling moment and its convention; Lateral Control- Aileron effectiveness, Aileron control force requirements, Aileron Balancing.
Dynamic Longitudinal Stability: Equations of motion-stick fixed and stick free, stability derivatives, Phugoid and short period, Lateral Dynamics- Equation of motion- Aileron fixed and free, Routh's discriminant, Dutch roll and Spiral instability, Auto rotation and Spin recovery.

Text Book:

1. Perkins, C D and Hage, R E; " Airplane Performance Stability and Control", Willey Toppan, 2010
2. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 1991

References:

1. J D Anderson, "Aircraft performance and Design", McGraw-Hill, New York, 2000.
2. Etkin, B., "Dynamics of Flight Stability and Control", John Wiley, New York, 1995.
3. Roskam Jan, "Airplane Flight Dynamics and Automatic Flight Controls". Design, Analysis and research Coorperation. 2003.
4. David G. Hull, "Fundamentals of Airplane Flight Mechanics" Springer-Verlag Berlin Heidelberg 2007.

17AE2021 AIRCRAFT PROPULSION

Credits: 3:0:0
Pre-requisites: 17AE2006 – Thermal Engineering for Aerospace Engineering

Course Objective:
- To familiarize with Principles of Propulsion systems
- To introduce working principles of Compressors and turbines
- To familiarize with the concept of Matching of compressors and turbines and Off design performance

Course Outcome:
Students will be able to
- Understand the performance of air breathing engines
- Analyse the performance of different Propulsion cycles.
- Understand the working of sub-systems of the propulsion system.
- Assess the performance of compressor and turbine
- Evaluate the combustion chamber, cooling and afterburner performance
- Find the causes of under-performance and remedial measures

Fundamentals Air-Breathing Engines: Review of thermodynamic principles, Principles of aircraft propulsion, Types of power plants, Cycle analysis jet engines. Illustration of working of gas turbine engine – The thrust equation – Factors affecting thrust – Effect of pressure, velocity and temperature changes of air entering compressor – Methods of thrust augmentation – Characteristics of turboprop, turbofan and turbojet – Performance characteristics. Principles of Pulsejets and Ramjets, Thermodynamic Cycle, Performance Parameters
Inlets and Nozzle for jet engines: Internal flow and Stall in subsonic inlets – Boundary layer separation – Major features of external flow near a subsonic inlet – Relation between minimum area ratio and eternal deceleration ratio – Diffuser performance – Supersonic inlets – Starting problem on supersonic inlets – Shock swallowing by area variation – External deceleration – Mode of inlet operation. **Nozzles:** Theory of flow in isentropic nozzles – Convergent / Convergent – divergent nozzles; Nozzle throat conditions – Nozzle efficiency – Losses in nozzles – Over expanded and under – expanded nozzles - Thrust reversal.
Compressors: Thermodynamics of Compressors, Development of parameters for compressor, Principle of operation of Axial and Centrifugal compressors. Work done and pressure rise – Velocity diagrams – Diffuser vane design considerations. Concepts of prewhirl, Rotation stall. Elementary theory of axial flow compressor. Velocity triangles – degree of reaction. Centrifugal and Axial compressor performance characteristics.
Combustion Chambers: Classification of combustion chambers – Important factors affecting combustion chamber design – Combustion process – Combustion chamber performance – Effect of operating variables on performance – Fuels and their properties and Fuel injection systems, Flame tube cooling – Flame stabilization – Use of flame holders and after burners.
Turbine: Thermodynamics of Turbines, Development of parameters for turbine, Types of turbines Principle of operation of Axial and Radial turbine– Design considerations – Performance parameters - Basics of blade design principles. Impulse and reaction blading of gas turbines – Velocity triangles and power output – Elementary theory – Vortex theory – Choice of blade profile, pitch and chord – Estimation of stage performance – Limiting factors in gas turbine design- Overall turbine performance – Methods of blade cooling – Matching of turbine and compressor for different types of Gas turbine Engines.

Text Books:

1. Hill, P.G. & Peterson, C.R., "Mechanics & Thermodynamics of Propulsion", Addison – Wesley Longman INC, 1999.
2. V. Ganesan, "Gas Turbines", Tata Mc Graw - Hill Publishing Company Ltd 1999

References:

1. Irwin E. Treager, `Gas Turbine Engine Technology`, GLENCOE Aviation Technology Series, 7th Edition, Tata McGraw Hill Publishing Co. Ltd. Print 2003.
2. Cohen, H, Rogers. G.F.C. and Saravanamuttoo. H.I.H., "Gas Turbine Theory", Pearson Education, 1989.
3. Oates, G.C., "Aero thermodynamics of Aircraft Engine Components" , AIAA Education Series, New York, 1985.
4. Mathur. M.L, and Sharma. R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers & Distributors, Delhi, 1999.

17AE2022 SPACE DYNAMICS

Credits: 3:0:0
Pre-requisites: 17AE2015 Foundations of Space Engineering

Course Objective:
- To familiarize with the performance of rockets
- To impart knowledge of basics of orbital mechanics
- To familiarize with various factors affecting the satellite orbits

Course Outcome:
Students will be able to
- Estimate performance of the rockets
- Attain a general knowledge of laws governing the orbital motion
- Use proper reference coordinate system for space trajectory analysis
- Compute the orbits of the satellites
- Study the effects of perturbations on the orbital motion
- Generate a preliminary design of inter-planetary trajectories

Rocket performance – Specific impulse, Derivation of rocket equation; Single and two stage rockets.
Solar system – planets, moons, asteroids, comets and meteoroids, Kepler's laws of motion; Reference frames – geocentric and heliocentric; the ecliptic - Motion of vernal equinox.
Properties of conics, Angular momentum; Computation of position and velocity vectors from orbital elements and vice-versa; Solution of Kepler's equation – elliptic and hyperbolic orbits.
Orbit perturbations – Earth's Oblateness, Sun-synchronous orbits, air drag, luni-solar perturbations; General and special perturbation methods; Cowell's and Encke's methods.
Single impulse maneuvers; Change of orbital inclination; Hohmann transfers from circular to circular orbits; Sphere of influence; Synodic period.

Textbooks:

1. Vladimir A. Chobotov, "Orbital Mechanics", AIAA Education Series, AIAA Education Series, Published by AIAA, 2002
2. Howard D. Curtis, "Orbital Mechanics for Engineering Students", Elsevier Butterworth-Heinemann, Third Edition, 2010

References:

1. Pini Gurfil, and P. Kenneth Seidelmann, "Celestial Mechanics and Astrodynamics: Theory and Practice", Springer, 2016
2. Gerald R. Hintz, "Orbital Mechanics and Astrodynamics: Tools and Techniques", Springer, 2015
3. J.W.Cornelisse, H.F.R. Schoyer, and K.F. Wakker, "Rocket Propulsion and Spaceflight Dynamics", Pitman, 2001
4. William E.Wiesel, "Spaceflight Dynamics", Aphelion Press, USA, Third Edition, 2010
5. David.A. Vallado,"Fundamentals of Astrodynamics and Applications", Microcosm and Kluwer , Second Edition,2004

17AE2023 COMPUTATIONAL FLUID DYNAMICS

Credits: 3:0:0
Pre-requisites: 17AE2013Gas Dynamics

Course Objective:
- To provide knowledge on governing equations of fluid dynamics
- To provide an understanding of the solution methodologies of discretised equations
- To provide knowledge on turbulence behaviour and its models of the flow

Course Outcome:
Students will be able to
- Understand the governing equations for fluid flow and its classification
- Choose the proper turbulent models for the given flow situation
- Apply proper solution methodology for PDE
- Arrive the proper domain for the numerical simulation for the given flow situation
- Define the boundary conditions and generate the grids
- Solve the real life fluid dynamic problems

Governing equations: Governing equations of fluid flow and heat transfer, Navier-Stoke's equations, Conservative, differential and integral form of transport equations; Classifications of PDEs and Numerical methods for different PDEs.
Introduction to CFD - Discretisation and grid generation, Problem solving with CFD, Finite difference method and finite volume method for one dimensional steady state diffusion, Finite volume method for one dimensional unsteady diffusion (heat conduction) – Explicit, Implicit and Crank-Nicholson scheme.
Convection diffusion problems: Steady one dimensional convection - diffusion, central difference, upwind differencing and hybrid schemes, Properties of discretisation schemes and convergence, Assessment of central difference, upwind differencing and hybrid schemes, Overview of Power law and QUICK schemes.
Various schemes: Staggered grid and momentum equations, SIMPLE, SIMPLER and SIMPLEC algorithms, Implementation of Boundary Conditions – Inlet, outlet, Wall, constant pressure, symmetric and cyclic.
Turbulence: Turbulence, Transition from Laminar to turbulent flows. Time averaged Navier-Stokes equations. Turbulence Models – zero equation- One equation - two equation and Reynolds stress models, Usage of turbulence models.

Text Books
1. Versteeg, H.K, and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method",Prentice Hall, 2nd Edition, 2007
2. Anderson, J.D., "Computational fluid dynamics – the basics with applications", 2005.

References:
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, 1980. Ane-Books2004 Indian Edition.

3. Muralidhar, K and Sundarajan .T., “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi, 2nd Ed, 2011
4. Bose, T.K., “Numerical Fluid Dynamics”, Narosa publishing House, 1997.
5. Wendt, J.F, Computational Fluid Dynamics, Springer, 3rd ed. 2009

17AE2024 CFD LABORATORY

Credits: 0:0:2
Co-requisites: 17AE2020 Computational Fluid Dynamics

Course Objective:

- To familiarize the students with the working of CFD codes
- To familiarize the students with actual setting up of the problem and solution procedure
- To extract the required data, post process and compare with available data

Course Outcome:
Students will able to

- Define the body shape in a CFD code
- Create the solution domain and grid generation
- Apply boundary conditions and generate the solution
- Validate the aerodynamic quantities from computed data
- Perform CFD Analysis over 2D and 3D objects.
- Solve the problems using different turbulence models.

List of Experiments:

1. Laminar Pipe Flow
2. Turbulent Pipe Flow
3. Modelling a mixing Elbow (2-D)
4. Flat Plate Boundary Layer
5. Forced Convection over a Flat Plate
6. Steady Flow past a Cylinder
7. Unsteady Flow past a Cylinder
8. Flow Over an Airfoil
9. Flow simulation over an aircraft
10. Flow simulation over a rocket
11. Supersonic Flow over a Wedge
12. Compressible Flow in a Nozzle
13. Analysis of 1D unsteady conduction by explicit and implicit schemes.

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.

17AE2025 ROCKET PROPULSION

Credit 3:0:0
Pre-requisites: 17AE2022 Aircraft Propulsion

Course Objective:

- To impart knowledge on concepts of Solid Propulsion rocket motor
- To impart knowledge on concepts of Liquid Propulsion rocket motor
- To impart knowledge on concepts of Advanced Propulsion systems

Course Outcome:
Students will be able to

- Evaluate the performance of rocket nozzle
- Understand and evaluate the performance of chemical propellant
- Select and design a suitable solid rocket motor
- Select and design a suitable liquid rocket motor
- Evaluate the performance of cooling system
- Select and design advanced propulsion systems

Fundamentals Of Rocket Propulsion: Overview of rockets, Rocket equation, Performance parameters, Staging and Clustering, Classification of rockets. Rocket nozzle and performance, Nozzle area ratio, conical nozzle and contour nozzle, under and over-expanded nozzles, Flow separation in nozzles, unconventional nozzles, Mass flow rate, Characteristic velocity, Thrust coefficient, Efficiencies, Specific impulse.
Chemical Propellants: Molecular mass, specific heat ratio, Energy release during combustion, Stoichiometric & mixture ratio, Types and classifications, Criterion for choice of propellant, Solid propellants, requirement, composition and processing, Liquid propellants, energy content, storability.
Solid Propulsion Systems: Classifications, Booster stage and upper stage rockets, Hardware components and functions, Propellant grain configuration and applications, Burn rate, burn rate index for stable operation, mechanism of burning, ignition and ignitors types, Action time and burn time, Factors influencing burn rates, thrust vector control.
Liquid Propulsion Systems: Liquid Propellant engines, Thrust chamber and its cooling, injectors and types, Propellant feed systems, Turbo pumps, Bipropellant rockets, Mono propellant thrusters, Cryogenic propulsion system, special features of cryogenic systems.
Advance Propulsion Techniques: Hybrid propellants and gelled propellants. Electrical rockets, types and working principle, Nuclear rockets, Solar sail, Concepts of some advance propulsion systems, Introduction to scramjet – Preliminary concepts in supersonic combustion, Integral ram-rocket.

Text books:

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edn., 2014.
2. Hill P.G. & Peterson, C.R., "Mechanics & Thermodynamics of Propulsion" Addison – Wesley Longman INC, 1999.

References:

1. Cohen, H., Rogers, G.F.C. and Saravanamutoo, H.I.H., "Gas Turbine Theory", Longman Co., ELBS Ed., 1989

2. Gorden, C.V., “Aero thermodynamics of Gas Turbine and Rocket propulsion”, AIAA Education series, New York, 1989
3. Mathur, M., and Sharma, R.P., “Gas Turbines and Jet and Rocket Propulsion”, standard Publishers, New Delhi, 1988
4. Vigor Yang, “Liquid rocket thrust chamber: Aspect of modeling, analysis and design”, American Institute of Aeronautics and Astronautics, 2004

17AE2026 PROPULSION LABORATORY

Credit: 0:0:2
Co-requisites: 17AE2022 Aircraft Propulsion

Course Objectives:

- To impart knowledge on basic concepts and operation of various propulsion system
- To provide practical exposure to the operation of various propulsion systems.
- To impart knowledge on shock tube.

