AEROSPACE ENGINEERING

ADDITIONAL SUBJECTS

Code	Name of the Subject	Credits
09AE201	Introduction to Aerospace Engineering	4:0:0
09AE202	Aircraft Structures	3:1:0
09AE203	Aircraft Structures Laboratory I	0:0:2
09AE204	Aircraft Structures Laboratory II	0:0:2
09AE205	Aerodynamics	4:0:0
09AE206	Aerodynamics Laboratory	0:0:2
09AE207	Gas Dynamics	4:0:0
09AE208	Space Dynamics	4:0:0
09AE209	Aircraft Propulsion	4:0:0
09AE210	Propulsion Lab	0:0:1
09AE211	Advanced Propulsion Systems	4:0:0
09AE212	Instrumentation & Control Systems	4:0:0
09AE213	Instrumentation & Control Laboratory	0:0:2
09AE214	Navigation, Guidance and Control	4:0:0
09AE215	Aircraft Stability and Control	4:0:0
09AE216	Aircraft Performance	4:0:0
09AE217	Aircraft Design Project	0:0:4
09AE218	CFD Laboratory	0:0:2
09AE219	CAD Laboratory	0:0:2
10AE201	Introduction to Aircraft Industry and Aircraft Systems	4:0:0
10AE202	Basics of Aerospace Engineering	3:0:0

09AE201 INTRODUCTION TO AEROSPACE ENGINEERING

Credits: 4:0:0

Course Objectives:

1. To introduce the basic concepts of aircrafts, rockets, satellites and their application
2. To familiarise with the basic parts and their function and construction details
3. To introduce the basics of aerodynamics, propulsion, materials, maneuvers, trajectories & orbits and flight testing
4. To familiarise with the national and international aeronautical and aerospace agencies

Course Outcomes:

Ability to

1. understand nature of aerospace technologies,
2. understand various types of aerospace vehicles, satellites and their applications,
3. Appreciation of various national and international aerospace agencies

Unit I

Early airplanes, Rockets, Developments in aerodynamics, materials, structures and propulsion over the years. Introduction to Ramjet and Scramjet. Different types of flight vehicles and Classifications, Conventional Control and Powered controls, Basic instruments for flying.

Unit II

Nomenclature used in aerodynamics, different parts of airplane, Aerodynamic forces on a wing. Lift and drag force, lift to drag ratio**.** Moment coefficients. Center of Pressure, Aerodynamics of wing. Sources of drag. Aircraft performance parameters, performance in steady flight, accelerated flight, air planes static stability and dynamic stability – longitudinal and lateral stability.

Unit III

General types of construction, Typical wing and fuselage structure. Metallic and non-metallic materials, Use of aluminium alloy, titanium, stainless steel and composite materials. Basic ideas about piston, turboprop and jet engines, Use of propeller and jets for thrust production. Comparative merits,

Unit IV

Principles of operation of rocket, types of rockets and typical applications, Exploration into space.

Satellite Missions and introduction to orbital dynamics, Different types of satellites and their applications, Spacecraft configurations: structures, Systems and subsystems identifications and functions of each, Spacecraft environment.

Unit V

Introduction to flight-testing: Purpose and Scope of Flight Testing, Types of Wind Tunnels, airport layout and terminologies. Introduction to aerospace industries – Research and Development organizations and Academic institutions in India and worldwide.

Text Books:

1. Anderson, J.D., "Introduction to Flight", McGraw-Hill, 1995.

2. Kermode A C: Mechanics of Flight, Pearson Education Low Price Edition, 2005.

Reference Books:

1. Khanna, Arora and SS. Jain, "Airport Planning and Design" NemChand and Brother, Roorkee, 1999
2. Chenna Keshu S and Ganapathy K K: Aircraft Production Technology and Management, Interline Publishing, Bangalore 1993
3. Kermode, A.C., "Flight without Formulae", McGraw-Hill, 1997.
4. The Basics of Satellite Communications by Joseph N. Pelton, International engineering consortium, (2003) Chicago, Illinois

09AE202 AIRCRAFT STRUCTURES

Credits: 3:1:0

Course Objectives:

1. To introduce the various structural components of aircrafts and aerospace vehicles
2. To study their behaviour under various types of loads
3. To familiarise with different types of beams and columns subjected to various types of loading and support conditions

Course Outcomes:

Ability to

1. appreciate structural design methods for aerospace vehicles,
2. identify various types of structural components and their loading pattern,
3. understand theoretical approaches

Unit I Shear Flow in Open and Closed Sections

Concept of shear flow, shear centre, Elastic axis. With one axis of symmetry, with wall effective and ineffective in bending, unsymmetrical beam sections. Bredt – Batho formula, Shear flow in single & multicell structures under torsion.

Unit II Stress Analysis in Wing And Fuselage

Procedure – Shear and bending moment distribution for semi cantilever and other types of wings and fuselage, thin webbed beam. With parallel and non parallel flanges, Shear resistant web beams, Tension field web beams (Wagner's).

Unit III Statically Determinate and Indeterminate Structures

Analysis of plane truss – Method of joints – 3 D Truss. Composite beam - Clapeyron's Three Moment Equation - Moment Distribution Method.

Unit IV Energy Methods

Strain Energy due to axial, bending and Torsional loads - Castigliano's theorem - Maxwell's Reciprocal theorem, Unit load method - application to beams, trusses, frames, rings, etc.

Unit V Columns

Columns with various end conditions – Euler's Column curve – Rankine's formula, Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum Strain energy theory – Application to aircraft Structural problems.

Text Books

1. Peery, D.J., and Azar, J.J., "Aircraft Structures", 2nd edition, McGraw–Hill, N.Y., 1993
2. Donaldson, B.K., "Analysis of Aircraft Structures – An Introduction", McGraw-Hill, 1993.

Reference Books

1. Megson, T.M.G., "Aircraft Structures for Engineering Students", Edward Arnold, 1995.
2. Bruhn. E.H. "Analysis and Design of Flight vehicles Structures", Tri – state off set company, USA, 1985.
3. Rivello, R.M., "Theory and Analysis of Flight Structures", McGraw-Hill, 1993.
4. Timoshenko, S., "Strength of Materials", Vol. I and II, Princeton D. Von Nostrand Co, 1990.

09AE203 AIRCRAFT STRUCTURES LABORATORY I

Credits: 0:0:2

Course Objectives:

1. To introduce the basic testing equipments for various structural components subjected to static loads
2. To familiarise with the measuring equipment and sensors
3. To familiarise with the test procedures

Course Outcomes:

Ability to

1. select test equipment for different types of static loading ,
2. mount sensors and measuring equipment,
3. conduct tests, analyse results and document
4. Compare with analytical/theoretical results

Experiments to familiarize

1. Tensile testing using UTM, Mech. & Optical extensometers, Stress Strain curves and strength tests for Steel
2. Tensile testing using UTM, Mech. & Optical extensometers, Stress Strain curves and strength tests for Aluminum
3. Bending tests, Stress and Deflection of Cantilever beams, verification of Maxwell's and Castigliano's theorems. Influence coefficients.
4. Bending tests, Stress and Deflection of beams for Simplified supported ends, verification of Maxwell's and Castigliano's theorems. Influence coefficients.
5. Bending tests, Stress and Deflection of beams under pure bending moment, verification of Maxwell's and Castigliano's theorems. Influence coefficients.
6. Tensile Tests on riveted joints.
7. Tensile Tests on bolted joints.
8. Compression tests on short columns. Critical buckling loads, Euler load by Southwell plot, influence lines, moment indicator, and frame analysis.
9. Compression tests on long columns. Critical buckling loads, Euler load by Southwell plot, influence lines, moment indicator, and frame analysis.
10. Compression tests on thin-walled open sections. Critical buckling loads, Euler load by Southwell plot, influence lines, moment indicator, and frame analysis.

11. Shear centre for Closed thin walled section
12. Shear centre for open thin walled section

09AE204 AIRCRAFT STRUCTURES LABORATORY II

Credits: 0:0:2

Course Objectives:

1. To introduce the basic testing equipments for various structural components subjected to dynamic loads
2. To familiarise with the measuring equipment and sensors
3. To familiarise with the test procedures

Course Outcomes:

Ability to

1. select test equipment for different types of static loading ,
2. mount sensors and measuring equipment,
3. conduct tests, analyse results and document
4. Compare with analytical/theoretical results

Experiments to familiarize

1. Determination of Natural frequency and mode shape of plate (cantilever)– Excitation on line symmetry
2. Determination of Natural frequency and mode shape of plate (cantilever)– Excitation away from line symmetry
3. Determination of Natural frequency and mode shape of plate (Fixed at one edge and simply supported at other edge) – Excitation on line symmetry
4. Determination of Natural frequency and mode shape of plate (Fixed at one edge and simply supported at other edge)– Excitation away from line symmetry
5. Determination of Natural frequency and mode shape of composite plate (cantilever)– Excitation on line symmetry
6. Determination of Natural frequency and mode shape of honeycomb panel (cantilever)– Excitation on line symmetry
7. Determination Natural frequency and mode shape of beam - One end fixed, other end free
8. Determination Natural frequency and mode shape of beam - One end fixed, other end simply supported
9. Determination Natural frequency and mode shape of beam - Both ends fixed,
10. Bending tests, Stress and Deflection of Cantilever Composite beams, verification of Maxwell's and Castigliano's theorems. Influence coefficients
11. Bending tests, Stress and Deflection of Simply supported Composite beams, verification of Maxwell's and Castigliano's theorems. Influence coefficients
12. Bending tests, Stress and Deflection of Composite beams under pre bending moment, verification of Maxwell's and Castigliano's theorems. Influence coefficients

09AE205 AERODYNAMICS

Credits: 4:0:0

Course Objective:

1. To introduce the basics of air flow
2. To familiarise with the airfoils and wings and the flow over them
3. To introduce concepts of forces and moments on flying vehicles under various flight regimes
4. To familiarise with the flow measurement techniques

Course Outcome:

Ability to

1. Understand the flow behavior over aircraft components
2. Assess the forces and moments due to flow
3. Devise the methods for flow/force measurement

Unit I Basics

Wing and Airfoil section geometry - Aerodynamic forces and moments-Force and Moment components and coefficients, Pressure distribution on an airfoil, Types of Drag, Estimation of lift, Drag and pitching moment coefficient from the pressure Distribution. Experimental methods,

Unit II Elementary Flows

Incompressible flow condition, Governing equation for irrotational, incompressible flow: Laplace's equation, Boundary conditions. Elementary flows. Combination of uniform flow with a Source and Sink, Doublet, Flow over a circular cylinder, Vortex flow. Circulation, Kutta-Joukowski theorem, Lifting flow over a cylinder, the vortex sheet. Kelvin circulation theorem

Unit III Drag and Thrust Evaluations

Drag of aerospace vehicle components. Total drag estimation, Methods of drag Reduction, Propellers, Performance analysis. Aerospace engines reciprocating, turbine and rockets. Design features. Performance characteristics.

Unit IV Aircraft Performance in Steady Flight

Level flight, Stall, Cruise, Maximum speed, Ceiling, Cruise climb, Range and Endurance. Climb performance, Performance optimization, Take off and landing Performance.

Unit V Flow Measurements and Model Testing

Non-dimensional parameters, Similarity of flows. Model testing in wind tunnels. Pressure, Velocity measurements – Hotwire and Laser – Doppler anemometer, Turbulence measurements. Flow visualization, Force measurements – Wind tunnel balances

Text Books:

1. John D. Anderson, Jr., "Fundamentals of Aerodynamics", Third edition, McGraw-Hill publications, 2001
2. Anderson J.D., "Introduction to Flight", McGraw Hill, 1987.

References:

1. E L Houghton and PW Carpenter, "Aerodynamics for Engineering students", Fourth edition, Edward Arnold publications, 1993.
2. Kermode A.C., "Flight without Formulae", McGraw Hill, 1985.
3. Theory of wing sections by Ira Herbert Abbott, Albert Edward Von Doenhoff, 1959

edition.
4. High speed wind tunnel testing by Alan Pope, R.L. Goin, Kennith L. Goin, 1965 edition.
5. Low speed wind tunnel testing by Alan Pope, William H. Rae, 1984
6.

09AE206 AERODYNAMICS LABORATORY

Credits: 0:0:2

Course Objectives:

1. To familiarize with various experimental facilities
2. To familiarize with different sensors and measurement techniques
3. To conduct the test, acquire the data and analyse and document

Course Outcomes:

Ability to

1. To choose proper experimental facilities
2. To configure the experiment and conduct the test
3. To draw inferences from acquired data

- Visualization of flow over 2D and 3D bodies by tuft & smoke methods
- Pressure distribution over 2D and 3D bodies

LIST OF EXPERIMENTS

1. Evaluation of test section speed versus fan speed characteristics of the subsonic wind tunnel by test section static pressure and pitot measurements.
2. Smoke visualization of flow over symmetric airfoil at 0, 5, 10, 15, 20 and 25 degree angle of attack at 20 m/s.
3. Smoke visualization of flow over cambered airfoil at 0, 5, 10, 15, 20 and 25 degree angle of attack at 20 m/s.
4. Smoke visualization of flow over a cylinder at 20, 25 and 30 m/s.
5. Smoke visualization of flow over a car model at 0and 5 degree yaw at 20 m/s.
6. Smoke visualization of flow over an aircraft model at 0, and 10 degree angles of attack and 0 and 5 degree yaw angles at 20 m/s.
7. Pressure measurement on the surface of a symmetric airfoil at 0 degree angle of attack at 20 m/s.
8. Pressure measurement on the surface of a symmetric airfoil at 5 degree angle of attack at 20 m/s.
9. Pressure measurement on the surface of a cambered airfoil at 0 degree angle of attack at 20 m/s.
10. Pressure measurement on the surface of a cambered airfoil at 5 degree angle of attack at 20 m/s.
11. Pressure measurement on the surface of a cylinder 20 m/s.
12. Pressure measurement in wake region of a cylinder at 3 downstream locations 20 m/s.

Reference Book:

1. Alan Pope, John Joseph Harper, William H. Rae and Jewell Barlow, " Low Speed Wind Tunnel Testing", Published March 3rd 1999 by John Wiley and Sons Ltd

09AE207 GAS DYNAMICS

Credits: 4:0:0

Course Objectives:

1. To familiarize with behavior of compressible gas flow
2. To understand the difference between subsonic and supersonic flow
3. To familiarize with high speed test facilities

Course Outcomes:

Ability to

1. To distinguish between various flow regimes
2. To analyse the flow under different flow conditions
3. To assess the flow behavior and consequent loads due to flow

Unit I One Dimensional Compressible Flow

Energy, Momentum, continuity and state equations, velocity of sound, Adiabatic steady state flow equations, Flow through converging, diverging passages, Performance under various back pressures.

Unit II Normal, Oblique Shocks and Expansion Waves

Prandtl equation and Rankine – Hugonoit relation, Normal shock equations, Pitot static tube, corrections for subsonic and supersonic flows, Oblique shocks and corresponding equations, Hodograph and pressure turning angle, shock polars, flow past wedges and concave corners, strong, weak and detached shocks, Rayleigh and Fanno Flow. Flow past convex corners, Expansion hodograph, Reflection and interaction of shocks and expansion, waves, Families of shocks, Methods of Characteristics, Two dimensional supersonic nozzle contours.

Unit III Differential Equations of Motion for Steady Compressible Flows

Small perturbation potential theory, solutions for supersonic flows, Mach waves and Mach angles, Prandtl-Glauert affine transformation for subsonic flows, Linearised two dimensional supersonic flow theory, Lift, drag pitching moment and center of pressure of supersonic profiles.

Unit IV Airfoil in High Speed Flows

Lower and upper critical Mach numbers, Lift and drag divergence, shock induced separation, Characteristics of swept wings, Effects of thickness, camber and aspect ratio of wings, Transonic area rule, Tip effects.

Unit V High Speed Wind Tunnels

Blow down, indraft and induction tunnel layouts and their design features, Transonic, supersonic and hypersonic tunnels and their peculiarities, Helium and gun tunnels, Shock tubes, Optical methods of flow visualization.

Text Books:

1. Rathakrishnan, E., “Gas Dynamics”, Prentice Hall of India, 2008
2. Liepmann H W and Roshko A, Elements of Gasdynamics, John Willey & Sons,2001

Reference Books:

1. Shapiro, A.H., “Dynamics and Thermodynamics of Compressible Fluid Flow”, Ronold Press, 1982.

2. Zucrow, M.J. and Anderson, J.D., "Elements of gas dynamics", McGraw-Hill Book Co., NY, 1989.
3. Mc Cornick. W., "Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, NY, 1979.
4. Anderson Jr., D., – "Modern compressible flows", McGraw-Hill Book Co., New York 1999.

09AE208 SPACE DYNAMICS

Credits: 4:0:0

Course Objectives:

1. To familiarize with the performance, stability and control of rockets
2. To introduce the Solar system, Reference frames and times
3. To familiarize with various factors effecting the satellite orbits

Course Outcomes:

Ability to

1. To estimate the trajectory and performance of the vehicle
2. To use proper reference coordinate system for space vehicle analysis
3. To generate Preliminary design of inter-planetary trajectory

Unit I

Performance of single and multistage rockets, staging, separation of stages.

Unit II

Rocket Stability and control: Definition of stability, equilibrium, definition of static and dynamic stability; Static Longitudinal Stability and Control , Lateral and directional Stability and Control. Dynamic Stability

Unit III

The solar system - Reference frames and coordinate systems - The celestial sphere - The ecliptic - Motion of vernal equinox - Sidireal time - Solar time - Standard time - The earth's atmosphere. Space environment - Peculiarities -Effect of space environment on the selection of materials of spacecraft.