Course Outcomes:

Students will be able to

- Understand the design the experiment for rocket motor performance.
- Assess the real time situation and corrective measures associated with rocket motors.
- Analyze the working of different parts of aircraft engine
- Estimation of calorific value of fuels
- Force distribution of axial compressor blade
- Solve Ignition delay studies using shock tube

LIST OF EXPERIMENTS

1. Study of an aircraft jet engine
2. Estimation of calorific value of fuels
3. Study on injector calibration
4. Shock speed measurement studies
5. Ignition delay studies using shock tube.
6. Storage losses of cryogenic fluids.
7. Cascade testing of a model for axial compressor blade row (symmetrical)
8. Cascade testing of a model for axial compressor blade row(cambered)
9. Study of convective heat transfer coefficient for liquids
10. Free convection heat transfer
11. Forced convection heat transfer
12. Nozzle performance test.

17AE2027 COMPUTATIONAL STRUCTURAL ANALYSIS LABORATORY

Credit 0:0:2
Co-requisites: 17AE2020 Computational Fluid Dynamics

Course Objective:

- To provide the knowledge on various structural analysis software packages

- To impart the understanding of the stress analysis of different types of structural components
- To impart the Knowledge on programming for various structural analysis

Course Outcome:
Students will be able to

- Understand the various structural software packages
- Solve the static structural analysis of one dimensional members
- Solve the static structural analysis of two dimensional & three dimensional problem
- Analyze the Static Thermal analysis of various objects
- Understand the various structural programming – open source software packages
- Program for various structures problem

List of Experiments:

1. Static stress analysis axial bar
2. a. Two dimensional (truss) frame with multiple materials and element types
   b. Three dimensional truss- Airframe
3. Simple two dimensional heat transfer problem
4. Modal analysis of Aircraft wing
5. Plate buckling analysis
6. Box Beam- Torsional and bending problem.
7. Fluid-structure interaction-Oscillating plate using Ansys workbench.
8. Programming of one dimensional bar with single material and axial load using Scilab.
9. Programming of one dimensional step bar, multiple material with different axial load direction using Scilab.
10. Programming for vibration analysis of bar using Scilab.
11. Programming for one- dimensional heat transfer problem using Scilab.
12. Programming for 2D truss using Scilab.

17AE2028 AIRCRAFT/SPACECRAFT DESIGN PROJECT

Credits: 0:0:4
Co-requisites: 17AE2020 Aircraft Stability and Control

Course Objective:

- To impart the knowledge of Aerodynamic design of Aircraft.
- To impart the knowledge of Performance analysis and stability aspects of different types of aircraft/Spacecraft.
- To impart the knowledge of the structural design of the aircraft/space craft.

Course Outcomes:
Students will be able to

- Choose the type of aircraft/spacecraft for comparative studies
- Calculate the aerodynamic parameter
- Design the aircraft and assess the performance of the design
- Analyse the stability of the designed vehicle

- Design the aircraft wings, tail, fuselage, landing gears
- Analysis the aircraft

Activities to be carried out:

1. Comparative studies of different types of airplanes and their specifications and performance details with reference to the design work under taken.
2. Preliminary weight estimation, Selection of design parameters, power plant selection, aerofoil selection, fixing the geometry of Wing, tail, control surfaces Landing gear selection.
3. Preparation of layout drawing, construction of balance and three view diagrams of the airplane under consideration.
4. Drag estimation, Performance calculations, Stability analysis and V-n diagram.
5. Preliminary design of an aircraft wing – Shrenck's curve, structural load distribution, shear force, bending moment and torque diagrams
6. Detailed design of an aircraft wing – Design of spars and stringers, bending stress and shear flow calculations – buckling analysis of wing panels
7. Preliminary design of an aircraft fuselage – load distribution on an aircraft fuselage 4. Detailed design of an aircraft fuselage – design of bulkheads and longerons – bending stress and shear flow calculations – buckling analysis of fuselage panels
8. Design of control surfaces - balancing and maneuvering loads on the tail plane and aileron, rudder loads
9. Design of wing-root attachment
10. Landing gear design
11. Preparation of a detailed design report with CAD drawings
12. Aerodynamic and Stability Analyse using open source software like XFLR5.

17AE2029 INSTRUMENTATION AND AVIONICS LABORATORY

Credit: 0:0:2
Pre-requisites: 17AE2014 - Elements of Avionics

Course Objective:

- To impart the knowledge about different types of Instruments and control systems
- To train students to measure parameters accurately and their importance in different applications in the field of Avionics

Course Outcome:

Students will be able to

- Understand the fundamentals of measurements.
- Understand the applications of these fundamental measurement systems.
- Understand the enormous amount of pressure that is put on these simple instrumentation in real time applications.
- Work with the avionics systems on an aircraft
- Apprehend the design concept of new control systems
- Familiarize with methods of troubleshoot and rectification of faulty instruments.

List of Experiments:

1. Stepper motor control
2. Displacement measurement using LVDT
3. Characteristics of load cells
4. Measurement of Pressure
5. Study of ON-OFF temperature control system
6. Design of Longitudinal autopilot for jet airplane
7. Measurement of Angular position using Gyroscope
8. Measurement of Air velocity using Hot wire Anemometer
9. Measurement of Acceleration using Accelerometer
10. Temperature measurement using thermocouple
11. Temperature measurement using RTD
12. Study on global positioning system
13. Programming with microprocessors

17AE2030 WIND TUNNEL TECHNIQUES

Credits: 3:0:0

Course Objective:

- To provide knowledge of various types of wind tunnels and test techniques.
- To introduce the basic concepts of measurement of pressure, velocity, forces and moments on models.
- To provide knowledge of various flow visualization techniques.

Course Outcome:

Students will be able to

- Understand the various types of wind tunnels and test techniques.
- Choose proper high speed wind tunnel for required test.
- Choose correct model for wind tunnel testing
- Estimate the forces and moments for given model
- Arrive the pressure, velocity and temperature using measurement techniques
- Choose the proper flow visualization techniques

Low speed wind tunnels: Flow similarity, Types of Wind Tunnel- subsonic, supersonic, transonic and hypersonic, Low Speed: layouts and nomenclature, types - closed circuit and open circuit, closed jet and open jet test section – application, Special purpose tunnels - Smoke Tunnels – Water Tunnels – Spin tunnel etc.,

Supersonic wind tunnel: Classification, Blow down, continuous and intermittent tunnel, Runtime calibration, mass flow rate, Size of pressure vessel, Starting and stopping Loads, Model Sizing.

Hypersonic wind tunnel: – Classification; Runtime Calculation; Shock Tube: Driver – driven section – Diaphragm – Type of operation – Shock Speed and Initial Diaphragm Pressure Ratio, Model sizing; Starting and stopping Loads - Calibration of test section for various Tunnels.

Measurements of forces and moments: Forces, moments and Reference Frames, Balances-Internal and External, Requirements and Specifications, Fundamentals of Model Installations.

Wind tunnel measurements: Pressure measurements – Barometers, Manometers, Pressure Transducer, Pressure sensitive Paints, Pitot-static tube, Velocity Measurements -Laser Doppler

Anemometer, Hot-wire Anemometer, PIV – PLIF - LDV, Temperature Measurements– Thermocouples, Temperature sensitive Paints, Heat flux measurements.
Flow visualization techniques: Path – Streak – Stream and Timelines; Techniques: Smoke, Tuft, Streaks, Surface oil flow, Interferometer, Schlieren and Shadowgraph technique.

Text Book:

1. Rae, W.H. and Pope, A. "Low Speed Wind Tunnel Testing", John Wiley Publication, 1999
2. Pope, A., and Goin, L., "High Speed wind Tunnel Testing", John Wiley Publication, 1999
3. Rathakrishnan E, Instrumentation, Measurements and Experiments in fluids. CRC Press, London, 2007

References:

1. John D. Anderson, Jr., "Fundamentals of Aerodynamics", Fifth edition, McGraw-Hill publications, 2010
2. J Lukosiewitz, M Dekkar, "Experimental Methods of Hypersonic", 1973
3. Rathakrishnan E, Gas Dynamics. PHI Learning Pvt Ltd, 2001

17AE2031 FINITE ELEMENT ANALYSIS IN AEROSPACE APPLICATION

Credits: 3:0:0

Course Objectives:

- To impart the basic concept of finite element theory
- To introduce concept of finite element method for analysis of aerospace structural components
- To provide the knowledge on various finite element procedures and solution techniques

Course Outcome:

Students will be able to

- Understand the different numerical solution to the FEA Problems
- Analyse the discrete and continuum problem using finite element method.
- Analyse the functions of different elements and stiffness matrix
- Solve the Axisymmetric problems
- Identify mathematical model for solution of common engineering problems
- Describe the usage of professional-level finite element software to solve engineering problems

Basic of finite element analysis (FEA): Fundamental concepts of engineering analysis – historical background of FEA – General Steps Involved – Discretization – weighted residual methods – Rayleigh –Ritz Method (Variational Method); Applications- Introduction to MATLAB/SCI-LAB Programming.
One dimensional finite element analysis – Co-ordinate systems - shape functions and stiffness matrix for bar element - shape functions and stiffness matrix beam element - shape functions and stiffness matrix for Truss element – related problems; Applications- MATLAB/SCI-LAB Programming- 1 D Elements – Truss Problems.

Two dimensional finite element analysis – Plane stress and plain strain problems – Constant strain triangular element – Shape function – Strain displacement matrix – stress strain relationship matrix – stiffness matrix equation - Linear strain triangular element – four noded rectangular element – Isoparametric elements; Applications-Programming- Two dimensional elements.
Higher order elements – Shape function of quadratic and cubic element-Shape function of eight noded quadrilateral element - Shape function of Nine noded quadrilateral element – Axisymmetric elements – problems – consistent mass matrix for various elements – lumped mass matrix – evaluation of Eigen values and Eigen vectors; Applications- MATLAB/SCI-LAB Programming- Higher order elements
Boundary Value Problems: One dimensional Heat transfer element – related problems – Applications to heat transfer in two dimension – related problems – application to fluid mechanics in two dimension – related problems – MATLAB/SCI-LAB programming for structural, heat transfer and fluid flow problems.

Text Books:

1. Robert D. Cook, David S. Malkus, Michael E. Plesha, "Concepts and Applications of Finite Element Analysis", John Wiley and Sons , 2007.
2. Young W.Kwon, Hyochoong Bang,'The Finite Element Method using MATLAB', CRC Press LLC, USA,1997.

References:

1. Segerlind,L.J. "Applied Finite Element Analysis", Second Edition, John Wiley and SonsInc., New York, 1984.
2. J.N. Reddy , "An Introduction to the Finite Element Method,", McGraw-Hill International Editions, 3rd ed., 2009
3. Tirupathi R. Chandrupatla and Ashok D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall, 2002
4. Rao S.S., "Finite Element Methods in Engineering", Pergamon Press, 4th Ed., 2005.
5. Robert D. Cook "Finite Element Modeling For Stress Analysis", John Wiley and Sons, 1995.
6. Roy R. Craig, Jr., "Structural Dynamics: An Introduction to Computer Methods," John Wiley and Sons, 1981.

17AE2032 - HEAT TRANSFER

Credit 3:0:0
Pre-requisites: 17ME2004 Engineering Thermodynamics

Course Objective:

- To understand the mechanisms of heat transfer under steady and transient conditions.
- To understand the concepts of heat transfer through extended surfaces.
- To learn the thermal analysis and sizing of heat exchangers and to understand the basic concepts of mass transfer.

Course Outcome

Students will be able to

- Understand the fundamental modes of heat transfer

- Understand the phase change heat transfer
- Use the heat transfer correlation for different heat transfer applications
- Understand the concept of hydrodynamic and thermal boundary layers
- Analyse and design the different types of heat exchangers
- Apply heat transfer principles of different applications.

(Use of standard HMT data book permitted)

Conduction: General Differential equation of Heat Conduction– Cartesian and Polar Coordinates – One Dimensional Steady State Heat Conduction — plane and Composite Systems – Critical thickness of insulation - Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis –Semi Infinite and Infinite Solids – Use of Heisler"s charts.
Convection: Dimensional analysis – forced and free convection- Significance of dimensionless number - Hydrodynamic and Thermal Boundary Layer. Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes.
Phase change heat transfer and heat exchangers: Nusselt"s theory of condensation - Regimes of Pool boiling and Flow boiling. Correlations in boiling and condensation. Heat Exchanger Types - Overall Heat Transfer Coefficient – Fouling Factors - Analysis – LMTD method – effectiveness, NTU method.
Radiation: Basic definitions - Black Body Radiation – Grey body radiation - Shape Factor – Electrical Analogy – Radiation between black surfaces - Radiation Shields - Radiation through gases.
Numerical methods in heat transfer and applications: Numerical analysis of heat conduction – finite difference formulation of differential equations – one-dimensional and two-dimensional steady heat conduction – Transient heat conduction in a plane wall-Application of heat transfer – Gas turbines-Rocket Thrust Chambers - Aerodynamic Heating -Ablative Heat Transfer.

Text Books:

1. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 2010
2. Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 2000

Reference Books:

1. Ghoshdastidar, P.S, "Heat Transfer", Oxford, 2004,
2. Nag, P.K., "Heat Transfer", Tata McGraw Hill, New Delhi, 2002
3. Ozisik, M.N., "Heat Transfer", McGraw Hill Book Co., 1994.
4. Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 1998.
5. Sutton,G.P., Rocket Propulsion Elements, John Wiley and Sons, Fifth Edition, 1986.