Unit IV

General Aspects of satellite Injections – Satellite Orbit Transfer –Various Cases – Orbit Deviations Due to Injection Errors – Special and General Perturbations – Cowell's Method – Encke's Method – Method of vibrations of Orbital Elements – General Perturbations Approach.

Unit V

Two dimensional interplanetary trajectories - Fast interplanetary trajectories - Three dimensional interplanetary Trajectories - Launch of interplanetary spacecraft, Trajectory geometry - Optimal flights - Time of flight .

Text Books:

1. "Rocket Propulsion Elements", Sutton, G.P. John Wiley, 2009.

2. ”Rocket Propulsion and Spaceflight Dynamics”, J.W.Cornelisse, H.F.R. Schoyer, and K.F. Wakker, Pitman, 2001

Reference Books:

1. “Orbital Mechanics”, Vladimir A. Chobotov, AIAA Education Series, AIAA Education Series, Published by AIAA, 2002
2. ”Fundamentals of Astrodynamics and Applications”, David.A. Vellado, Microcosm and Kluwer, 2001
3. ”Spaceflight Dynamics”, William E.Wiesel, McGraw-Hill, 1997
4. “Elements of Astromechanics”, Van de Kamp, P,Pitman, 1979.
5. Parker E.R., “Materials for Missiles and Spacecraft”, McGraw-Hill Book Co. Inc., 1982. Koelle, Astronatical Engineers Hand book,

09AE209 AIRCRAFT PROPULSION

Credits: 4:0:0

Course Objectives:

1. To familiarize with Principles of Propulsion
2. To introduce working principles of Compressors and turbines
3. To familiarize with the concept of Matching of compressors and turbines and Off-design performance

Course Outcomes:

Ability to

1. To assess the performance of different Propulsion cycles.
2. To assess the performance of various sub-systems of the propulsion system and their matching
3. To understand the causes of under-performance and remedial measures

Unit I

Introduction: Review of thermodynamic concepts, Principles of jet propulsion, Working cycles and airflow, Operational envelope and standard atmospheres.

Unit II

Centrifugal Compressors: Basic concepts, Principle of operation, Work done and pressure rise, compressibility effects, Compressor characteristics.

Axial flow Compressors: Basic operation & Elementary theory. Factors affecting static pressure ratio, Degree of reaction, Off-design performance, Axial flow compressor characteristics.

Unit III

Combustion systems: Operational requirements, Types of Combustion systems, some important factors affecting combustor design.

Axial and Radial flow Turbines: Elementary theory, Vortex theory. Choice of blade profiles, Pitch and Chord, Estimation of Stage performance. Overall turbine performance.

Unit IV

Afterburners: Afterburner Components, diffuser, Fuel Injection, Atomisation and Vaporization, Ignition, Flame stabilization. Afterburner liner, Total pressure loss, Afterburner Design Parameters.
Inlets and Exhaust nozzles: Introduction to Inlets and Nozzles. Inlets- Types Subsonic Inlet, Supersonic Inlets, Exhaust nozzles.

Unit V
Prediction and Performance of Simple gas Turbines: Component characteristics. Off-design operation of the Single Shaft Gas Turbine, Equilibrium running of a Gas Generator. Off-design operation of Free Turbine Engine, Incorporation of variable running losses.
Performance prediction turbo-fan engines: Matching Procedures for turbo-fan engine. Some notes on the behaviour of twin-spool engines, Transient behaviour of Gas Turbines, Principles of Control systems.

Text Books:
1. V. Ganesan, Gas Turbines, Tata Mc Graw - Hill Publishing Company Ltd 1999.

Reference Books:
1. J.D Mattingly, William H. Heiser & David T. Pratt Aircraft Engine Design (AIAA Education Series), AIAA, Dec 2002 ISBN - 1563475383.
2. Rolls Royce Plc, The Jet Engine, 1996, ISBN 090212235
3. E. Irwin Treager, Aircraft Gas Turbine Engine Technology, 3rd Edition 1995 'ISBN-00201828
4. H. Cohen & F.C Rogers and H.I.H Saravana muthu, Gas Turbine Theory, Edition, Longman 2001.
5. Marcel Barrere, Rocket Propulsion, Elsevier,1960

09AE210 PROPULSION LAB

Credit: 0:0:1

Course Objectives:
1. To introduce the concept of combustion and related issues
2. To assess the performance of rocket motors

Course Outcomes:
Ability to
1. To design the experiment for rocket motor performance
2. To assess the real lie situation and corrective measures associated with rocket motors

LIST OF EXPERIMENTS

1. Estimation of Performance of a Rocket motor –To measure the thrust of the rocket motor and correlate to the chamber pressure and nozzle parameters
2. Ignition Delay Studies –To estimate the time required for a propellant combination to ignite and sustain combustion
3. Studies regarding Injector Performance – To assess the performance of the injectors of various types, their flow and atomization characteristics
4. Storage losses in an insulated liquid Oxygen tank

5. Impingement and cooling requirement of a Rocket exhaust over a 'J' type jet deflector, thermal response of the deflector
6. Measurement of nozzle heat flux in a convergent-divergent nozzle

09AE211 ADVANCED PROPULSION SYSTEMS

Credits: 4:0:0

Course Objectives:

1. To introduce the concepts of Rocket Propulsion
2. To introduce the concept of combustion in RAM Jet and SCRAM Jet
3. To familiarize with Advanced propulsion Techniques

Course Outcomes:

Ability to

1. To assess the performance of rocket propulsion system
2. To understand the need for different propulsion systems and their usage
3. To make preliminary design of propulsion system

Unit I AIRCRAFT GAS TURBINES

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 – Numerical problems.

Unit II RAMJET PROPULSION

Operating principle – Sub critical, critical and supercritical operation – Combustion in ramjet engine – Ramjet performance – Sample ramjet design calculations – Introduction to scramjet – Preliminary concepts in supersonic combustion – Integral ram- rocket- Numerical problems.

Unit III FUNDAMENTALS OF ROCKET PROPULSION

Operating principle – Specific impulse of a rocket – internal ballistics- Rocket nozzle classification – Rocket performance considerations – Numerical Problems.

Unit IV CHEMICAL ROCKETS

Solid propellant rockets – Selection criteria of solid propellants – Important hardware components of solid rockets – Propellant grain design considerations – Liquid propellant rockets – Selection of liquid propellants – Thrust control in liquid rockets – Cooling in liquid rockets – Limitations of hybrid rockets – Relative advantages of liquid rockets over solid rockets- Numerical Problems.

Unit V ADVANCED PROPULSION TECHNIQUES

Electric rocket propulsion – Ion propulsion techniques – Nuclear rocket – Types – Solar sail- Preliminary Concepts in nozzleless propulsion.

Text Books:

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edn., 1993.

2. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Addison – Wesley Longman INC, 1999.

Reference Books :

1. Cohen, H., Rogers, G.F.C. and Saravanamuttoo, 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.

09AE212 INSTRUMENTATION & CONTROL SYSTEMS

Credits: 4:0:0

Course Objectives:

1. To provide knowledge on the fundamentals of measurement science and measuring instruments
2. To provide a knowledge on the basics of control system theory

Course Outcomes:

1. Students will be conversant with measurement techniques and the use of measuring instruments
2. Students will have working knowledge for dealing with problems involving control system fundamentals

Unit I

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.

Unit II

Measurement of displacement, time, speed, frequency, acceleration - vibrometer, accelerometer etc. Pressure measurement: gravitational, Bourdon, elastic transducers, strain gauge, pressure cells, and measurement of high and low pressure. Temperature measurement: bi-metallic, resistance thermometer, thermocouples, pyrometer, thermistors. Hot-wire anemometer, magnetic flow meter , ultrasonic flow meter.

Unit III

Viscosity: Capillary tube viscometer, efflux viscometer, Humidity: absorption hydrometer, Dew point meter. Strain: strain gauges, types, gauge rosettes calibration. Force measurement: scales and torque measurement: Mechanical torsion meter, electrical torsion meter, fibre optic & piezo electric transducer.

Unit IV

Control systems: Wheatstone bridge circuits. Open and closed systems, servomechanisms, transfer functions, signal flow graphs, block diagram algebra and hydraulic and pneumatic control systems. Two –way control, proportional control, differential and integral control. Simple problems.

Unit V

Time response of first order and second order systems, concept of stability, necessary condition for stability, routh stability criterion, Polar and Bode plots, Nyquist stability criterion. Simple Problems.

Text Books:

1. Sawheny, A.K. "Electrical and Electronics Measurements & Instrumentation", Dhanpat Rai & Co., 1993
2. Nagoor Kani. A., 'Control Systems', RBA Publications, 1998 (for units IV & V)

Reference Books:

1. Thomas G. Beckwith, Lewis buck N. Ray D. Maragoni, 'Mechanical Measurements, Narosa Publishing House new Delhi, 1989.
2. Collet. C. V. and Hope. A.D. 'Engineering Measurements' 2nd Edition ELBS
3. Nagrath. M. and Gopal. I.J. Control systems Engineering, Wiley eastern Ltd., 1991.