17AE2033 EXPERIMENTAL STRESS ANALYSIS OF AIRCRAFT STRUCTURE

Credits: 3:0:0

Course Objectives:

- To impart the knowledge in experimental method of finding the response of the structure to different types of load.
- To provide the basic knowledge in Electrical-Resistance strain gauges and it application
- To impart the knowledge in photo-elasticity techniques

Course Outcome:
Students will be able to

- Get the knowledge of the general aspects of strain measurements
- Ability to understand the principle of operation of different type of strain gauges.
- Choose the electrical resistance strain gauge for different application
- Get the knowledge of the 2D Photo elastic stress analysis
- Get the knowledge of the three dimensional photo elasticity
- Identify the suitable stress coating methods

Basics: Principle of measurements-Accuracy, sensitivity and range- Definition of strain and its relation to experimental determinations Properties of strain gauge systems, Types of strain gauge systems- Mechanical, Optical, Acoustical and Electrical extensometers.
Strain Gauges: Electrical-Resistance strain gauges and circuits, Principle of operation and requirements - Types and their uses- Materials for strain gauge-Calibration and temperature compensation-Cross sensitivity- Rosette analysis- Wheatstone bridge-Potentiometer circuits for static and dynamic strain measurements Strain indicators- Transducer applications- Load cells-Diaphragm pressure transducers. Case Study-Six component strain gauge balancing, foil type strain gauge mounting on plate - cantilever beam- Aircraft wing section- strain analysis with respect to different load.
Optical method of stress analysis: Polariscope – interferometer, Moiré Method,. Concepts of photoelastic effects, Photoelastic materials-Stress optic law- Plane Polariscope –Circular Polariscope -Transmission and Reflection type, Effect of stressed model in Plane and Circular Polariscope, Interpretation of fringe pattern - Isoclinics and Isochromatics. Case study- Aircraft wing spar and stringer cross section- Stress concentration, Principal stress and strain analysis using plane polariscope – circular polariscope.
Three dimensional photoelasticity: Introduction, Locking in model deformations – Material for three- dimensional photoelasiticity, Machining, cementing and slicing three dimensional models. Shear –Difference method, Frozen-stress method, Scattered- Light method.
Birefringent Coatings: Coating stresses and strain- Coating sensitivity – Coating materials-Application of coatings- Effect of coating thickness-Fringe-Order Determinations in coatings-Stress separation methods. – Applications.

Text Book:

1. J.W. Dally and M.F. Riley, “Experimental Stress Analysis”, McGraw-Hill Book Co., New.York, 1988.
2. Srinath,L.S., Raghava,M.R., Lingaiah,K. Gargesha,G., Pant B. and Ramachandra,K., “Experimental Stress Analysis” , Tata McGraw Hill, New Delhi, 1984

References:

1. Hetenyi, “Handbook of Experimental Stress Analysis”, John Wiley & Sons Inc., New York, 1980.
2. G.S. Holister, “Experimental Stress Analysis, Principles and Methods”, Cambridge University Press, 1987.
3. A.J. Durelli and V.J. Parks, “Moire Analysis of Strain”, Prentice Hall Inc., Englewood Cliffs, New Jersey, 1980.

17AE2034 COMPOSITES MATERIALS

Credits: 3:0:0

Course Objectives:

- To impart knowledge on Types and applications of composite materials
- To impart knowledge on Nature of various forms of reinforcement and matrix.
- To impart knowledge on Processing and testing of composite materials

Course Outcomes:

Students will be able to

- Understanding the mechanics of composite materials
- Understand the behaviour Composite Materials under Various Loads
- Understand the structure of the composite materials
- Analyze the different Failure modes of Composite Materials
- Analyze the laminated composites for various loading eases
- Get knowledge in manufacture of composites

Micromechanics: Introduction - advantages and application of composite materials – types of reinforcements and matrices - micro mechanics – mechanics of materials approach, elasticity approach- bounding techniques – fiber volume ratio – mass fraction – density of composites; Effect of voids in composites.

Micromechanics: Generalized Hooke's Law - elastic constants for anisotropic, orthotropic and isotropic materials - macro mechanics – stress-strain relations with respect to natural axis, arbitrary axis – determination of in plane strengths of a lamina - experimental characterization of lamina; Failure theories of a lamina.

Laminated Plate Theory: Governing differential equation for a laminate, stress – strain relations for a laminate, Different types of laminates, in plane and flexural constants of a laminate. hydrothermal stresses and strains in a laminate, Failure analysis of a laminate, impact resistance and inter laminar stresses; Netting analysis

Fabrication Process and Repair Methods: Various open and closed mould processes, manufacture of fibers, importance of repair and different types of repair techniques in composites – autoclave and non-autoclave methods.

Sandwich Constructions:

Basic design concepts of sandwich construction - materials used for sandwich construction - failure modes of sandwich panels - bending stress and shear flow in composite beams.

Text Books:

1. R.M. Jones, "Mechanics of Composite Materials", 2nd Edition, Taylor & Francis, 1999
2. B.D. Agarwal and L.J. Broutman, "Analysis and Performance of fiber composites", John-Wiley and Sons, 1990

References:

1. L.R. Calcote, "Analysis of laminated structures", Van Nostrand Reinhold Co.,1989.
2. Autar K. Kaw, Mechanics of Composite Materials, CRC Press LLC, 1997
3. G.Lubin, "Hand Book on Fibre glass and advanced plastic composites", Van Nostrand Co., New York, 1989. 5.
4. B.D. Agarwal and L.J. Broutman, "Analysis and Performance of fiber composites", John-Wiley and Sons, 1990

17AE2035 NAVIGATION, GUIDANCE AND CONTROL

Credits: 3:0:0

Course Objectives:

- To impart the concept of Control system fundamentals and its analysis.
- To introduce the concepts and working principles of different navigation methods and guidance.
- To model of aerospace vehicles and flight control system.

Course Outcomes:

Students will be able to

- Understand the control system and assess its performance and stability using routh Hurwitz criterion and root locus.
- Analyze time and frequency domain specifications and perform analysis using bode plot, polar plot and Nyquist stability criteria.
- Deploy the skills effectively in design of control for aerospace vehicle systems
- Understand the working principles and specifications of navigation methods.
- Simulate and assess the performance of autopilots, augmentation systems and missile guidance systems.
- Apprehend the functionality of advanced navigation and guidance systems.

Introduction to Control System: Introduction to Control System - open loop and closed loop control system-Transfer function poles and zeroes - block diagram reduction- signal flow graph - Mason's gain formula - Characteristics equation-concept of stability - Routh's stability Criteria, Root Locus.

Time and Frequency Domain Analysis: Time domain - Transient and Steady State Response-Time domain Specifications - Second Order system. Frequency Domain Analysis Closed Loop Frequency Response-Bode Plot-Polar Plot-Nyquist Stability Criteria-Stability Analysis from Bode Plot

Introduction to navigation systems: Introduction to navigation systems - Types Different co-ordinate systems - Transformation Techniques; Different types of radio navigation; - Introduction to Inertial Sensors; INS components; Introduction to GPS - system description - basic principles - position and velocity determination.

Introduction to guidance and control: Introduction to guidance and control, Need for automatic flight control systems; Displacement Autopilot - Pitch Orientation Control system; Methods of Obtaining Coordinates, Yaw Orientation Control system, Lateral Autopilot, Missile Autopilot.

Introduction to Advanced systems: Introduction to Advanced systems, Introduction to Fly-by-wire flight control systems, Instrument Landing System, microwave landing system, Operating principles and design of guidance laws, Radar systems, command and housing guidance systems.

Text Books:

1. Gopal.M., "Control System", Tata McGraw Hill, 2008
2. Ching-Fang Lin, "Modern Navigation, Guidance and Control Processing", Prentice Hall Inc., Englewood Cliffs, New Jersey, 1991

References:

1. Myron Kyton, Walfred Fried, ‘Avionics Navigation Systems’, John Wiley & Sons, 2nd edition, 1997
2. Nagaraja, N.S. “Elements of Electronic Navigation”, Tata McGraw-Hill Pub. Co., 15th reprint, 2006.
3. Blake Lock, J.H ‘Automatic control of Aircraft and missiles’, John Wiley Sons, Second Edition, 1991.
4. Stevens B.L & Lewis F.L, ‘Aircraft control & simulation’, John Wiley Sons, Second Edition, 2003.
5. Collinson R.P.G. “Introduction to Avionics Systems”, Springer Science + Business Media B.V, 2011.
6. Garnel.P. & East.D.J, ‘Guided Weapon control systems’, Pergamon Press; 2nd edition, 1980.
7. Nelson R.C ‘Flight stability & Automatic Control’, McGraw Hill, Second Edition, 2007.
8. Bernad Etikin,’Dynamic of flight stability and control’, Revised, John Wiley, 1995.

17AE2036 CRYOGENIC PROPULSION

Credit 3:0:0

Course Objective

- To study the engineering concept of cryogenic propulsion
- To know the various application of these propulsion in Aerospace field

Course Outcome

Student will be able to

1. Understand the thermal, physical and fluid dynamic properties of cryogenic fluids.
2. Understand the liquefaction systems to produce cryogenic fluids
3. Know the various method of cryogenic insulations, its storage and instrumentation
4. Understand the various cryogenic equipment’s used in Aerospace application.
5. Understand the vacuum technology used in cryogenic engineering
6. Know the various applications of cryogenics in engineering

Introduction to Cryogenic Engineering: Introduction to cryogenic systems-Historical background - Low temperature properties of materials –Thermal properties – Electric and magnetic properties – properties of cryogenic fluids – Fluids other than hydrogen and helium - Hydrogen – Helium 4 – Helium 3.

Liquefaction systems: Thermodynamically ideal system – Joule-Thomson effect –Adiabatic expansion – Liquefaction systems- Simple Linde Hampson system-Precooled Linde Hampson system-Claude system – kapitza system – Heylandt system – comparison of liquefaction systems.

Cryogenic refrigeration systems: Concept of ideal refrigeration systems – Joule-Thompson refrigeration systems – Philips refrigerator – Vuilleumier refrigerator – Solvay refrigerator – Gifford-Mcmanon refrigerator-Magnetic cooling – Magnetic refrigeration systems – Dilution refrigerators.

Cryogenic fluid storage and transfer systems: Cryogenic fluid storage vessels- Basic storage vessels – Inner and outer vessel design – Piping- Draining the vessels –Safety devices –

Insulations – Cryogenic fluid transfer systems- Uninsulated and porous insulated lines –Vacuum insulated lines – Cryogenic valves.
Cryogenic Engine: Introduction to cryogenic engines, types and their application- Schematic diagram-working principle of Cryogenic engine, Precaution for testing the engine. Numerical problems

Text Books:

1. R. Barron , "Cryogenic Systems", Oxford University Press, 1985
2. T.M. Flynn, Marcel Dekker., "Cryogenic Engineering", New York, 1997

Reference Books:

1. Bose and P. Sengupta, "Cryogenics: Applications and Progress", Tata McGraw Hill, 1985
2. R.W. Vance and W.M. Duke , "Applied Cryogenic Engineering" , John Wiley & sons., 1962

17AE2037 INDUSTRIAL AERODYNAMICS

Credits: 3:0:0
Prerequisites: 16AE2001–Fluid Mechanics & 14AE2006 - Aerodynamics

Course Objective:

- To impart information about non-aeronautical uses of aerodynamics, such as road vehicle, building aerodynamics
- To familiarize the concept of wind energy system and its applications
- To provide the knowledge on solution of problems in flow induced vibrations

Course Outcome:
Students will be able to

1. Understandthe airflow over a surface
2. Apply the principles of aerodynamics to different ground vehicles
3. Asses various wind energy system
4. Predict the behaviour of airflow over civil structures
5. Analyse the flow field over trains
6. Estimate the flow induced vibrations the cables and bridges

ATMOSPHERIC BOUNDARY LAYER: Atmospheric circulation-local winds – terrain types – mean velocity profiles- power law and logarithmic law, wind speeds, turbulence profiles, Roughness parameters – simulation techniques in wind tunnels
BLUFF BODY AERODYNAMICS: Boundary layers and separation, 2-D wake and vortex formation, Strouhal and Reynolds numbers, separation and reattachments, power requirements and drag coefficients of automobiles, effect of cut back angle, and aerodynamics of trains
WIND ENERGY COLLETORS: Horizontal and vertical axis machines, energy density of different rotors, power coefficient, Betz coefficient by momentum theory.
BUILDING AERODYNAMICS: Pressure distribution on low rise buildings, wind forces on buildings, environmental winds in city blocks, and special problems of tall buildings, building codes, ventilation and architectural aerodynamics.

FLOW INDUCED VIBRATION: Vortex shedding, effect of Reynolds number on wake formation in turbulent flows, across wind galloping, wake galloping, along wind galloping of circular cables, oscillation of tall structures and launch vehicles under wind loads, stall flutter.

Text Books

1. Gino Sovran, "Aerodynamics Drag Mechanisms of Bluff Bodies and Road Vehicles" Springer;2012
2. Sachs P, "Wind Forces in Engineering:, Pergamon Press,1988

References

1. Tom Lawson, Building Aerodynamics", Icp; first edition, 2001
2. John D.Holmes, "Wind Loading of Structures", CRC Press, second Edition, 2007
3. Steven R.H, Rex E.B., "Wind Flow and Vapor Cloud Dispersion at Industrial and Urban Sites", John Wiley& Sons, 2003.
4. Blevins R.D., "Flow Induced Vibrations", Van Nostrand, 1990.

17AE2038 INTRODUCTION TO UNMANNED AIRCRAFT SYSTEMS

Credits: 3:0:0

Course Objective:

- To incorporate awareness about the basic terminology, models and prototypes of UAS
- To impart knowledge on design considerations of UAV systems
- To obtain knowledge on aerodynamics and communication systems of UAS

Course Outcome:

Students will be able to

- Know the evolution of UAS and the various models and prototypes
- Understand the design parameters of UAV systems
- Obtain knowledge on the application of aerodynamic principles to design UAS
- Understand the principles of communication systems used in UAVs
- Obtain knowledge on payloads and launch systems for UAS
- Understand the application of UAS to various societal applications

Introduction to Unmanned Aircraft Systems – Aviation History and unmanned flight – Definitions and terminology – Classification of UAVs – UAV categories - Unmanned Aircraft systems

Design and selection of UAV system - Conceptual phase – Preliminary design – detail design – selection of system – UAV mission – UAV design specifications – Initial sizing – Airfoil selection – structural requirements and engine selection

Aspects of Airframe design – Lift induced drag – parasitic drag – Scale effects - Structure and Mechanics - Mechanical design - Selection of power plants

Payloads - Dispensable and non-dispensable pay loads – Communication media - Radio communication – Radio tracking - Antenna types

Launch of HTOL & VTOL systems – recovery of HTOL & VTOL systems - Naval roles – Army roles – Civilian roles – paramedical and commercial roles – commercial applications

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, Douglas M. Marshall, Eric Shappee, "Introduction to Unmanned Aircraft systems", CRC press, Taylor and Francis, New York, 2012.

References:

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.

17AE2039 AERO-ELASTICITY

Credits: 3:0:0
Pre-requisites:17AE2020 Aircraft Stability and Control

Course Objectives:

- To impart the basic concepts of Aeroelasticity
- To provide knowledge about the Static Aeroelastic phenomena
- To understand the Dynamic Aeroelastic phenomena

Course Outcome:
Students will be able to

- Understand the Aero-elastic phenomena
- Get Knowledge in preventing body (i.e. Aircrafts) from Aeroelastic instability
- Understand the vibration system
- Analyse the static Aeroelasticbehaviour of the Aircraft
- Analyse the Dynamic Aeroelasticbehaviour of the Aircraft
- Analyse the Flutter and Gust behaviour of the Aircraft.

Introduction to Aero-elasticity: Introduction to Aero-elasticity- The aero-elastic triangle of forces- Prevention of Aero-elastic instabilities- Influence and stiffness coefficients-History of Aero-elasticity- Introduction to Unsteady Aerodynamics and Loads, introduction of elasticity to be introduced
Vibration Systems: Vibration of Single Degree of Freedom Systems- Vibration of Multiple Degree of Freedom Systems- Vibration of Continuous Systems – Discretization Approach
Static Aero-elasticity: Effect of Wing Flexibility on Lift Distribution and Divergence- Static aero-elastic behaviour of a two-dimensional rigid airfoil with spring attachment- Static aero-elastic behaviour of a fixed root flexible wing- Effect of trim on static aero-elastic behaviour- Effect of wing sweep on static aero-elastic behaviour
Dynamic Aero-elasticity-Flutter: General form of the aero-elastic equations- Simplified unsteady aerodynamic model- Aero-elastic behaviour of the binary model - Eigen value solution of flutter equations - Aero-elastic behaviour of a flexible wing- Aero-elastic behaviour of a multiple mode system- Flutter speed prediction for binary systems.

Dynamic Aero-elasticity-Gust: Introduction to Gust - General form of equations in the time domain - Rigid aircraft in heave/pitch Motion- Frequency domain turbulence response – General form of equations in the frequency domain

Text Book

1. Jan R. Wright Jonathan E. Cooper "Introduction to Aircraft Aeroelasticity and Loads" John wiley & sons, Ltd ,2007
2. Y.C. Fung, "An Introduction to the Theory of Aeroelasticity", John Wiley & Sons Inc., New York, 2008.

References:

1. Earl H. Dowell, Robert Clark, David Cox, H.C. Curtiss, Jr, John W. Edwards, Kenneth C. Hall, David A. Peters, Robert Scanlan, Emil Simiu, Fernando Sisto and Thomas W. Strganac, "A Modern Course in Aeroelasticity", Fourth Revised and Enlarged Edition, 2004.
2. R.L. Bisplinghoff, H.Ashley, and R.L. Halfmann, "Aeroelasticity", II Edition Addison Wesley Publishing Co., Inc., 1996.
3. R.H. Scanlan and R.Rosenbaum, "Introduction to the study of Aircraft Vibration and Flutter", Macmillan Co., New York, 1981.
4. E.G. Broadbent, "Elementary Theory of Aeroelasticity", Bun Hill Publications Ltd., 1986

17AE2040 ANALYTICS FOR AEROSPACE ENGINEERS

Credits: 3:0:0

Course Objectives:

- To impart knowledge on various operations research techniques to ensure the effective utilization of resources
- To understand network models for project planning and scheduling
- To obtain knowledge on Quality Management Systems

Course Outcome:

Students will be able to

- Understand the importance of customer satisfaction and motivation
- Distinguish the roles of a manager and customer
- Apply mathematical models for physical problems to find optimal Solutions
- Design network models for project planning, scheduling and project management
- Understand the principles of quality management
- Apply Quality management concepts in product/service industry to the end users

Quality Concepts : Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement
Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen –
Analysis Models : Network analysis: Project Networks – Critical Path Method – Project Evaluation and Review technique - 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.

Text Books:

1. Dale H.Besterfiled, et al., "Total Quality Management", Pearson Education, Inc. 2003. (Indian reprint 2004).
2. N P Agarwal, R k tailor, "Human Resource Management" RBSA Publishers, Jaipur, 2009.

References:

1. Handy Taha. A., "Operations Research" (Sixth Edition) Prentice – Hall of India Private Limited, New Delhi, 2010.
2. S. Bhaskar., "Operations Research" Anuradha Publications, Chennai, 2013.

17AE2041 ADVANCED SPACE DYNAMICS

Credits: 3:0:0
Pre-requisites: 17AE2022 - Space Dynamics

Course Objective:

- To impart the knowledge related to the basics of celestial mechanics,
- To impart the knowledge of orbital transfers
- To impart the knowledge related to the orbits in restricted three-body problem

Course Outcome:
Students will be able to

- Understand two-body orbital motion
- Gain knowledge of orbital transfer technique
- Understand the concept of dynamical systems
- Understand orbital motion in restricted three-body problem
- Attain knowledge of equilibrium points and its uses
- Gain knowledge of orbits in 3-dimensional restricted three-body problem

Basics: Fundamental principles and definitions, Two-body problem: Central orbits, Derivation of equation of motion, Derivation of Lambert's theorem.
Planar circular restricted three-body problem - Equations of motion in sidereal and synodic coordinate systems, Derivation of Jacobi integral, Tisserand's criterion for the identification of comets.
Totality of solutions; Concept of phase space; Manifold of the states of motion and their singularities; Computation of location of collinear and equilateral points.
Motion near the equilibrium points, derivation of variational equations, Characteristic equation, Motion around the collinear and equilateral points, Critical mass.
Three-dimensional restricted three-body problem, Motion around the equilibrium points, Halo orbits, Lissajous orbits, Hill's problem.

Textbooks:

1. Howard D. Curtis, Orbital Mechanics for Engineering Students, Elsevier Butterworth-Heinemann, Third Edition, 2010
2. Victor G. Szebehely, “Theory of Orbits - The Restricted Problem of Three Bodies”, Academic Press, New York and London,1967

References:

1. Pini Gurfil, and P. Kenneth Seidelmann, “Celestial Mechanics and Astrodynamics: Theory and Practice”, Springer, 2016
2. Gerald R. Hintz, "Orbital Mechanics and Astrodynamics: Tools and Techniques", 1st edition, 2015
3. J.M.A.Danby, “Fundamental of Celestial Mechanics” ,Inc., 2nd Edition, Willman-Bell,USA,1992
4. Carl D. Murray and Stanley F. Dermott, "Solar System Dynamics", Cambridge University Press, 1999
5. Vladimir A. Chobotov, “Orbital Mechanics”, AIAA Education Series, AIAA Education Series, Published by AIAA, 2002

17AE2042 AIR TRAFFIC CONTROL AND AERODROME DETAILS

Credits: 3:0:0

Course objective:

- To impart the knowledge on the scope and purpose of Air traffic services.
- To inculcate the importance of radar services in air traffic control.
- To impart the knowledge in procedure of the formation of aerodrome and its design and air traffic control.

Course outcome:

Students will be able to

- Understand the basic concepts of ATS and its services.
- Identify the flight operations between different altitudes.
- Know the working routines of radar services
- Appreciate the concepts of Aerodrome layouts and its design.
- Differentiate the runway restrictions and limitations.
- Apprehend the various approach and guidance systems.

Air Traffic Services: Objectives of ATS - Parts of ATC service – Scope and Provision of ATCs –VFR & IFR operations – Classification of ATS air spaces – Varies kinds of separation – Altimeter setting procedures – Establishment, designation and identification of units providing ATS – Division of responsibility of control.

Area control service: Assignment of cruising levels minimum flight altitude ATS routes and significant points – RNAV and RNP – Vertical, lateral and longitudinal separations based on time / distance –ATC clearances – Flight plans – position report

Radar services and control: Radar services, Basic radar terminology – Identification procedures using primary / secondary radar – performance checks – use of radar in area and approach control services – assurance control and co-ordination between radar / non radar control – emergencies – Flight information and advisory service – Alerting service – Co-ordination and emergency procedures – Rules of the air.

Aerodrome Details: Aerodrome data - Basic terminology – Aerodrome reference code – Aerodrome reference point – Aerodrome elevation – Aerodrome reference temperature – Instrument runway, physical Characteristics; length of primary / secondary runway – Width of runways – Minimum distance between parallel runways etc. – obstacles restriction.

Visual Aids: Visual aids for navigation Wind direction indicator – Landing direction indicator – Location and characteristics of signal area – Markings, general requirements – Various markings – Lights, general requirements – Aerodrome beacon, identification beacon – Simple approach lighting system and various lighting systems – VASI & PAPI - Visual aids for denoting obstacles; object to be marked and lighter – Emergency and other services.

Text Books:

1. AIP (India) Vol. I & II, "The English Book Store", 17-1, Connaught Circus, New Delhi.

References

1. "Aircraft Manual (India) Volume I", Latest Edition, The English Book Store, 17-1, Connaught Circus, New Delhi.
2. "PANS – RAC – ICAO DOC 4444", Latest Edition, The English Book Store, 17-1, Connaught Circus, New Delhi.

14AE2043 NON - DESTRUCTIVE TESTING

Credits: 3:0:0

Course Objectives:

- To provide the knowledge in various processes involved in non-destructive testing
- To get trained in locating discontinuities
- To impart knowledge in NDT application in Aerospace maintenance field

Course Outcome:

Students will be able to

- Understanding various types of discontinuities
- Knowledge in non – destructive testing, its scope and purpose
- Understand the different NDT processes
- Evaluate the properties of material without causing damage
- Learn dynamic behavior of defect with NDT tools
- Choose the best NDT method for different application

Visual Inspection and Liquid Penetrant Testing: Scope and features of NDT, NDT vs. Destructive Testing, Visual Inspection-Basic principle, Optical aids used for Visual Inspection. Liquid Penetrant Testing- Principles, Procedures, Penetrant Testing Methods, Sensitivity, Applications and Limitations, Standards.

Magnetic Particle Testing and Eddy Current Testing: Magnetizing techniques, Procedures, Equipments for MPT, Sensitivity, and Limitations. Eddy Current Testing –Principles, Instrumentation, Techniques in MPT, Applications and limitations.

Radiography: Electromagnetic Radiation Sources, Radiation attenuation in the specimen, Effect of radiation on film, Radiographic Imaging, Inspection Techniques in Radiography, Applications and limitations.
Acoustic Emission Testing and Ultrasonic Testing: Instrumentation of Acoustic Emission Technique, Sensitivity, Applications and limitations. Ultrasonic Testing-Basic properties of sound beam, Inspection methods, Techniques for Normal Beam Inspection and Angle Beam Inspection, Modes of display, applications and limitations.
Thermography: History and development, theory and basic principles, Detectors and Equipment, Techniques, Variables, Evaluation of test results and reports, Applications-electronics industry, aerospace applications and electrical applications, advantages and limitations, Standards.

Text Books:

1. Baldev Raj, T. Jayakumar, M. Thavasimuthu, "Practical Non-destructive Testing", Woodhead Publishing, 2002.
2. P. E. Mix, "Introduction to non-destructive testing", Wiley Interscience,, John Wiley &Sons, Inc, Publ., 2005.

References:

1. Lalith Gupta, "Aircraft General Engineering", Himalaya Book House, Delhi 2003.
2. Ravi Prakash, "Non-Destructive Testing", New Age Sciences, New Delhi,2009.
3. Louis Cartz, "Nondestructive Testing: Radiography, Ultrasonics, Liquid Penetrant,Magnetic Particle, Eddy Current", Asm International, 1995.
4. C. Hellier, "Handbook of Nondestructive Evaluation", McGraw-Hill, 1994.

17AE2044 INTRODUCTION TO HYPERSONIC FLOWS

Credits: 4:0:0
Pre-requisites: 17AE2016 Gas Dynamics

Course Objective:
- To introduce the features of in-viscid hypersonic flows, viscous hypersonic flows and high temperature effects
- To provide knowledge regarding estimation of flow over bodies under hypersonic conditions
- To introduce the high temperature issues of hypersonic wings

Course Outcome:
Students will be able to
- Solve the problems involving in-viscid and viscous hypersonic flows
- Estimate the high temperature effects in hypersonic aerodynamics
- Asses the design issues for hypersonic wings
- Apply the computational tools to evaluate hypersonic flows
- Distinguish the high Mach number flow from the supersonic flows
- Estimate flow parameters over a vehicles under hypersonic conditions

Introduction: Features of hypersonic flows, thin shock layers, Entropy layer, Viscous-Inviscid Interaction, High Temperature effects, Low Density Effects.

Inviscid hypersonic flows

Hypersonic Shock relations, Hypersonic Similarity Parameters and Shock relations, Hypersonic Expansion Wave relation, Methods of calculating surface pressures- Newtonian Flows, Modified Newtonian Laws, Centrifugal Force Correction, Tangent wedge Method, Tangent Cone Method, Shock Expansion Method.

Hypersonic inviscid flow field: Approximate Methods for inviscid hypersonic flows, Mach number independence Principle, Hypersonic slender body theory for all angle of attack, hypersonic similarity laws, Thin Shock layer theory.

Viscous hypersonic flows: Viscous hypersonic flows-Boundary layer Equations,Navier-Stokes equations, Similarity Parameters, Boundary Conditions, Hypersonic Boundary Layer Theory, Self-similar Solution – Flat Plate and Stagnation Point, Non-similar Boundary Layer, Local similarity Method, Hypersonic Transition, Turbulent Boundary layer,

Aerodynamic heating and viscous-inviscid interaction: Turbulent boundary layer,Hypersonic Aerodynamic Heating, axisymmetric analogue for three dimensional bodies, hypersonicviscous Interactions.