09AE213 INSTRUMENTATION & CONTROL LABORATORY

Credits: 0:0:2

Course Objectives:

1. To introduce different types of Instruments
2. To introduce different types of Controls
3. To train students to measure parameters accurately

Course Outcomes:

The students will be

1. Work in control room in process Industries
2. Design new control systems
3. Troubleshoot & rectify faulty Instruments

List of Exercises

1. Study on different kinds of Instruments and controls
2. Flow measurements using hot wire anemometer
3. Flow visualization using shadowgraph Techniques
4. Flow visualization using Schlieren Techniques
5. Temperature measurements using thermocouples
6. Temperature measurements using pyrometery
7. Instrumentation study of IC engines.
8. Study of Data acquisition system and processing using Labview software
9. Controls in Refrigeration systems
10. Controls in Air conditioning systems
11. Study measurement and analysis of electrical Power using power analyser
12. Various instrumentation part in Boiler control

(Depending availability new experiments may be offered)

09AE214 NAVIGATION, GUIDANCE AND CONTROL

Credits: 4:0:0

Course Objectives:

1. To introduce the concept of Control system and its analysis
2. To introduce the concept of Navigation and Guidance system
3. To model of Aerospace vehicles and flight control system

Course Outcomes:

Ability to

1. To analyse the control system and assess its performance
2. To relate the control systems and guidance/control of launch vehicles
3. To design and analyse Auto-pilot for Aerospace vehicles

Unit I

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

Unit II

Time Domain Analysis Transient and Steady State Response-Time domain Specifications-Second Order system- Impulse and Step Response-Steady State error analysis

Unit III

Frequency Domain Analysis Closed Loop Frequency Response-Bode Plot-Polar Plot-Gain Margin-Phase Margin-Nyquist Stability Criteria-Stability Analysis from Bode Plot Fuzzy Logic-Neural Control-Robust Control

Unit IV

Introduction to the concepts of navigation guidance and control. General principles of early conventional navigation systems. Geometric concepts of navigation. Reference frames. Direction cosine matrix, Euler angles, Transformation of angular velocities, Quaternion representation in co-ordinate transformation. Comparison of transformation methods.

Unit V

Modeling of Aerospace vehicles, Linear system analysis, Stabilization and Control of space crafts, Missile control systems and Autopilots, Launch vehicle flight control systems. Longitudinal and lateral autopilots for aircraft. Radar systems command and housing guidance systems

Text Books:

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

Reference Books:

1. 'Aerospace Avionics System - A Modern Synthesis' by George M Siouris, Academic Press Inc.,1993
2. Modern Space Craft Dynamics and Control', Kaplan M , Wiley, 1976

3. 'Guided Weapon Control Systems', Garnele P, Pergamon, 1980
4. 'Automatic Control of Aircraft and Missiles', Blaklock J H, Wiley, 1990
5. 'Introduction to Radar Systems', Stolnik R E, McGraw Hill, 1982

09AE215 AIRCRAFT STABILITY AND CONTROL

Credits: 4:0:0

Course Objectives:

1. To familiarize with the concept of Stability and control of Aircraft
2. To familiarize with various Aircraft motions and related stability
3. To familiarize with the concept of dynamic stability of Aircraft

Course Outcomess:

Ability to

1. To analyse the stability of aircraft using dynamical analysis
2. To assess the requirement of control force and power plant
3. To understand the motion of unstable aircraft and related modes of unstability

Unit I

Degrees of Freedom of a system, Static and Dynamic Stability, Need for Stability in an Airplane, Purpose of Controls, Inherently and Marginally stable Systems

Stick Fixed Static Longitudinal Stability – Basic equations of equilibrium, Stability criterion, Wing and tail Moments, Effects of Fuselage and nacelles, Effect of CG location

Unit II

Stick Fixed Static Longitudinal Stability –Power effects, Stabiliser settings and CG location, Elevator Effects, Stick fixed Neutral Points

Stick Free Longitudinal Stability – Hinge moment Coefficients, Stick free neutral point, Symmetric maneuvers, Stick Force gradients and Stick force per g load, Aerodynamic balancing of Control Surfaces

Unit III

Static Lateral Stability – Dihedral Effect, Coupling between rolling moment and yawing moment, Adverse yaw, Aileron power, Aileron reversal

Static Directional Stability – Weathercocking Effect, Rudder Requirements, One engine In-operative Conditions, Rudder Lock

Unit IV

Dynamic Longitudinal Stability – Equations of motion, stability Derivatives, Routh's discrimnant, Solving the stability quartic, Phugoid motion, Factors effecting the period and damping

Unit V

Dynamic Lateral and Directional Stability – Dutch roll and Spiral instability, Auto rotation and Spin, Two control airplane

Text Books:

1. Perkins, C D and Hage, R E; " Airplane Performance Stability and Control", Willey Toppan, 1974

Reference Books:

1. Babister A W: Aircraft Dynamic Stability and Response. Elsever 1980
2. McCormic, B W; "Aerodynamics, Aeronautics and Flight mechanics", John Willey, 1995
3. Nelson, R C; "Flight Stability and Automatic Contril", McGraw Hill, 1989
4. Roskam Jan: Airplane Flight Dynamics and Automatic Flight Controls. Roskam Aviation and Engineering Corporation 1979. Second Printing 1982

09AE216 AIRCRAFT PERFORMANCE

Credits: 4:0:0

Course Objectives:

1. To familiarize with the concepts of Flight performance
2. To understand the parameters effecting the performance
3. To familiarize with the various theories of propeller analysis and design

Course Outcomes:

Ability to

1. To make preliminary performance estimation
2. To make preliminary design of propeller
3. To assess various aircraft parameters and their effect of performance

Unit I

Streamlined and Bluff bodies, Aerofoil characteristics, Pressure Distribution around circular cylinder and aerofoils, Aerofoil Classification

Types of Drag; Effect of Reynolds Number on Skin friction and Pressure drag,

Unit II

Drag reduction of Airplanes, Momentum Theory of Finite wings, Induces drag, Chordwise and spanwise pressure distribution, Aspect Ratio, Camber and planform Characteristics , Drag polar

Unit III

Steady Level Flight, Thrust/Power available and required with altitudes, Estimation of Maximum level flight speed, Conditions for minimum drag and minimum power required

Unit IV

Maximum range, minimum rate of glide, Shallow angle of climb, Rates of Climb and Ceilings, Glide Hodograph

Range and endurance of jet and propeller type of airplanes, Estimation of take-off and landing distances, High Lift Devices, use of thrust augmentation and reverse thrust

Unit V

Bank angle and load factor, Limitation of turn, Pull up and Push over V-n diagram; Froude momentum and blade element theories, propeller coefficients, Use of propeller charts, performance of fixed and variable pitch propellers

Text Books:

1. Roskan, Jan and Lan, Chuan-tau E, " Airplane Aerodynamics and Performance", DAR Corporation, Lawrence, Kansas, USA, 1997

2. Perkins, C D and Hage, R E; " Airplane Performance Stability and Control", Willey Toppan, 1974

Reference Books:

1. Houghton, E L and Carruthers, N B; "Aerodynamics for Engineering Students", Edward Arnold Publishers, 1988
2. Kuethe, A M and Chow, C Y; " Foundations of Aerodynamics", John Willey & Sons, 1982
3. Bertin J J; " Aerodynamics for Engineers" Pitman, 1986
4. Schlichting, H and Truckenbrodt, E; "Aerodynamics of the Airplane", McGraw Hill, 1979

09AE217 AIRCRAFT DESIGN PROJECT

Credits: 0:0:4

Course Objectives:

1. To familiarize with inputs required for Aircraft design
2. To familiarize with methodology for aerodynamic design of aircraft
3. To select proper power plant to meet performance requirements
4. To familiarize with methodology for structural design of aircraft

Course Outcomes:

Ability to

1. To carry out preliminary design of aircraft configuration
2. To carry out preliminary structural design of aircraft components
3. To select a power plant suitable for the required performance

The following are the assignments to be carried out.

1. Comparitive study of the different type of the airplanes and their specifications and performance details.
2. Preliminary weight estimations, selection of main parameters, Power plant selection, Aerofoil selection for Wing, Tail and Control surfaces
3. Preparation of lay out of balance diagram and three view drawings
4. Drag estimation, Detailed performance calculation and Stability Estimates, V-n diagram

Reference Books:

1. Jan Roskam - Airplane Design Part I-VIII, DAR Corporation, 2000
2. John P Fielding – Introduction to Aircraft Design, Cambridge University Press, 2005

09AE218 CFD LABORATORY

Credits: 0:0:2

Course Objectives:

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

Course Outcomes:

Ability to

1. To define the body shape in a CFD code
2. To set up solution domain and grid generation
3. To set up boundary conditions and generate the solution
4. To derive aerodynamic quantities from computed data

It is planned to have flow simulation for different flow regimes for simple bodies

1. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=0.1, $\alpha=0^o$
2. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=0.1, $\alpha=10^o$
3. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=0.8, $\alpha=0^o$
4. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=0.8, $\alpha=10^o$
5. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=01.2, $\alpha=0^o$
6. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=01.2, $\alpha=10^o$
7. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=2.0, $\alpha=0^o$
8. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=2.0, $\alpha=10^o$
9. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=3.0, $\alpha=0^o$
10. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=3.0, $\alpha=10^o$
11. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=5.0, $\alpha=0^o$
12. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=5.0, $\alpha=10^o$
13. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=0.1, $\alpha=0^o$
14. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=0.1, $\alpha=10^o$
15. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=0.8, $\alpha=0^o$
16. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=0.8, $\alpha=10^o$
17. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=01.2, $\alpha=0^o$
18. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=01.2, $\alpha=10^o$
19. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=2.0, $\alpha=0^o$
20. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=2.0, $\alpha=10^o$
21. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=3.0, $\alpha=0^o$
22. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=3.0, $\alpha=10^o$
23. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=5.0, $\alpha=0^o$
24. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=5.0, $\alpha=10^o$

This will expose students to differences between flow field over 2D and 3D bodies and also difference in flow pattern for different flow regime (M=0.1, 0.8, 1.2 2.0 3.0,5.0) at different angle of attack ($\alpha=0^o$ and $\alpha=10^o$)
Suitable exercise will be chosen from among these.

Later, an exercise may be taken up for flow simulation over real life geometry of interest

(Any 12 experiments can be offered)

09AE219 CAD LABORATORY

Credits: 0:0:2

Course Objectives:

- To train the students with CAD packages like PRO-E.
- To impart the 2D and 3D modeling skills to the students.

Course Outcomes:

- Students will be able to design different parts of mechanical equipments
- Students will be able to apply their skills in various designing and Manufacturing industries

LIST OF EXPERIMENTS

1. Scaling, rotation, translation, editing, dimensioning – Typical CAD command structure.
2. Wire frame modeling – surface modeling
3. Solid Modeling.
4. Computer aided modeling of typical aircraft wing.
5. Computer aided modeling of typical fuselage structure
6. Computer aided modeling of landing gear
7. Three view diagram of a typical aircraft
8. Lay out of control systems
9. Taper Turning – Straight Interpolation
10. Taper Turning – Circular Interpolation
11. Incremental programme G 90 operation.
12. Mirroring.
13. Incremental Programme G 91 operation
14. Absolute Programme G 90 operation

(Any 12 experiments can be offered)

10AE201 INTRODUCTION TO AIRCRAFT INDUSTRY AND AIRCRAFT SYSTEMS

Credit: 4:0:0

Remarks:

- This syllabus is adopted from the Faculty Enablement programme offered by Infosys through Infosys Campus connect programme.
- This subject can be offered as an Elective for the 6th Semester or 7th Semester Mechanical Students
- This course will add credit to the students when they appear for Infosys placement.

Course Objective:

To enable the student to get an exposure to the Aerospace Industry and understand the Basics of Aircraft Systems and Aircraft Structures. This course will also impart Industry Practices on Design of Aircraft Structures and enable the student to understand the applicability of Design aspects in Aircraft Design so that he/she can relate the theoretical knowledge with the design of Aircraft Structures.

UNIT - I AIRCRAFT INDUSTRY OVERVIEW

Evolution and History of Flight, Types Of Aerospace Industry, Key Players in Aerospace Industry, Aerospace Manufacturing, Industry Supply Chain, Prime contractors, Tier 1 Suppliers, Key challenges in Industry Supply Chain, OEM Supply Chain Strategies, Mergers and Acquisitions, Aerospace Industry Trends, Advances in Engineering/CAD/CAM/CAE Tools and Materials technology, Global and Indian Aircraft Scenario.

UNIT - II INTRODUCTION TO AIRCRAFTS

Basic components of an Aircraft, Structural members, Aircraft Axis System, Aircraft Motions, Control surfaces and High lift Devices.

Types of Aircrafts - Lighter than Air/Heavier than Air Aircrafts Conventional Design Configurations based on Power Plant Location, Wing vertical location, intake location, Tail Unit Arrangements, Landing Gear Arrangements. Unconventional Configurations-Biplane, Variable Sweep, Canard Layout, Twin Boom Layouts, Span loaders, Blended Body Wing Layout, STOL and STOVL Aircraft, Stealth Aircraft. Advantages and disadvantages of these Configurations.

UNIT – III FUNDAMENTALS OF AIRCRAFT SYSTEMS

Types of Aircraft Systems. Mechanical Systems. Electrical and Electronic Systems. Auxiliary systems. Mechanical Systems: Environmental control systems (ECS), Pneumatic systems, Hydraulic systems, Fuel systems, Landing gear systems, Engine Control Systems, Ice and rain protection systems, Cabin Pressurization and Air Conditioning Systems, Steering and Brakes Systems Auxiliary Power Unit, Electrical system. Introduction to Avionics.

UNIT - IV BASIC PRINCIPLES OF FLIGHT

Significance of speed of Sound, Air speed and Ground Speed, Properties of Atmosphere, Bernoulli's Equation, Forces on the airplane, Airflow over wing section, Pressure Distribution

over a wing section, Generation of Lift, Drag, Pitching moments, Types of Drag, Lift curve, Drag Curve, Lift/Drag Ratio Curve, Factors affecting Lift and Drag, Center of Pressure and its effects.

Aerofoil Nomenclature, Types of Aerofoil, Wing Section- Aerodynamic Center, Aspect Ratio, Effects of lift, Drag, speed, Air density on drag,

UNIT - V BASICS OF FLIGHT MECHANICS

Mach Waves, Mach Angles, Sonic and Supersonic Flight and its effects

Stability and Control - Degree of Stability- Lateral, Longitudinal and Directional Stability and controls of Aircraft. Effects of Flaps and Slats on Lift Coefficients, Control Tabs, Stalling, Landing, Gliding Turning, Speed of Sound, Mach Numbers, Shock Waves

Aircraft Performance and Maneuvers - Power Curves, Maximum and minimum speeds of horizontal flight, Effects of Changes of Engine Power, Effects of Altitude on Power Curves, Forces acting on a Aero plane during a Turn, Loads during a Turn, Correct and incorrect Angles of Bank, Aerobatics, Inverted Maneuvers, Maneuverability

Text books:

1. John D Anderson Jr, "**Introduction to Flight**",Tata McGraw Hill Education Private Limited, NewDelhi, 5th Edition, 2009.
2. Karunya notes & website links (only for Unit I)

Reference books:

1. David A Lombardo, "**Aircraft Systems**", Tata McGraw Hill Education Private Limited, NewDelhi, 2nd Edition, 1998.
2. A.C Kermode, "**Flight without Formulae**" , Pearson Education,5th Edition, 2008.
3. Course material of Faculty Enablement Programme on "**Introduction to Aircraft Industry**", conducted by Infosys, Mysore through Campus connect programme from June 21st-30th, 2010.

10AE202 BASICS OF AEROSPACE ENGINEERING

Credit 3:0:0

Course Objective

To introduce the basic concepts of aerospace engineering and the current developments in the field.

UNIT I HISTORICAL EVOLUTION

Early airplanes, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

UNIT II AIRCRAFT CONFIGURATIONS

Components of an airplane and their functions. Different types of flight vehicles, classifications.

Conventional control, Powered control, Basic instruments for flying, Typical systems for control actuation. Introduction to Avionics and its components.

UNIT III PRINCIPLES OF FLIGHT

Physical properties and structure of the atmosphere, Temperature, pressure and altitude relationships, Evolution of lift, drag and moment. Aerofoils, Mach number, Maneuvers.

UNIT IV AEROSPACE STRUCTURES

General types of Aircraft construction, Aerospace materials, metallic and non-metallic materials, Typical wing and fuselage structure. Landing Gear Structure

UNIT V AEROSPACE POWER PLANTS

Basic knowledge about piston, turboprop and jet engines, Use of propeller and jets for thrust production. Comparative merits, Principles of operation of rocket, types of rockets and typical applications.

Text book:

1. John D Anderson Jr, "**Introduction to Flight**", Tata McGraw Hill Education Private Limited, New Delhi, 5th Edition, 2009.

Reference Books

1. A.C Kermode, "**Flight without Formulae**" , Pearson Education,5th Edition, 2008.
2. David A Lombardo, "**Aircraft Systems**", Tata McGraw Hill Education Private Limited, New Delhi, 2nd Edition, 1998.
3. Course material of Faculty Enablement Programme on "**Introduction to Aircraft Industry**", conducted by Infosys, Mysore through Campus connect programme from June 21st-30th, 2010.