Text Books:

1. John D.AndersonJr.,"Hypersonic and High Temperature Gas dynamics", AIAA, 2nd Edition 2006
2. John J Bertin., "Hypersonic Aerothermodynamics", AIAA Education Series., Washington DC, 1994

Reference Books:

1. Hayes, Wallace.D and Probstein R F., "Hypersonic Inviscid Flow", Dover Publications,2004
2. Ernst Heinrich Hirschel., "Basics of Aerothermodynamics", Springer Verlag Berlin, 2005
3. Wilbur L. Hankey (1988), Re-entry Aerodynamics, AIAA Education series, Washington DC
4. Vladimir V. Lunev, Real Gas Flows with High Velocities, CRC Press, 2009
5. Maurice Rasmussen, Hypersonic Flow, John Wiley & Sons (4 Oct 1994)

17AE2045 AIRCRAFT SYSTEMS

Credits: 3:0:0

Course Objective:

- To impart knowledge on importance and operating principles of aircraft systems
- To impart knowledge on aircraft environmental and flight conditions

Course Outcome:

- Ability to design systems for different category of aircraft
- Ability to diagnose aircraft systems performance

Aircraft Hydraulic systems: Hydraulic fluid – Types of Hydraulic Fluids – Phosphate Ester Base Fluids - Basic Hydraulic Systems – Contamination check and control – filters - Reservoirs

– Pumps - Pressure Regulation Actuating cylinders – Relief valves - Selector valves – Aircraft Pneumatic systems – Pneumatic system components – typical Pneumatic power system.

Landing Gear systems: Main landing gear Alignment, support, Retraction – Emergency extension systems – Landing gear safety devices – Nose wheel steering systems – Brake Systems – Brake assemblies - inspection and maintenance of brakes – Aircraft landing wheels – Aircraft tires – Aircraft tire maintenance – Antiskid system – Landing gear system maintenance.

Fuel systems: characteristics and properties of Aviation Gasoline – Turbine engine fuels – fuel system contamination – fuel system components – indicators – multiengine fuel systems – fuel jettison systems – Reciprocating engine ignition systems – battery ignition system – magneto ignition system operating principles - auxiliary ignition units.

Engine starting systems: Reciprocating engine starting systems – Gas Turbine engine starters – Air turbine starters – Lubrication systems – principles of engine lubrication – Requirements and characteristics – Reciprocating engine lubrication system – Turbine engine lubrication system – Engine cooling system – Turbine engine cooling.

Cabin atmosphere control systems: need for oxygen – air conditioning and pressurization systems – basic requirements – sources of cabin pressure – cabin pressure control systems – air distribution - air conditioning system – heating systems – cooling systems – electronic cabin temperature control system – oxygen systems – portable oxygen equipments – smoke protection equipments – oxygen cylinders – oxygen masks.

Text Books:

1. Ion Moir and Allan Seabridge, Aircraft Systems, John Wiley & Sons Ltd, England, Third edition, 2008
2. Roy Langton, Chuck Clark, Martin Hewitt and Lonnie Richards, Aircraft Fuel Systems, Wiley & Sons Ltd, England, 2009

References:

1. General Hand Books of Airframe and Power plant Mechanics", U.S. Dept. of Transportation, Federal Aviation Administration, The English Book Store, New Delhi1995
2. Mekinley, J.L. and Bent, R.D., "Aircraft Power Plants", McGraw-Hill, 1993
3. Pallet, E.H.J., "Aircraft Instruments & Principles", Pitman & Co., 1993
4. Treager, S., "Gas Turbine Technology", McGraw-Hill, 1997
5. McKinley, J.L., and Bent, R.D., "Aircraft Maintenance & Repair", McGraw-Hill, 1993

17AE2045 BASICS OF AEROSPACE ENGINEERING

(University)- This course is offered to other dept/school students

Credits: 3:0:0

Course Objective:

- To introduce the basic concepts of aircrafts, rockets, satellites and their development
- To impart knowledge about the basic parts and their function and construction
- To know the basics of propulsion and application of rockets

Course Outcome:

Students will be able to

- Understand the evolution of aircrafts and flying vehicles

- Understand the parts and function of aircrafts
- Obtain knowledge on principles of flight
- Understand the fundamentals of structures and materials used
- Understand the principles of aircraft and rocket propulsion
- Obtain knowledge on the engines used in aircraft propulsion

Historical evolution**;** Developments in aerodynamics, materials, structures and propulsion over the years
Components of an airplane and their functions; Different types of flight vehicles, classifications; Basic instruments for flying
Principles of flight**-** Evolution of lift, drag and moment; altitude and standard atmosphere – Airfoil and nomenclature – Basic aerodymanics
General types of Aircraft construction, Fuselage and Wing Structure; Aerospace materials, metallic and non-metallic materials;
Basic ideas about piston, turboprop and jet engines, Basic Propeller theory; Principles of operation of rocket, types of rockets and typical applications, Exploration into space.

Text Book:

1. John D Anderson Jr, "Introduction to Flight", Tata McGraw Hill Education Private Limited, New Delhi, 5th Edition, 2009.
2. A.C Kermode, "Flight without Formulae", Pearson Education, 2008.

References:

1. Anderson. David, Wand Scott Eberhardt. "Understanding Flight". 2nd ed. McGraw-Hill Professional, 2009.
2. Course material of Faculty Enablement Programme on "Introduction to Aircraft Industry", conducted by Infosys, Mysore through Campus connect programme.

17AE2046 THEORY OF VIBRATION

Credits: 3:0:0

Course Objective:

- 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:

Students will be able 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

- Understand the Damping Concepts

Single degree of freedom systems: Introduction to simple harmonic motion, D‟Alembert‟s principle, free vibrations – damped vibrations – forced vibrations, with and without damping – support excitation – transmissibility - vibration measuring instruments.
Multi degrees of freedom systems: Two degrees of freedom systems - static and dynamic couplings - vibration absorber- principal coordinates - principal modes and orthogonal conditions - eigen value problems - hamilton‟s principle - lagrangean equations and application
Continuous systems: Vibration of elastic bodies - vibration of strings – longitudinal, lateral and torsional vibrations
Approximate methods: Approximate methods - Rayleigh's method - Dunkerlay‟s method – Rayleigh-ritz method, matrix iteration method
Damping: Vibration isolation- Structural vibration limits - Vibration intensity- Vibration velocity - Structural damage - Effects of damping on vibration response of structures - The measurement of structural damping - Sources of damping- Inherent damping – Added Active damping systems - Energy dissipation in non-linear structures

Text Books:

1. Singiresu.S.Rao., "Mechanical Vibrations", Addison Wesley Longman ,2003.
2. V.P Singh "Mechanical Vibrations" DHANPAT RAI & CO,2016

References:

1. Benson H Tongue, " Principles of vibration"(2nd edition)Oxford University Press, 2002
2. Kelly, "Fundamentals of Mechanical Vibrations", Mc Graw Hill Publications, 2000.
3. Thomson, W.T.,--"Theory of Vibration with Applications" CBS Publishers and Distributers,
4. NewDelhi,2002
5. Rao V. Dukkipati, J. Srinivas., Vibrations:problem solving companion,Narosa Publishers, 2007.

17AE3001 VIBRATION AND AERO-ELASTICITY

Credits: 3:0:0

Course Objective:

- 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:

Students will be able 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

- Understand the Damping Concepts

Single degree of freedom systems: Introduction to simple harmonic motion, D'Alembert‟s principle, free vibrations – damped vibrations – forced vibrations, with and without damping – support excitation – transmissibility - vibration measuring instruments.
Multi degrees of freedom systems: Two degrees of freedom systems - static and dynamic couplings - vibration absorber- principal coordinates - principal modes and orthogonal conditions - eigen value problems - hamilton‟s principle - lagrangean equations and application
Continuous systems &Approximate methods: Vibration of elastic bodies - vibration of strings – longitudinal, lateral and torsional vibrations. Approximate methods - Rayleigh‟s method – Dunkerlay's method – Rayleigh-Ritz method- Matrix iteration method.
Damping: Vibration isolation- Structural vibration limits - Vibration intensity- Vibration velocity - Structural damage - Effects of damping on vibration response of structures - The measurement of structural damping - Sources of damping- Inherent damping – Added Active damping systems - Energy dissipation in non-linear structures.
Elements of Aero-elasticity: Concepts – Coupling – Aero elastic instabilities and their prevention – Collar's Triangle- Basic ideas on wing divergence, loss and reversal of aileron control–Flutter and its prevention.

References :

3. Singiresu.S.Rao., "Mechanical Vibrations", Addison Wesley Longman ,2003.
4. V.P Singh "Mechanical Vibrations" DHANPAT RAI & CO,2016
5. Benson H Tongue, " Principles of vibration"(2nd edition)Oxford University Press, 2002
6. Kelly, "Fundamentals of Mechanical Vibrations", Mc Graw Hill Publications, 2000.
7. Thomson, W.T.,--"Theory of Vibration with Applications" CBS Publishers and Distributers,NewDelhi,2002
8. Rao V. Dukkipati, J. Srinivas., Vibrations :problem solving companion, NarosaPublishers, 2007.
9. Y.C. Fung, "An Introduction to the Theory of Aeroelasticity", John Wiley & Sons Inc., New York, 2008.

17AE3002 ADVANCED AERODYNAMICS

Credits: 3:0:0

Course Objective:
- To familiarize student with the airfoils and wings and the flow over them
- To impart knowledge of compressibility effects over an aerofoil and finite wings
- To provide knowledge of high temperature effects over an hypersonic wings

Course Outcome:
Students will be able to
- Understand the flow behaviour over various body shapes
- Assess the forces and moments due to flow
- Apply the compressibility corrections for flow in C-D passages and instrument like Pitot static tube
- Assess the nature of compressible flow over airfoils and finite wings
- Solve the problems involving in-viscid and viscous hypersonic flows

- Use the computational tools to evaluate hypersonic flows

INCOMPRESSIBLE FLOW: Aerodynamic forces and moments. Centre of pressure. Rotation, deformation, vortex theorems, and Conservation laws: integral and differential formulations-mass, momentum and energy equation,
POTENTIAL FLOW: Elementary flows and its combination: non-lifting and lifting flow over cylinders. Kutta – Joukowski theorem and generation of lift, Kutta condition, thin airfoil theory, Vortex filament, Helmholtz theorems. Introduction to Prandtl's lifting line theory and lift distribution.
INTRODUCTION TO COMPRESSIBLE FLOW: Compressibility, Velocity of sound, Concept of Mach Number, Isentropic relations, Flow through converging-diverging passages, Performance under various back pressures, corrections of Pitot static tube for subsonic and supersonic Mach numbers
SHOCKS AND EXPANSION WAVES: Normal shock and its relations, Prandtl equation and Rankine – Hugoniot relation, Oblique shocks and corresponding equations, Hodograph and flow turning angle, shock polar, Flow past wedges, Strong, weak and detached shocks, Expansion waves & its corresponding equations, Flow past concave & convex corners, Intersection and Reflection of shocks with wall and expansion waves, Rayleigh and Fanno Flow.
ELEMENTS OF HYPERSONIC FLOW: Features of hypersonic flows, thin shock layers, Entropy layer, Viscous Interaction, High Temperature effects, Low Density Effects , Hypersonic Shock & Expansion Wave relation, Methods of calculating surface pressures- Newtonian and Modified Newtonian Laws, Centrifugal Force Correction, Tangent wedge and Tangent Cone Method, Shock Expansion Method.

References:

1. John D. Anderson, Jr., "Fundamentals of Aerodynamics", Fifth edition, McGraw-Hill publications, 2010
2. Rathakrishnan, E, Theoretical Aerodynamics, John Wiley & Sons, 2013
3. John D.Anderson Jr.,"Hypersonic and High Temperature Gas dynamics", AIAA, 2nd Edition 2006E L Houghton and PW Carpenter, "Aerodynamics for Engineering students", Sixth edition, Edward Arnold publications, 2012.
4. L.M Milne Thomson, "Theoretical Aerodynamics", 1996
5. Liepmann H W and Roshko A, "Elements of Gasdynamics", John Willey & Sons, 1957
6. Shapiro, A.H., "Dynamics and Thermodynamics of Compressible Fluid Flow", Ronald Press,1982

17AE3003 ADVANCED AERODYNAMICS LABORATORY

Credits: 3:0:0

Course Objective:
- To impart knowledge of basics of subsonic and supersonic flow over the model
- To impart knowledge of forces and moments over an aerofoil
- To impart knowledge of basics of
- To impart knowledge of shock wave over various model

Course Outcome:
Students will be able to

- Understand the aerodynamic variable connected with airflow
- Estimate lift and drag of various stream line and bluff bodies
- Visualize subsonic flow over various model
- Calibration of supersonic wind tunnel
- Visualize shock wave and Estimate shock angle over various model
- Effect of back pressure in C-D nozzle

List of Experiments:

1. Velocity distribution at three transverse locations of the test section of subsonic wind tunnel.
2. Estimation of the Lift and drag of symmetric and cambered aerofoil using pressure measurements.
3. The pressure distribution over a cascade aerofoil.
4. Force and moment measurements of aircraft model by using strain gauge balance.
5. Boundary layer measurements on an airfoil around flow separation region.
6. Flow visualisation of multi-storey building simulating the earth boundary layer in subsonic wind tunnel.
7. Smoke flow visualization over a car.
8. Simulation of von-Karman Vortex Street in the water tunnel facility.
9. Study of starting process of supersonic wind tunnel.
10. Flow visualisation using oil flow, Schlieren and shadowgraph technique.
11. Study of Mach disc formation in the conical nozzle flow exhaust.
12. Flow separation studies in an over expanded nozzle.
13. Jet pluming study using high altitude jet facility.
14. Multiple jet interaction studies
15. Background noise study in supersonic tunnel.

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 the semester

17AE3004 AEROSPACE PROPULSION

Credits: 3:0:0

Course Objective:

- To impart knowledge on working principles, operation and performance of Gas Turbine Engine (GTE),
- To impart knowledge on characteristics of GTE modules and its matching
- To impart knowledge on Ramjet, Scramjet and Rocket engines

Course Outcome:

Students will be able to

- Assess the performance of engine for aerospace application
- Evaluate GTE performance at component and system level
- Design the inlets for aircraft engines.
- Analyze the combustion chamber related issues
- Evaluate different rocket engines.

- Analyze the performance of space thrusters

Elements of aircraft propulsion: Classification of power plants- Method of aircraft propulsion- Propulsive efficiency- Specific Fuel consumption- Thrust and power- Factors affecting thrust and power- Illustration of work cycle of gas turbine engine- Characteristics of turboprop, turbofan and turbojet, Ramjet working principle, use of ramjet in missiles.

Axial flow compressors, fans and turbines: Introduction to centrifugal compressors- Axial flow compressors- geometry- twin spools- three spools- Performance and Characteristics- velocity polygons- axial flow turbines- geometry- stage analysis and characteristics- Design & off-design Performance. Surge margin requirements, surge margin stack up. Engine performance monitoring.

Combustion chambers: Classification of combustion chambers- Combustion chamber performance- Flame stabilization- Flame tube cooling- After burner- Types and characteristics- Operation and process. Scram jet- Supersonic combustion in scramjet engine- Methods of thrust augmentation. Introduction to Shock tube-ignition delay studies.

Inlets: Subsonic and Supersonic inlets- Relation between minimum area ratio and external deceleration ratio- Starting problem in supersonic inlets- Performance and characteristics- Modes of inlet operation.

Nozzle: Jet nozzle- Efficiencies- Over expanded, under expanded and optimum expansion in nozzles- Thrust Reversals- Off design operation and matching of various GTE. Introduction to High Altitude test facility -working principle – Introduction to open Jet facility and its working Principle.

References:

1. Sutton G.P., “Rocket Propulsion Elements”, Eight Edition, John Wiley & Sons Inc.,New Jersey, 2010
2. Hill, P.G. & Peterson, C.R., “Mechanics & Thermodynamics of Propulsion”, Addison – Wesley Longman INC, 1999.
3. V. Ganesan, “Gas Turbines, Second Edition”, Tata McGraw Hill Education Private Limited, New Delhi, 2014.
4. H. Cohen, G.F.C. Rogers and H.I.H. Saravanmuttoo, “Gas Turbine Theory”, Fifth Edition, Pearson Education Ltd, 2009
5. P.P Walsh and P. Peletcher, “Gas Turbine Performance” Blackwell Science, 1998, ISBN 0632047843.
6. Jack .D Mattingly, “Elements of Gas Turbine Propulsion”, Tata McGraw Hill Publishing Co. 2005
7. E. Irwin Treager, “Aircraft Gas Turbine Engine Technology”, 3rd Edition 1995 'ISBN-00201828
8. KlauseHunecke, “Jet Engines Fundamentals of Theory, Design and Operation”, Motors book international publishers & Wholesalers, 6th edition, 1997.
9. Ahmed F El-Sayed, “Fundamental of Aircraft and Rocket Propulsion”, Springer Verlag London,2016.

17AE3005 AEROSPACE PROPULSIONLABORATORY

Credit: 0:0:2

Course Objective:

- To introduce the concept of systems of rocket motors
- To assess the performance of air-breathing engines
- To impart knowledge on various engine component

Course Outcome:

Students will be able to

- Design the experiment for rocket motor performance.
- Assess the real lie situation and corrective measures associated with rocket motors.
- Analyze the working of different parts of aircraft engine.
- Get knowledge in combustion
- Identify suitable fuel injector
- Calculate of convective heat transfer coefficient for real time application.

List of Experiments:

1. Shock velocity measurement using a shock tube.
2. Ignition Delay studiesin shock tube.
3. Heat transfer measurement in shock tube.
4. Blast pressure measurement in shock tube.
5. Injector Performance study.
6. Estimation of cryogenic fuel evaporation losses.
7. Cooling requirement studies for a Rocket exhaust over a 'J' type jet deflector.
8. Ramjet engine testing of a scaled engine.
9. Diffuser test of centrifugal compressor.
10. Estimation of convective heat transfer of the fluid with and without additives.
11. Cascade testing of a model for axial compressor blade row (symmetrical)
12. Cascade testing of a model for axial compressor blade row(cambered)
13. Nozzle performance test.
14. Nozzle thrust measurements for cold flow.
15. Thrust measurements of propeller

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 the semester

17AE3006 ADVANCED COMPUTATIONAL FLUID DYNAMICS

Credits: 3:0:0

Course Objective:

- To provide knowledge on governing equations of fluid dynamics
- To provide an understanding of the solution methodologies of discretised equations,
- To impart knowledge of turbulence and combustion models and its behaviour.

Course Outcome:
Students will be able to

- Understand the governing equations for fluid flow and its classification
- Knowledge about turbulent behaviour of flow and methods to accounts for it
- Attain the numerical simulation of PDE and its applications to thermal problems
- Apply the numerical procedure for convection – diffusion problems
- Knowledge of performing CFD Analysis
- Apply the boundary conditions and solve CFD problems using turbulence and combustion models

GOVERNING EQUATIONS: Governing equations of fluid flow and heat transfer, Navier-Stoke's equations, Conservative, differential and integral form of transport equations; Classifications of PDEs and Numerical methods for different PDEs.
FDM & FVM FOR DIFFUSION: Finite difference method and finite volume method for one dimensional steady state diffusion, Finite volume method for two and three dimensional steady state diffusion problems, Finite volume method for one dimensional unsteady diffusion (heat conduction) – Explicit, Implicit and Crank- Nicholson scheme.
SOLUTION METHODOLOGY: Introduction, TDMA, application of TDMA, point iterating method- Jacobi, Gauss Seidel, Relaxation Methods, Multi-grid Techniques-Multigrid procedure with examples, multi grid cycles.
GRID GENERATION: 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.
TURBULENCE: Introduction,Turbulence models, Reynold's Averaged Navier-Stoke's Equation - RANS, Large Eddy Simulation, Detached EddySimulation, and Direct Numerical Simulation.

References:

1. Versteeg, H.K, and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method",Prentice Hall, 2nd Edition, 2007
2. Anderson, J.D., "Computational fluid dynamics – the basics with applications", 2005.Ghoshdastidar, P.S., "Computer simulation of flow and heat transfer", Tata McGraw – Hill publishing Company Ltd., 1998.
3. Patankar, S.V., "Numerical Heat Transfer and Fluid Flow", McGraw-Hill, 1980. Ane-Books2004 Indian Edition.
4. Muralidhar, K and Sundarajan .T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2nd Ed, 2011
5. Bose, T.K., "Numerical Fluid Dynamics", Narosa publishing House, 1997

17AE3007 COMPUTATIONAL HEAT TRANSFER

Credits: 3:0:0

Course Objective:

- To understand the different solution methods of heat transfer under steady and transient conditions.
- To understand the concepts of computational heat transfer through extended surfaces.

- To learn the heat transfer analysis in practical applications of heat transfer.

Course Outcome:
Students will be able to

- Know the mathematical concepts of computational heat transfer
- Know the different applications of heat transfer
- Understand the different computational methods of heat transfer
- Understand the heat transfer methods in FDM and FEM
- Apply the computational heat transfer methods in practical applications
- Analyse the real time problems of heat transfer in aerospace applications
- Understand the working of various sensors and instruments for thermal measurements.

Conduction Heat Transfer-General 3D-heat conduction equation in Cartesian, cylindrical and spherical coordinates. Computation (FDM) of One –dimensional steady state heat conduction –with and without Heat generation- 2D-heat conduction problem with different boundary conditions- Numerical treatment for extended surfaces. Numerical treatment for 3D- Heat conduction. Numerical treatment to 1D-steady heat conduction using FEM.
Transient Heat Conduction - Introduction to Implicit, explicit Schemes and Crank-Niolson Schemes, Computation(FDM) of One – dimensional un-steady heat conduction –with heat Generation-without Heat generation - 2D- transient heat conduction problem with different boundary conditions using Implicit, explicit Schemes. Importance of Cell Fourier number. Analysis for 1-D,2-D transient heat Conduction problems.
Convective Heat Transfer -Convection- Numerical treatment (FDM) of steady and unsteady 1-D and 2-D heat convection-diffusion steady-unsteady problems- Computation of thermal and Velocity boundary layer flows. Upwind scheme. Stream function-vorticity approach-Creeping flow.
Radiative Heat Transfer - Radiation fundamentals-Shape factor calculation-Radiosity method-Absorption Method-Monte-Carlo method-Introduction to Finite Volume Method- Numerical treatment of radiation enclosures using finite Volume method. Developing a numerical code for 1D, 2D heat transfer problems.
Heat transfer Measurements: Temperature measurements- Thermocouples- RTD sensors, Thermistor, Thermopiles, Thin platinum sensors, heat flux measurements – Gardon Gauge, Thick film heat flux gauge, Thin film sensors, Thermo- Non-contact types of measurement-Infrared camera, Pyrometer, Line reversal methods.

References:

1. R. H Pletcher, Tannehill C.Jhon, Dale A. Andersons, “Computational fluid Mechanics and Heat Trasnfer” 3rd Edition, CRC press 2012.
2. Yunus A. Cengel, Heat Transfer – A Practical Approach Tata McGraw Hill Edition, 2003.
3. T.-W. Lee, “ Thermal and Flow Measurements” CRC Press, 2008.
4. S.C. Sachdeva, “Fundamentals of Engineering Heat & Mass Transfer”, Wiley Eastern Ltd., New Delhi, 1981.
5. John H. Lienhard, “A Heat Transfer Text Book”, Prentice Hall Inc., 1981.
6. J.P. Holman, “Heat Transfer”, McGraw-Hill Book Co., Inc., New York, 6th Edition, 1991.
7. T.J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2002

8. C.Yk.Chow, “Introduction to Computational Fluid Dynamics”, John Wiley, 1979.
9. John D. Anderson, Jr., “Computational Fluid Dynamics”, McGraw-Hill Book Co., Inc., New York, 1995

17AE3008 ADVANCED COMPUTATIONAL FLUID DYNAMICS LABORATORY

Credits: 0:0:1

Course Objective:

- To familiarize the students with the working of CFD codes.
- To familiarize the students with actual setting up of the problem and solution procedure.
- To extract the required data, post process and compare with available data.

Course Outcome:

Student will be able to

- Define the body shape in a CFD code
- Understand the solution domain and grid generation.
- Apply boundary conditions and generate the solution.
- Validate the aerodynamic quantities from computed data.
- Perform CFD Analysis over 2D and 3 D objects.
- Solve problems using turbulence models.

List of Experiments:

1. Flow past over a flat plate at M=0.1, $\alpha = o^{o}$ and 10^{o}
2. Supersonic Flow over a flat plate
3. Flow Over an Airfoil
4. Flow simulation over ONERA M6 wing.
5. Flow analysis of gaseous combustion
6. Flow with thermal boundary layer.
7. Coding-One Dimensional flow in duct

14AE3009 FLIGHT PERFORMANCE AND DYNAMICS

Credits: 3:0:0

Course Objective:

- To introduce the parameters effecting the Flight performance
- To impart knowledge about the concept of Stability and control of Aircraft
- To introduce with the concept of dynamic stability of Aircraft

Course Outcome:

Students will be able to

- Understand the preliminary performance estimation
- understand the performance characteristics in level Flight
- perform the Static longitudinal analysis in the stability of aircraft
- perform the Static lateral & Directional analysis in the stability of aircraft

- perform the Static longitudinal analysis in the stability of aircraft
- identify the Aircraft response to control

Performance Characteristics in Level Flights: Assumptions for Aircraft Performance - Drag Components- Drag Polar, Performance characteristics of aircraft steady level flight- Maximum speed- Range and Endurance - Breguet formula: Rate of Climb- Maximum Climb Angle - Maximum Rate of Climb Velocity- Angle of climb; Gliding Flight - Turn flight; V - n diagram.
Static Longitudinal Stability: Degrees of Freedom of a system; Static Longitudinal Stability–Basic equations of equilibrium- Stability criterion: Stick fixed Longitudinal Stability- Wing and tail contribution; Effects of Fuselage and nacelles-Power effects- Neutral Point- Elevator hinge moment; Stick Free Longitudinal Stability –Neutral point and Static Margin; Stick Force gradients and Stick force.
Static Lateral and Directional Stability: Static Lateral Stability – Basic equations of equilibrium- Stability criterion Contribution of wing –Fuselage –Vertical tail; Dihedral Effect; Roll Control- Rolling moment due to aileron- Damping moment -Rate of roll achieved-Aileron reversal-Aerodynamic Balance; Static Directional Stability – Basic equations of equilibrium-Stability criterion - Contribution of wing –Fuselage –Vertical tail- Propeller -Weather cocking Effect, Rudder Requirements, One engine In-operative Conditions, Rudder Lock-Problems
Dynamic Longitudinal Stability: Dynamic Longitudinal Stability – Equations of motion, stability Derivatives, Routh's discriminant;Phugoid Motion and short term MotionsDutch roll and Spiral instability, Auto rotation and Spin-Problems.
Aircraft Response to Control: Introduction-Equation of motion in a Non uniform atmosphere-Pure vertical/Plunging motion, Atmospheric turbulence, Harmonic analysis-Turbulence models, Wind shear -Problems.

References:

1. J D Anderson, "Aircraft performance and Design", McGraw-Hill, New York, 2000.
2. Perkins, C D and Hage, R E; " Airplane Performance Stability and Control", Willey Toppan, 2010
3. Roskam, Jan and Lan, Chuan-tau E, "Airplane Aerodynamics and Performance", DAR Corporation, Lawrence, Kansas, USA, 1997.
4. Houghton, E L and Carruthers, N B; "Aerodynamics for Engineering Students", Edward Arnold Publishers, 1988.
5. Filippone, A, "Advanced Aircraft Flight Performance, Cambridge University Press, 2012
6. Roskam Jan, "Airplane Flight Dynamics and Automatic Flight Controls". Design, Analysis and research Coorperation. 3rd Printing 2003
7. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 1991

17AE3010 AEROSPACE STRUCTURE AND COMPOSITE

Credits: 3:0:0

Course Objective:
- To impart the knowledge on the structural behavior of aircraft components under different types of loads
- To provide the understanding in structural Analysis methods for aerospace vehicles
- To impart the knowledge stress distribution various section of aerospace component.