ADDITIONAL SUBJECTS

S.No.	Sub. Code	Name of the Subject	Credits
1	11AE201	Introduction to Aerospace Engineering	4:0:0
2	11AE202	Aircraft Structures	3:1:0
3	11AE203	Aircraft Structures Lab	0:0:2
4	11AE204	Flight Mechanics and Performance	3:1:0
5	11AE205	Aerodynamics	4:0:0
6	11AE206	Aircraft/Launch vehicle Design Project	0:0:4

11AE201 INTRODUCTION TO AEROSPACE ENGINEERING

Credits 4:0:0

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 details
- To introduce the basics of aerodynamics, propulsion, materials, maneuvers, trajectories & orbits and flight testing
- To familiarize with the national and international aeronautical and aerospace agencies

Course Outcome:

Ability to

- understand nature of aerospace technologies,
- understand various types of aerospace vehicles, satellites and their applications,
- Appreciation of various national and international aerospace agencies

UNIT I HISTORICAL EVOLUTION

History of aviation, early development of airplanes, biplanes and monoplanes, history of spaceflight, development of space vehicle, classification of duct jet propulsion, rocket propulsion, advance propulsion and applications.

UNIT II CONFIGURATIONS

Anatomy of flight vehicles, components of an airplanes and their function, configuration of space vehicle, earth's atmosphere and gravitational field, bluff bodies v/s streamlined body, airfoil. lift generation, significance of L/D ratio, aerodynamic forces.

UNIT III PROPULSION

Classification and essential features of propulsion, jet propulsion, general characteristics of rocket engines, theory of propulsion, elementary gas dynamics, spacecrafts and aircraft performance.

UNIT IV AEROSPACE STRUCTURES AND MATERIALS

General types of construction and structural layout, flight envelope and V-n diagrams, monocoque, semimonocoque, corrugated, sandwich structure, reinforced and honeycomb structures, geodesic construction, aerospace materials, metallic and non metallic materials, use of aluminum alloy, titanium, stainless steel, composite and ceramic materials.

UNIT V ROCKETS AND SPACE APPLICATION

Principles of operation of rocket, types of rockets and typical applications, Exploration into space. Satellite Missions and introduction to orbital dynamics, Different types of satellites and their

applications, Spacecraft configurations: structures, Systems and subsystems identifications and functions of each, Spacecraft environment.

TEXT BOOKS:

1. Shevel, "Fundamentals of Flight", Prentice Hall, 1989.
2. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 1993.

REFERENCES:

1. Anderson, J. D., "Introduction to Flight", McGraw-Hill, 2000.
2. Kermode, A. C., "Flight without Formulae", Pitman, 1970.

11AE202 AIRCRAFT STRUCTURES

Credits 3:1:0

Course Objectives:

1. To introduce the various structural components of aircrafts and aerospace vehicles
2. To study their behaviour under various types of loads
3. To familiarise with different types of beams and columns subjected to various types of loading and support conditions

Course Outcome:

Ability to

1. appreciate structural design methods for aerospace vehicles,
2. identify various types of structural components and their loading pattern,
3. understand theoretical approaches

UNIT I: STATICALLY DETERMINATE AND INDETERMINATE STRUCTURES

Analysis of plane truss – Method of joints – 3 D Truss. Composite beam - Clapeyron's Three Moment Equation - Moment Distribution Method.

UNIT II: ENERGY METHODS

Strain Energy due to axial, bending and Torsional loads - Castigliano's theorem - Maxwell's Reciprocal theorem, Unit load method - application to beams, trusses, frames, rings, etc.

UNIT III: COLUMNS

Columns with various end conditions – Euler's Column curve – Rankine's formula, Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum Strain energy theory – Application to aircraft Structural problems.

UNIT IV: Shear Flow in Open and Closed Sections

Concept of shear flow, shear centre, Elastic axis. With one axis of symmetry, with wall effective and ineffective in bending, unsymmetrical beam sections. Bredt – Batho formula, Shear flow in single & multicell structures under torsion.

UNIT V: STRESS ANALYSIS IN WING AND FUSELAGE

Procedure – Shear and bending moment distribution for semi cantilever and other types of wings and fuselage, thin webbed beam. With parallel and non parallel flanges, Shear resistant web beams, Tension field web beams (Wagner's).

TEXT BOOKS

1. Peery, D.J., and Azar, J.J., "Aircraft Structures", 2nd edition, McGraw–Hill, N.Y., 1993
2. Donaldson, B.K., "Analysis of Aircraft Structures – An Introduction", McGraw-Hill, 1993.

REFERENCE BOOKS

1. Megson, T.M.G., "Aircraft Structures for Engineering Students", Edward Arnold, 1995.
2. Timoshenko, S., "Strength of Materials", Vol. I and II, Princeton D. Von Nostrand Co, 1990.
3. Rajput, Strength of materials
4. Bansal Strength of materials

11AE203 AIRCRAFT STRUCTURES LABORATORY

Credits: 0:0:2

Course Objectives:

1. To introduce the basic testing equipments for various structural components subjected to static loads
2. To familiarise with the measuring equipment and sensors
3. To familiarise with the test procedures

Course Outcome:

Ability to

1. select test equipment for different types of static loading ,
2. mount sensors and measuring equipment,
3. conduct tests, analyse results and document
4. Compare with analytical/theoretical results

Experiments to familiarize

1. Tensile testing using UTM, Mech. & Optical extensometers, Stress Strain curves and strength tests for different materials
2. Deflection of beams with various end conditions.
3. Verification of Maxwell's Reciprocal theorem & principle of superposition
4. Column Testing - South well's plot.
5. Tensile testing using UTM on riveted joints and bolted joints
6. Torsion on circular shaft
7. Unsymmetrical bending of beams
8. Shear centre location for open sections
9. Bending stiffness on composite beam
10. Stresses in circular discs and beams using photoelastic techniques
11. Vibrations of beams
12. Wagner beam – Tension field beam

11AE 204 FLIGHT MECHANICS AND PERFORMANCE

Credits: 3:1:0

Course Objectives:

1. To familiarize with the concepts of Flight performance
2. To understand the parameters effecting the performance
3. To familiarize with the concept of Stability and control of Aircraft
4. To familiarize with the concept of dynamic stability of Aircraft

Course Outcome:

Ability to

1. To make preliminary performance estimation
2. To assess various aircraft parameters and their effect of performance
3. To analyse the stability of aircraft using dynamical analysis
4. To assess the requirement of control force

UNIT I DRAG ON THE AIRPLANE

International Standard Atmosphere - Forces and moments acting on a flight vehicle - Equation of motion of a rigid flight vehicle - Different types of drag - Drag polars of vehicles from low speed to high speed - Variation of thrust, power and SFC with velocity and altitudes for air breathing engines and rockets - Power available and power required curves.

UNIT II AIRCRAFT PERFORMANCE

Performance of airplane in level flight - Maximum speed in level flight - Conditions for minimum drag and power required - Range and endurance - Climbing and gliding flight (Maximum rate of climb and steepest angle of climb, minimum rate of sink and shallowest angle of glide) -Turning performance (Turning rate, turn radius). Bank angle and load factor - Limitations of pull up and push over - V-n diagram and load factor.

UNIT III STATIC LONGITUDINAL STABILITY

Degree of freedom of rigid bodies in space - Static and dynamic stability - Purpose of controls in airplanes -Inherently stable and marginal stable airplanes – Static Longitudinal stability - Stick fixed stability - Basic equilibrium equation - Stability criterion - Effects of fuselage and nacelle - Influence of CG location - Power effects - Stick fixed neutral point - Stick free stability-Hinge moment coefficient - Stick free neutral points-Symmetric maneuvers - Stick force gradients - Stick force per 'g' - Aerodynamic balancing. Determination of neutral points and maneuver points from flight test.

UNIT IV LATERAL AND DIRECTIONAL STABILITY

Dihedral effect - Lateral control - Coupling between rolling and yawing moments - Adverse yaw effects - Aileron reversal - Static directional stability - Weather cocking effect - Rudder requirements - One engine inoperative condition - Rudder lock.

UNIT V DYNAMIC STABILITY

Dynamic longitudinal stability: Equations of motion - Stability derivatives - Characteristic equation of stick fixed case - Modes and stability criterion - Effect of freeing-the stick - Brief description of lateral and directional. Dynamic stability - Spiral, divergence, Dutch roll, auto rotation and spin.

TEXT BOOKS

1. Perkins, C.D., and Hage, R.E., “Airplane Performance stability and Control”, John Wiley & Son:, Inc, New York, 2000.
2. J D Anderson, “Aircraft performance and Design”, McGraw-Hill, , New York, 2000.

REFERENCE BOOKS

1. Etkin, B., “Dynamics of Flight Stability and Control”, Edn. 2, John Wiley, New York, 1982.
2. Nelson, R.C. “Flight Stability and Automatic Control”, McGraw-Hill Book Co., 1991

11AE 205 AERODYNAMICS

Credits: 4:0:0

Course Objectives:

1. To introduce the basics of air flow
2. To familiarise with the airfoils and wings and the flow over them
3. To introduce concepts of forces and moments on flying vehicles under various flight regimes
4. To familiarise with the flow measurement techniques

Course Outcome:

Ability to

1. Understand the flow behavior over aircraft components
2. Assess the forces and moments due to flow
3. Devise the methods for flow/force measurement

UNIT I REVIEW OF BASIC FLUID MECHANICS

Continuity, momentum and energy equations, Inviscid flow, Euler equation, incompressible Bernoulli's Equation. Circulation and Vorticity, Green's Lemma and Stoke's Theorem, Barotropic Flow, Kelvin's theorem, Streamline, Stream Function, Irrotational flow, Potential Function, Equipontential Lines, Elementary Flows and their combinations.

UNIT II TWO DIMENSIONAL INVISCID INCOMPRESSIBLE FLOW

Ideal Flow over a circular cylinder, D'Alembert's Paradox, Magnus effect, Kutta –Joukowski's Theorem, Starting Vortex, Kutta condition, Real flow over smooth and rough cylinder.

UNIT III AIRFOIL THEORY

Cauchy-Riemann relations, Complex Potential, Methodology of Conformal Transformation, Kutta-Joukowski transformation and its applications, Karman Trefftz Profiles, Thin Airfoil theory and its applications.

UNIT IV INTRODUCTION TO LAMINAR AND TURBULENT FLOW

Boundary layer and boundary layer thickness, displacement thickness, momentum thickness, Energy thickness, Shape parameter, Boundary layer equations for a steady, two dimensional incompressible flow, Boundary Layer growth over a Flat plate, Critical Reynolds Number, Clasius solution, Basics of Turbulent flow, Prandtl's mixing length hypothesis, Free shear layers.

UNIT V SUBSONIC WING THEORY

Vortex Filament, Biot and Savart Law, Bound Vortex and trailing Vortex, Horse Shoe Vortex, Lifting Line Theory and its limitations

TEXT BOOKS

1. John D. Anderson, Jr., "Fundamentals of Aerodynamics", Third edition, McGraw-Hill publications, 2001
2. E L Houghton and PW Carpenter, "Aerodynamics for Engineering students", Fourth edition, Edward Arnold publications, 1993.

REFERENCE BOOKS

1. Anderson, J.D., Fundamentals of Aerodynamics, MaGraw Hill Book Co., 1999
2. Kermode A.C., "Flight without Formulae", McGraw Hill, 1985.
3. Milne Thomson, L.H., Theoretical Aerodynamics, Macmillan, 1985
4. Theory of wing sections by Ira Herbert Abbott, Albert Edward Von Doenhoff, 1959 edition

11AE206 AIRCRAFT/ LAUNCH VEHICLE DESIGN PROJECT

Credits: 0:0:4

Course Objectives:

1. To familiarize with inputs required for Aircraft/ Launch vehcle design
2. To familiarize with methodology for aerodynamic design of Aircraft/ Launch vehcle
3. To select proper power plant to meet performance requirements
4. To familiarize with methodology for structural design of Aircraft/ Launch vehicle

Course Outcome:

Ability to

1. To carry out preliminary design of Aircraft/ Launch vehicle configuration
2. To carry out preliminary structural design of Aircraft/ Launch vehicle components
3. To select a power plant suitable for the required performance

The following are the assignments to be carried out.

1. Comparitive study of the different type of the Aircraft/ Launch vehicles and their specifications and performance details.
2. Preliminary weight estimations, selection of main parameters, Power plant selection, Aerofoil selection for Wing, Tail and Control surfaces
3. Preparation of lay out of balance diagram and three view drawings
4. Drag estimation, Detailed performance calculation and Stability Estimates, V-n diagram

Reference Books:

1. Jan Roskam - Airplane Design Part I-VIII, DAR Corporation, 2000
2. John P Fielding – Introduction to Aircraft Design, Cambridge University Press, 2005

DEPARTMENT OF AEROSPACE ENGINEERING

LIST OF SUBJECTS AND SYLLABI

Sub. Code	Name of the Subjects	Credits
12AE201	Introduction to Aerospace Engineering	4:0:0
12AE202	Thermodynamics	4:0:0
12AE203	Strength of Aerospace Materials	4:0:0
12AE204	Aerodynamics	4:0:0
12AE205	Aerodynamics Laboratory - 1	0:0:2
12AE206	Aerodynamics Laboratory - 2	0:0:2
12AE207	Thermal Engineering	3:0:0
12AE208	Thermal Laboratory	0:0:2
12AE209	Wind Tunnel Techniques	3:0:0
12AE210	CAD Laboratory	0:0:2
12AE211	Aircraft Instrumentation and Avionics	3:0:0
12AE212	Aircraft Structures	4:0:0
12AE213	Aircraft Structures Laboratory	0:0:2
12AE214	Flight Dynamics	4:0:0
12AE215	Space Dynamics	4:0:0
12AE216	Computational Fluid Dynamics	4:0:0
12AE217	CFD Laboratory	0:0:2
12AE218	Aerospace Propulsion	4:0:0
12AE219	Propulsion Laboratory	0:0:2
12AE220	Gas Dynamics	4:0:0
12AE221	Heat & Mass Transfer	4:0:0
12AE222	Finite Element Analysis	4:0:0
12AE223	Guidance and Control of Aerospace Vehicles	4:0:0
12AE224	Aircraft/Spacecraft Design Project	0:0:2
12AE225	Fatigue and Fracture Mechanics	4:0:0
12AE226	Air Traffic Control and Aerodrome details	4:0:0
12AE227	Introduction to Composite Materials & Structure	4:0:0
12AE228	Cryogenic Propulsion	4:0:0
12AE229	Introduction to Non Destructive Testing	4:0:0
12AE230	Boundary Layer Theory	4:0:0
12AE231	Basics of Aerospace Engineering	3:0:0

12AE201 INTRODUCTION TO AEROSPACE ENGINEERING

Credits: 4:0:0

Course Objective:

- To introduce the basic concepts of aircrafts, rockets, satellites and their application
- To familiarize with the basic parts and their function and construction details
- To familiarize with the national and international aeronautical and aerospace agencies

Course Outcome:

By the end of the course students will be able to understand

- Nature of aerospace technologies,
- Various types of aerospace vehicles, satellites and their applications,
- Appreciation of various national and international aerospace agencies

Unit I

HISTORICAL EVOLUTION: History of aviation, early development of airplanes, biplanes and monoplanes, history of spaceflight, development of space vehicle, History of Aerodynamics, Structures and Propulsion system throughout the years.

Unit II

AIRCRAFT COMPONENTS AND CLASSIFICATION: Components of an airplane and their functions, Conventional flight control surfaces, Different types of flight vehicles, classifications, configuration of space vehicle, Standard and International atmosphere, Airfoil – its nomenclature and classification, Evolution of lift, drag and moment, wing configuration – monoplane, biplane – High, mid, low – aspect ratio – swept back, swept forward.

Unit III

INTRODUCTION TO STRUCTURES: General types of aircraft construction and structural layout, Fuselage construction - monocoque, semi-monocoque, and geodesic construction, Wing structure , aerospace materials -metallic and non metallic materials, use of aluminum alloy, titanium, stainless steel, composite materials.

Unit IV

PROPULSION SYSTEMS: Basic ideas about piston, turboprop and jet engines, Principles of Thrust generation- propeller and jets, comparative merits.

ROCKETS AND SATELLITES: Principles of operation of rocket, types of rockets and typical applications, Exploration into space, Satellites –types and applications.

Unit V

FLIGHT TESTING: Introduction to flight-testing, Purpose and Scope of Flight Testing, Basic instruments for flying.

AEROSPACE INDUSTRIES AND INSTITUTIONS: Introduction to aerospace industries – Research and Development organizations and Academic institutions in India and worldwide

Text Book

1. Anderson, J. D., “Introduction to Flight”, McGraw-Hill, 2006.

Reference Books

1. Kermode, A. C., “Flight without Formulae”, Pitman, 2002.
2. Sutton, G.P., et al., “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 2004

12AE202 THERMODYNAMICS

Credits: 4:0:0

Course Objective:

- To understand the basic concepts of engineering thermodynamics.
- To acquire knowledge about the laws of thermodynamics, properties of pure substances and gas mixtures
- To understand about Quantum principles applied to the system of particles.

Course Outcome:

By the end of the course students will be able to understand

- The first and second laws of thermodynamics and learn how to apply these laws to both open and closed systems.
- The concept availability as a combination of these laws of thermodynamics and will be able to use the availability to evaluate engineering systems.

Unit I

FIRST LAW OF THERMODYNAMICS: Microscopic and macroscopic approach, Thermodynamic properties, Processes and cycles - thermodynamic Equilibrium – Quasi static process – Zeroth Law – Work transfer and Heat transfer – Point and path functions - First law of thermodynamics – application to closed and open systems,
Steady flow and variable flow process – Problems.