Course Outcome:
Students will be able to

- Get knowledge in various methods of analysis of aerospace structural members.
- Analyze the buckling property of plates and to predict the failure stress
- Understand the basic structural members of an Aircraft and launch vehicle.
- Predict the shear flow, and shear center in various open and close section of Aircraft structures
- Solve stress problem in aircraft components
- Design the Aircraft composite panel for Aerospace structure.

Virtual work: Principle of virtual work -Applications of the principle of virtual work. Energy methods - Unit load method. Flexibility method, Total potential energy, the principle of the stationary value of the total potential energy, Principle of superposition, the reciprocal theorem, Temperature effects.
Matrix methods- Stiffness matrix for an elastic spring -Stiffness matrix for two elastic springs in line-Matrix analysis of pin-jointed frameworks - Application to statically indeterminate frameworks - Matrix analysis of space frames - Stiffness matrix for a uniform beam Finite element method for continuum structures.
Buckling of thin plates: Inelastic buckling of plates- Experimental determination of critical load for a flat plate - Local instability -Instability of stiffened panels - Failure stress in plates and stiffened panels - Tension field beams.
Bending, Shear and Torsion of Thin-Walled Beams - Bending of open and closed, thin-walled beams – Symmetrical and Unsymmetrical bending. **Shear of beams** - General stress, strain and displacement relationships for open and single cell closed section thin-walled beams - Shear of open section beams and closed section beams. Torsion of beams- Torsion of closed and open section beams. **Structural idealization**-Principle of Idealization of a panel- Effect of idealization on the analysis of open and closed section beams - Deflection of open and closed section beams.
Stress Analysis of Aircraft Components: Wing spars and box beams- Tapered wing spar- Open and closed section beams-Beams having variable stringer areas. Fuselages - Bending –Shear-Torsion - Cut-outs in fuselages. Wings-Three-boom shell – Bending-Torsion - Shear - Shear center -Tapered wings - Deflections - Cut-outs in wings. Fuselage frames and wing ribs - Principles of stiffener/web construction - Fuselage frames - Wing ribs.
Laminated composite structures - Elastic constants of a simple lamina - Stress–strain relationships for an orthotropic ply (macro- approach) - Thin-walled composite beams

References:

1. Megson, T.H.G., "Aircraft Structures for Engineering Students", 2010.
2. T. H. G. Megson "An Introduction to Aircraft Structural Analysis" Butterworth-Heinemann, 2010
3. G Lakshmi Narasaiah "Aircraft Structures", BS Publications.,2010
4. Sun C T, " Mechanics of Aircraft Structures", Wiley India,2010
5. Peery, D.J., "Aircraft Structures", McGraw–Hill, N.Y., 2011.
6. Donaldson B K, "Analysis of Aircraft Structures" Cambridge Aerospace, 2008
7. G F Titterton, Aircraft Materials and Processes, Himalayan Books, New Delhi, 1956

17AE3011 STRUCTURAL ANALYSIS AND COMPOSITE LABORATORY

Credits: 0:0:2
Co-requisite: 17AE3010 **-** Aerospace Structural Analysis

Course Objective:

- To provide the basic knowledge on the testing equipment for various structural components.
- To impart the practical exposure with the measuring equipment and sensors.
- To impart the practical exposure with composite material manufacturing

Course Outcome:
Students will be able to

- Select test equipment for different types of static loading,
- Conduct tests, analyse results, document and compare with analytical/theoretical results
- Assess different types of structural failures
- MakeComposite material and Laminate
- Choose strain gauge for different application and get knowledge in strain gauge installation.
- Understand the stress distribution with respect to different cross-section shape and loading condition

List of Experiments:

1. Compression test on columns, critical buckling loads – Southwell plot.
2. Unsymmetrical bending of beams-Z section.
3. Determination of the natural frequency of vibrations of a cantilever beam
4. Shear centre location for open sections
5. Bending of beam with and without shear.
6. Torsion of a thin walled tube having various closed cross section at the ends
7. Structural behaviour of a semi tension field beam (Wagner Beam)
8. Using photo elastic techniques: Calibration of circular disc in compression to find the fringe value and Determination of stress concentration factor due to compression in circular ring
9. Composite material Manufacturing and Testing- Tensile and Three point bending
10. Strain Gauge Calibration
11. Thin wall cylinder - Hoop Stress Analysis
12. Brittle Lacquer Method

17AE3012 ADVANCED AVIONICS

Credits: 3:0:0

Course Objective:

- To impart the understanding in basic principles, theory and operation of flight instruments and modern avionics systems

- To familiarize the student with the concepts of guidance and control of an aircraft and to provide the necessary mathematical knowledge that are needed in modeling the guidance and control methods.
- To familiarize the student with the advanced concepts of remote sensing and image processing for aerospace applications.

Course Outcome:
Students will able to

- Understand the theory of transmission and reception of radio waves and functioning of radar systems.
- Understand the various approach guidance systems.
- Understand the advanced guidance and navigation systems.
- Design autopilots and missile guidance systems and ability to deploy these skills effectively in the design of control of aerospace systems.
- Appreciate the operation of various navigational systems used in the history of aviation
- Apprehend vision based navigation and control and modeling physical process.

Advanced Avionics and other systems. Advanced Avionics Systems – Enhanced Ground Proximity Warning Systems, Indian Regional Navigation Satellite systems, Microwave landing systems, Instrument landing systems, Precision approach landing systems.
HF Communication. HF Communication – HF range and propagation, Antennas in aircraft – location, structure, range, working principles. Single Side Band modulation, SELCAL, HF radio equipment. Radar guidance systems
Inertial systems. Inertial guidance systems, Inertial navigation systems, Avionics system requirements, EFIS, Autopilot flight detector system, Flight management systems, Flight data and cockpit voice recorder
Navigation principles. Principle and operation of different navigation systems – location, operation of NAVAIDS, Transponder, Radar Altimeter & Traffic Collision Avoidance Systems.
Autopilot and other applications. Longitudinal Autopilot, Lateral Autopilot, Fundamentals of UAV, Electronic warfare. Case studies - vision based navigation and control.

References:

1. Collinson, R.P.G., Introduction to Avionics Systems, 2nd Ed., Kluwer, 2003
2. Middleton, D.H., Avionic Systems, Longman Scientific and Technical, 1989
3. Blake Lock, J.H ‘Automatic control of Aircraft and missiles’, John Wiley Sons, New York, 1990Garnell.P. & East. D.J, ’Guided Weapon Control Systems’, Pergamon Press, Oxford, 1977
4. Rafael C.Gonzalez and Richard E. Woods, “Digital Image Processing’, Third Edition, Pearson Education, 2008
5. Ron Graham, Alexander Koh, “Digital Aerial Survey: Theory and Practice”, Whittles Publishing; First Edition,2002

17AE3013 AIRCRAFT MODELING LABORATORY

Credits: 0:0:1

Course Objective:

- To train the students with CAD packages like Solid Works.

- To impart the 2D and 3D modeling skills to the students.
- To enable Students to design different parts of Aircraft.

Course Outcome:
Students will be able to

- Understand the construction of various parts of wing and fuselage
- Create solid model of different types of structural components
- Create surface model of different types of structural components
- Create sheet metal model of different types of structural components
- Design and assemble different parts of propeller
- Assemble different parts of aircraft

List of Experiments:

1. Part modelling of internal structural components - wing/fuselage.
2. Modeling of typical joints.
3. Surface modeling of airframe
4. Assembly of components, joints and airframe.
5. Modeling of propeller blade(Propeller/Helicopter)
6. Modeling of hub(Propeller/Helicopter).
7. Assembly of hub and propeller blade.

17AE3014 ADVANCED AVIONICS LABORATORY

Credit: 0:0:1

Course Objective:

- To impart the knowledge about different types of Instruments and control systems
- To train students to measure parameters accurately and their importance in different applications in the field of Avionics

Course Outcome:
Students will be able to

- Familiarize Matlab and LabVIEW programming.
- Understand the applications of these fundamental measurement systems.
- Understand the enormous amount of pressure that is put on this simple instrumentation in real time applications.
- Work with the avionics systems on an aircraft
- Understand the design concept of new control systems
- Familiarize with methods of troubleshoot and rectification of faulty instruments.

List of Experiments:

1. Matlab programming of displacement autopilot for a jet airplane.
2. Matlab programming of lateral autopilot for an airplane.
3. Matlab programming of missile autopilot.
4. LabVIEW Programming of Measurement of Angular position using Gyroscope.
5. LabVIEW Programming of Measurement of Air velocity using Hot wire Anemometer
6. LabVIEW Programming of Measurement of Acceleration using Accelerometer.

7. LabVIEW Programming of Temperature measurement using thermocouple.
8. LabVIEW Programming of Temperature measurement using RTD.
9. LabVIEW Programming of Global positioning system.
10. LabVIEW Programming of Aircraft data bus communication.

17AE3015 ORBITAL SPACE DYNAMICS

Credits: 3:0:0

Course Objective:

- To impart the knowledge in two-body problem
- To impart the knowledge in restricted three-body problem
- To provide necessary knowledge to compute the orbits of satellites and interplanetary trajectories.

Course outcome:

Students will be able to

- Apply laws governing the orbital motion
- Compute the orbits of the satellites
- Study the effects of perturbations on the orbital motion
- Generate preliminary design of inter-planetary trajectories
- Understand orbital motion in restricted three-body problem
- Use knowledge of equilibrium points and its uses

Fundamental principles - Kepler's laws, Problem of two bodies - Derivation of equation of motion, Solution of Kepler’s equation, Computation of orbital elements from state vectors.
Force model, Perturbations - Oblateness, Computation of Sun-synchronous orbit, Special perturbation techniques: Cowell's and Encke's method.
Single impulse Maneuvers, Hohmann transfer, Sphere of influence, Derivation of Lambert’s theorem.
Planar circular restricted three-body problem - Equations of motion, Derivation of Jacobi integral, Tisserand's criterion for the identification of comets.
Location of equilibrium points, Characteristic equation, Motion near the collinear and the equilateral points.

References:

1. PiniGurfil, and P. Kenneth Seidelmann, “Celestial Mechanics and Astrodynamics: Theory and Practice”, Springer, 2016
2. Gerald R. Hintz, "Orbital Mechanics and Astrodynamics: Tools and Techniques", 1st Edition, 2015
3. J.M.A.Danby, “Fundamental of Celestial Mechanics” ,Inc., 2nd Edition, Willman-Bell, USA,1992
4. Victor G. Szebehely, “Theory of Orbits - The Restricted Problem of Three Bodies”, Academic Press, New York and London,1967
5. Carl D. Murray and Stanley F. Dermott, "Solar System Dynamics", Cambridge University Press, 1999

6. Vladimir A. Chobotov, "Orbital Mechanics", AIAA Education Series, AIAA Education Series, Published by AIAA, 2002
7. Howard D. Curtis, Orbital Mechanics for Engineering Students, Elsevier Butterworth-Heinemann, 2005

17AE3016 BOUNDARY LAYER THEORY

Credits 3:0:0

Course Objective:

- To introduce the concept of boundary layers and its applications
- To familiarize the students with viscous flow phenomena.
- To impart knowledge on laminar and thermal boundary layer equations

Course outcome:

Students will be able to

- Define the fundamentals Boundary layer theory
- Solve the equations involved in boundary layer theory
- Analyze the different kinds of Boundary Layer control
- Differentiate between the turbulent and laminar boundary layers
- Estimate the boundary layer thickness for flow over a different body
- Attain the knowledge of boundary layer effects in hypersonic flows

Fundamentals of boundary layer theory: Boundary layer concept-Laminar and Turbulent boundary layer on a flat plate, Boundary layer on an airfoil-separation of the boundary layer. Description of Flow fields, continuity, Momentum and Navier-Stokes equations. Energy equation, Stokes Hypothesis.

Exact solutions of Navier-Stokes equations: Steady Plane Flows-Couette-Poiseuille Flows, Jeffery- Hamel Flows , Flow past a parabolic body and circular cylinder. Steady Axisymmetric Flows-Flow at a rotating disk and Axisymmetric free jet. Unsteady Axisymmetric Flows-Vortex Decay

Laminar boundary layer equations: Boundary Layer equations, Wall friction, separation and displacement. Dimensional representation of the boundary layer equations, friction drag, Plate boundary layer. Integral relations of boundary layer-Momentum Integral equation, Energy Integral equation, Moment of Momentum Integral equations

Thermal boundary layer: Thermal boundary layers with coupling of the velocity field of the temperature field-Boundary layer equations. Compressible Boundary layers- Simple solutions of energy equation, Integral methods, Boundary layers in Hypersonic flows

Boundary layer control: Different Kinds of Boundary Layer control, Continuous suction and blowing-Massive suction, Massive Blowing, Plate flow with uniform suction or blowing, Airfoil. Three –Dimensional boundary layers-boundary layer at cylinder, Boundary layer at a yawing cylinder.

References:-

1. Schlichting, Herrmann, Gersten, Klaus Translated by Mayes-"Boundary Layer Theory" 8th rev. and enlarged ed. 2000
2. Frank White, "Viscous Fluid flow" – McGraw Hill, 2005
3. Pantan, R. L., "Incompressible Flow", Willey Student Edition, 2009

4. Ian. J. Sobey, “Introduction to interactive Boundary Layer Theory”, Oxford University Press, USA, 2001
5. Ronald L., Panton, “Incompressible fluid flow”, John Wiley & Sons, 2005
6. J. Reynolds, “Turbulent flows in Engineering”, John Wiley & Sons, 1992
7. TuncerCebeci and Peter Bradshaw, “Momentum transfer in boundary layers”, Hemisphere Publishing Corporation, 1977

17AE3017 THEORY OF ELASTICITY

Credits: 3:0:0

Course Objective:

- To impart an understanding of the basic concepts of stress, strain, displacement and transformations
- To provide the in-depth knowledge in formulating stress and strain equations
- To solve two-dimensional elasticity problems

Course Outcome:

Students will be able to

- Understand the elastic properties of solids
- Get the knowledge in various elasticity theory
- Formulate the governing equations of elastic behaviour for real problem
- Calculate the stresses in simplified form
- Constitute elasticity equations in polar form to solve axisymmetric problems
- Predict stress distribution of various section due to torsional load

Assumptions in elasticity: Definitions- notations and sign conventions for stress and strain, Components of stress and strain, Hooke’s law, Plane stress and Plane strain, Equations of equilibrium.

Basic equations of elasticity: Strain – displacement relations, Stress – strain relations, Lame’s constant – cubical dilation, Compressibility of material, bulk modulus, Shear modulus, Compatibility equations for strains, Principal stresses and principal strains, Mohr’s circle, Saint Venant’s principle.

Plane stress and plane strain problems: Airy’s stress function, Bi-harmonic equations, Polynomial solutions, Simple two-dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams, etc.

Polar coordinates: Equations of equilibrium, Strain displacement relations, Stress – strain relations, Axi – symmetric problems, Kirsch, Michell’s and Boussinesque problems.

Torsion: Navier’s theory, St. Venant’s theory, Prandtl’s theory on torsion, The semi- inverse method and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections.

References:

1. Enrico Volterra& J.H. Caines, “Advanced Strength of Materials”, Prentice Hall New Jersey, 2001.
2. Timoshenko, S., and Goodier, T.N., “Theory of Elasticity”, Tata McGraw–Hill Education,2001.
3. R.C. Ugural, S.K. Fenster . “Advanced strength and applied elasticity”, Elsevier, 2003

4. S.Timoshenko, “Strength of material part-2”, East-West press pvt.Ltd, .N. Delhi, 1991
5. Egor P. Popov, “ Engineering Mechanics Of Solids”, 2 Edition, Prentice-Hall, 2002
6. James M. Gere, Stephen Timoshenko, “Mechanics of Materials” 2 Edition CBS, Publisher, 2004

17AE3018 AIRCRAFT DESIGN

Credits: 3:0:0

Course Objective:

- To impart knowledge about inputs required for Aircraft design
- To introduce methodology for aerodynamic design of aircraft
- To introduce power plant selection to meet performance requirements
- To introduce the methodology for structural design of aircraft

Course Outcome:

Students will be able to:

- Design an aircraft/Spacecraft with given configuration
- Estimate the design parameters required for its better performance
- Understand the design requirements of the Aircraft
- Analyze the weight estimation characteristics
- Understand the configuration of fuselage structures
- Analyze the Materials selection for the Aircraft Components

Categories and types of aircrafts – various configurations – Layouts and their relative merits – strength, stiffness, fail-safe and fatigue requirements – Maneuvering load factors – Gust and maneuverability envelopes – Balancing and maneuvering loads on tail planes.
Characteristics of different types of power plants – Propeller characteristics and selection – Relative merits of location of power plant.
Selection of geometric and aerodynamic parameters – Weight estimation and balance diagram – Drag estimation of complete aircraft – Level flight, climb, takeoff and landing calculations – range and endurance – static and dynamic stability estimates – control requirements.
Layout peculiarities of subsonic and supersonic aircraft – optimization of wing loading to achieve desired performance, loads on undercarriages and design requirements.
Estimation of loads on complete aircraft and components – Structural design of fuselage, wings and undercarriages, controls, connections and joints, Materials for modern aircraft – Methods of analysis, testing and fabrication.

References:

1. D.P. Raymer, “Aircraft conceptual design”, AIAA Series, 2012.
2. DarrolStinton, “The Design of the airplane” Oxford BSP Professional Books,1993E. Torenbeek, “Synthesis of Subsonic Airplane Design”, Delft University Press, London, Springer, 2010.
3. H.N.Kota, Integrated design approach to Design fly by wire” Lecture notes Interline Pub., Bangalore, 1992.
4. E.F. Bruhn, “Analysis and Design of Flight Vehicle Structures”, Tristate Offset Co., U.S.A., 1980.

5. A.A. Lebedenski, “Notes on airplane design”, Part-I, I.I.Sc., Bangalore, 1971.
6. G. Corning, “Supersonic & Subsonic Airplane Design”, 4th Edition, Edwards Brothers Inc., Michigan, 1989.

17AE3019 ROCKETS AND MISSILES

Credits: 3:0:0

Course Objective:

- To impart the knowledge on rocket and missile aerodynamics
- To impart the knowledge on rocket and missile in free space and gravitational field
- To impart the knowledge on staging & control of rockets

Course Outcome:

Students will be able to

- Discuss types of rockets and missiles with respect to Indian & international scenario
- Understand aerodynamics of rocket and missiles
- Design the basic staging of rockets and missiles
- Estimate the rocket motion in free space and gravitational field
- Understand the control of rockets missiles
- Design the basic launch vehicle

Classification of rockets and missiles: Various methods of classification of missiles and rockets – Basic aerodynamic characteristics of surface to surface, surface to air, air to surface and air to air missiles – Examples of various Indian space launch vehicles and missiles – Current status of Indian rocket programme with respect to international scenario.

Aerodynamics of rockets and missiles: Airframe components of rockets and missiles – forces acting on a missile while passing through atmosphere – classification of missiles – slender body aerodynamics – method of describing forces and moments – lift force and lateral moment – lateral aerodynamic damping moment – longitudinal moment – drag estimation – upwash and downwash in missile bodies – rocket dispersion.

Rocket motion in free space and gravitational field: One dimensional and two-dimensional rocket motions in free space and homogeneous gravitational fields – description of vertical, inclined and gravity turn trajectories – determination of range and altitude – simple approximations to determine burn out velocity and altitude – estimation of culmination time and altitude.

Staging of rockets and missiles: Design philosophy behind multi-staging of launch vehicles and ballistic missiles – optimization of multi-stage vehicles – stage separation techniques in atmosphere and in space – stage separation dynamics and lateral separation characteristics.

Control of rockets and missiles: Introduction to aerodynamic and jet control methods – various types of aerodynamic control methods for tactical and short range missiles- aerodynamic characteristics - various types of thrust vector control methods including secondary injection thrust vector control for launch vehicles and ballistic missiles.

References

1. George P.Sutton, and Oscar Biblarz, Rocket Propulsion Elements, John Wiley & Sons Inc., New York, 8th Edition, 2010.
2. Ashish Tewari, Atmospheric and Space Flight Dynamics, Birkhauser, 2007.

3. E. Roy, Orbital Motion, Fourth Edition, IOP Publishing Ltd 2005.
4. J. W. Cornelisse, H.F.R. Schoyer, and K.F. Wakker,. Rocket Propulsion and Spaceflight Dynamics, Pitman, 2001.
5. William E.Wiesel, Spaceflight Dynamics, McGraw-Hill, 3rd Edition, 2010.
6. Howard D. Curtis, Orbital Mechanics for Engineering Students, ELSEVIER, Butterworth, Heinemann, 3rd Edition, 2013.

17AE3020 UNMANNED AERIAL SYSTEMS

Credits: 3:0:0

Course Objective:

- To incorporate awareness about the basic terminology, models and prototypes of UAV system
- To impart the knowledge on design considerations of UAV systems
- To be able to design a UAV system for specific requirements

Course Outcome:

Students should be able to:

- Understand the basic terminologies and classification of UAS
- Relate the design parameters of UAV systems
- Obtain knowledge on the application of aerodynamic principles to design UAS
- Understand the principles of communication systems used in UAVs
- Obtain knowledge on payloads and launch systems for UAS
- Apply the principles to design UAS for specific applications

Introduction to Unmanned Aircraft Systems (UAS) – Systematic basis of UAS – System composition - Categories and Roles – Elements of UAS – Unmanned Aircraft system operations
Design and selection of UAS – Aerodynamics and airframe configurations – Aspects of airframe design - Unmanned Aircraft characteristics – Long range, Medium and Close range UAVs – Mini, Micro and Nano UAVs – Novel hybrid combinations
Unmanned Design standards and Regulatory aspects – Airframe design – Ancillary equipment – Design of Stealth
Sensors and payloads – payload types – Communications, Control and stability, Navigation – Launch and recovery
Certification and ground testing – inflight testing - Human factors in UAS – Future of UAS and challenges

References:

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, Douglas M. Marshall, Eric Shappee, "Introduction to Unmanned Aircraft systems", CRC press, Taylor and Francis, New York, 2012. Richard Microcontroller Systems for a UAV, A. Skafidas, 2002.
3. Paul.G.Fahlstrom, Thomas.J.Gleason Introduction to UAV systems, UAV SYSTEMS, Ins.. 2013.

4. Armand.J. Chaput, “Design of UAV Systems” , Lockheed Martin Aeronautics Company, 2001.

17AE3021 FINITE ELEMENT ANALYSIS FOR AEROSPACE STRUCTURAL APPLICATION

Credits: 3:0:0

Course Objective:

- To impart the basic concept of finite element Analysis (FEA)
- To provide the knowledge on various finite element procedures and solution techniques
- To impart the basic knowledge in FEA programing for Aerospace structural problems

Course Outcome:

Students will be able to

- Understand the different numerical solution to the FEA Problems
- Analyse the discrete and continuum problem using finite element method
- Identify the boundary condition for various aerospace structural problems.
- Program the various type of elements to solve different type of problems
- Solve the one dimension, Two dimensional and Three dimensional problems
- Find the solution for various complex problem in aerospace structures

Approximation Techniques in Finite Element Analysis (FEA): History and Stages of Finite Element Method, Approximation Techniques in FEA: Methods of Weighted Residual, Weak Formulation, Piecewise Continuous Trial Function, Galerkin’’s Finite Element Formulation, Variational Method, Rayleigh-Ritz Method; MATLAB/SCI-LAB programming- Application to Approximation Techniques.

Two-Dimensional and Isoparametric Elements: Governing Equation, Linear Triangular Element, Bilinear Rectangular Element, Boundary Integral, Axisymmetric Analysis. Application to 2-D Steady State Analysis, Axisymmetric Analysis and Transient Analysis. One-Dimensional Elements, Quadrilateral Elements, Triangular Elements, Gauss Quadrature, MATLAB/SCI-LAB programming- Application to Gauss Quadrature.

Truss and Beam Structures: One-Dimensional Truss, Plane Truss, Space Truss, MATLAB Application to Static Analysis, Eigen Value Analysis and Transient Analysis. Euler-Bernoulli Beam, Beam Elements with only displacement degrees of freedom, MATLAB/SCI-LAB programming- Application to Static Analysis, Eigenvalue Analysis and Transient Analysis.

Elasticity Problems: Plane Stress and Plane Strain, Force Vector, Energy Method, Three-Dimensional Solid, Axisymmetric solid, Dynamic Analysis, MATLAB/SCI-LAB programming- Application to 2-D Stress Analysis, Axisymmetric Analysis,3-D Stress Analysis.

Plate Structures: Classical Plate Theory, Classical Plate Bending Elements, Shear Deformable Plate Element, Plate Element with Displacement Degrees of Freedom, Mixed Plate Element, Hybrid Plate Element , MATLAB/SCI-LAB programming- Application.

References:

1. Robert D. Cook, David S. Malkus, Michael E. Plesha, “Concepts and Applications of Finite Element Analysis”, John Wiley and Sons , 2007.

2. Young W.Kwon, HyochoongBang,'The Finite Element Method using MATLAB', CRC Press LLC, USA,1997.
3. Segerlind,L.J. "Applied Finite Element Analysis", Second Edition, John Wiley and Sons Inc., New York, 1984.
4. J.N. Reddy , "An Introduction to the Finite Element Method,", McGraw-Hill International Editions, 3rd ed., 2009
5. Tirupathi R. Chandrupatla and Ashok D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall, 2002
6. Rao S.S., "Finite Element Methods in Engineering", Pergamon Press, 4th Ed., 2005.
7. Roy R. Craig, Jr., "Structural Dynamics: An Introduction to Computer Methods," John Wiley and Sons, 1981.

17AE3022 ELEMENTS OF AEROSPACE ENGINEERING

Credits: 3:0:0

Course Objectives:

- To introduce the basic concepts of aircrafts, rockets, satellites and their application
- To familiarize with the basic parts and their function and construction
- To provide knowledge and understanding of aerospace materials

Course Outcomes:

Students will be able to

- Understand standard atmosphere and properties
- Understand Principles of flight
- Get Knowledge in aerodynamic shapes
- Understand Aerospace materials and aircraft structural component
- Classify the Aircraft instrumentation systems
- Categorize the Power plants used in various aircraft

History of aviation: Early flying vehicles – hot air balloons – heavier than air flying machines - Classification of flight vehicles, airplanes and Helicopters – Components of an airplane and their functions.

Basics of flight : International Standard Atmosphere, Temperature, pressure and altitude relationships, lift, drag and moment, Airfoil nomenclature, Flow characteristics of airfoils, NACA nomenclature, propagation of sound, Mach number, subsonic, transonic, supersonic, hypersonic flows.

Aircraft Structures: General types of construction, Monocoque and Semi monocoque - construction, typical wing and fuselage Structures - Materials used in Aircraft.

Systems and instruments: Conventional control, Powered controls, Basic instruments for flying, typical systems for control actuation.

Power plants used in aircrafts: Basic ideas about piston, turboprop and jet engines – comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.

References

1. John D Anderson Jr, “Introduction to Flight”, Tata McGraw Hill Education Private Limited, New Delhi, 5th Edition, 2009.
2. A.C Kermode, “Flight without Formulae”, Pearson Education, 5th Edition, 2008.
3. **C**ourse material of Faculty Enablement Programme on “Introduction to Aircraft Industry”, conducted by Infosys, Mysore through Campus connect programme.
4. Manuel Soler, “Fundamentals of Aerospace Engineering”, Createspace Independent Publishing, Platform, 2014.
5. Stephen Corda, “Introduction to Aerospace Engineering with a flight test”, John Wiley & Sons, UK, 2017.
6. Shevell, R.S., “Fundamentals of flights”, Pearson education 2004.