Unit II

SECOND LAW OF THERMODYNAMICS: Cyclic Heat Engine - Kelvin's and Clausius statements of second law – Refrigerator and Heat pump - Reversibility and irreversibility - Carnot cycle, Carnot Theorem, reversed Carnot cycle, efficiency – Entropy – Clausius Inequality - Applications of Entropy - Entropy generation
Available energy – Law of degradation of Energy – Maximum work and available wok - Availability

Unit III

PROPERTIES OF PURE SUBSTANCES & GAS MIXTURES: Thermodynamic properties of pure substances - phase rule P-V, P-T, T-V, T-S, H-S diagrams, - Thermodynamic properties and charts – Dryness fraction - Calorimeter- simple problems - Gases and Mixtures – Ideal Gas – Compression - compressibility chart – Gibbs function

Unit IV

THERMODYNAMIC RELATIONS: Maxwell's Equation – Tds Equation – Energy Equation – Joule Kelvin effect – Clausius Clapeyron equation – Gibbs phase rule – Equilibrium – stability – Third law of thermodynamics

Unit V

INTRODUCTION TO STATISTICAL THERMODYNAMICS: Quantum principle – Wave and particle duality – uncertainty principle – wave equation – Maxwell Boltzmann statistics – Equi partition of energy – Thermodynamic particles

Text Book

1. P.K. Nag, "Basic and applied Thermodynamics", TMH, New Delhi, 2002.

Reference Books

1. Holman. J.P., "Thermodynamics", 4th edition, McGraw Hill, 2002
2. Y.V.C. Rao, "An introduction to Thermodynamics", New Age International (P) Ltd, 1998.

12AE203 STRENGTH OF AEROSPACE MATERIALS

Credits: 4:0:0

Course Objective:

- To introduce the concepts of stress and strain
- To introduce the concepts of Shear force and Bending moment
- To introduce the concepts of deflection of beams

Course Outcome:

By the end of the course students will be able to

- Understand material properties like elasticity,
- Understand various methods of analysis of aerospace structural members.
- Understand the failure theories of the materials

Unit I

STRESS STRAIN AND STRAIN ENERGY: Stresses and strain due to axial force, Hooke's law, factor of safety, Stresses in composite bars due to axial force, Thermal stresses, Stresses due to impact load, Lateral strain: Poisson's ratio - change in volume, Shear stress - shear strain, Relationship between elastic constants - Hoop and longitudinal stress in thin cylindrical and spherical shells – changes in dimensions and volume, Strain energy due to axial force,

Unit II

ANALYSIS OF SHEAR FORCE AND BENDING MOMENT: Introduction on shear force and bending moment, shear force and bending moment diagrams for cantilever, simply supported and overhanging beams subjected to concentrated loads and uniformly distributed loads - maximum bending moment and point of contra flexure.

Unit III

THEORY OF BENDING AND TORSION: Theory of simple bending and assumptions – simple bending equation - calculation of normal stresses due to bending application, Strain Energy Due to Bending Moment, Torsion -Theory of torsion and assumptions – Torsion equation - Stresses and Deformation in circular Solid and Hollow Shafts – Composite Shaft – Strain Energy due to Torsion, Stress due to combined bending and Torsion, Deformations and Stresses in Helical and Leaf Springs

Unit IV

DEFLECTION OF BEAMS AND COLUMN BUCKLING: Relation between slope - deflection and radius of curvature, Methods of determining slope and deflection using double integration method, Macaulay's method, area moment method.

Columns: Buckling of long columns due to axial load - Euler's and Rankine's formulae for columns of different end conditions

Unit V

PRINCIPAL STRESS AND THEORY OF FAILURE: State of stress at a point, normal and tangential stresses on inclined planes - principal stresses and their planes - plane of maximum shear - Mohr's circle of stresses. Theories Of Elastic Failure: Maximum principal stress theory – Maximum shear stress theory–Maximum principal strain theory – Strain energy theory - Mohr's theory.

Text Book

1. Bansal R K, “Strength of Materials”, Laxmi Publishing co, New Delhi, 2007.

Reference Books

1. G Lakshmi Narasaiah “Aircraft Structures”, BS Publications.,2010
2. Ramamurtham .S “Strength of Materials”, Dhanpat Rai Publishing co, New Delhi, 2008.
3. Rajput R K, "Strength of Materials”, 2006

12AE204 AERODYNAMICS

Credits: 4:0:0

Course Objective:

- To introduce the basics of air flow
- To familiarize with the airfoils and wings and the flow over them

Course Outcome:

By the end of the course students will be able to

- Understand the flow behavior over aircraft wings
- Assess the forces and moments due to flow

Unit I

BASICS: Fundamental Aerodynamic variables. Aerodynamic forces and moments. Centre of pressure. Types of flow. Scalar and vector fields. Gradient of a scalar field vector field, divergence and curl of a vector field and their physical meaning. Line, surface and volume integrals and the relationships between them. Finite control volume and infinitesimal fluid element approach.

Unit II

FLUID FLOW: Continuity equation. Momentum equation and drag of a two dimensional body. Energy equation. Fundamental equations in terms of the substantial derivative. Path lines, Stream lines and Streak lines. Angular velocity, Vorticity and Strain. Circulation. Stream function, Velocity potential and their relationship.

Unit III

POTENTIAL FLOW: Euler’s and Bernoulli’s equations. Pitot tube. Pressure co-efficient. Laplace equation. Infinity and wall boundary conditions. Elementary flows: Uniform flow, Source flow, Sink flow, Doublet and Vortesx flow. Combination of elementary flows: Semi-infinite body, Rankine body, non-lifting and lifting flow over cylinders. Kutta – joukowski theorm and generation of lift.

Unit IV

INCOMPRESSIBLE FLOW OVER AIRFOILS: Airfoil characteristics. The vortex sheet. The Kutta condition. Kevins circulation theorm. Introduction to classical thin airfoil theory - symmetric and cambered airfoil.

Unit V

INCOMPRESSIBLE FLOW OVER FINITE WINGS: Down wash and induced drag. Vortex filament, Helmholtz theorems. Introduction to Prandtl’s lifting line theory and lift distribution

Text Book

1. John D. Anderson, Jr., "Fundamentals of Aerodynamics", Third edition, McGraw-Hill publications, 2001

Reference Books

1. E L Houghton and PW Carpenter, "Aerodynamics for Engineering students", Fourth edition, Edward Arnold publications, 1993.
2. L.M Miline Thomson, “Theoretical Aerodynamics”, 1996

12AE205 AERODYNAMICS LABORATORY - I

Credits: 0:0:2

Course Objective:

- To familiarize with various experimental facilities
- To familiarize with different sensors and measurement techniques
- To conduct the test, acquire the data and analyze and document

Course Outcome:

By the end of the course students will be able

- To choose proper experimental facilities
- To configure the experiment and conduct the test
- To Visualize the flow and pressure distribution over 2D and 3D bodies by tuft & smoke methods

List of Experiments

1. Introduction to Measurement of Pressure & Force and Flow Visualization in SubSonic Wind Tunnel.
2. Performance determination of a Low Speed Wind Tunnel – Test Section Velocity Vs RPM of the Fan.
3. Velocity Measurement at a given cross-section of the Test Section.
4. Smoke Flow Visualization over Symmetrical and Unsymmetrical Airfoils at different Angles of Attack.
5. Smoke Flow Visualization over a Cylinder.
6. Smoke Flow visualization over an Aircraft Model.
7. Flow visualization over a Car Model using Tufts.
8. Pressure Measurement on the surface of a Symmetrical Airfoil at different Angles of Attack.
9. Pressure Measurement on the surface of a Unsymmetrical Airfoil at different Angles of Attack.
10. Pressure Measurement on the surface of a Cylinder.
11. Force Measurement using Wind Tunnel Balance on an Aircraft Model.
12. Wake Survey.
13. Flow Visualization over a Cylinder and Aircraft model using Water Tunnel.

(Any 12 experiments from the above list)

12AE206 AERODYNAMICS LABORATORY - II

Credits: 0:0:2

Course Objective:

- To familiarize with various experimental facilities
- To familiarize with different sensors and measurement techniques
- To conduct the test, acquire the data and analyze and document

Course Outcome:

By the end of the course students will be able

- To choose proper experimental facilities
- To configure the experiment and conduct the test
- To draw inferences from acquired data

List of Experiments

1. Runtime Determination of Supersonic Wind Tunnel.
2. Flow visualization by Schlieren Technique.
3. Flow Visualization by Shadow Graph Method.
4. Pressure measurements over a Double Wedge model.
5. Pressure measurements over a Cone model.
6. Pressure measurements over a Sphere Cylinder model.
7. Unsteady Pressure Measurements in Supersonic Wind Tunnel.
8. Shock Speed Measurements in Shock Tube.
9. Heat Transfer rate Measurements in Shock Tube.
10. Determination of Natural Frequency of Pressure Transducer using Shock Tube.
11. Back Wall Temperature Measurements in Kinetic Heating Simulation facility.
12. Heat flux Measurements in Kinetic Heating Simulation facility.

12AE207 THERMAL ENGINEERING

Credits: 3:0:0

Course Objective:

- To understand the basic concepts of thermal engineering and its applications.
- To apply the concepts of Thermodynamics in practical power cycles of engines
- To learn about steam turbine, Air compressors, Refrigeration and Air conditioning systems

Course Outcome:

By the end of the course students will be able to understand

- Working of various gas power cycles and its thermodynamic basics.
- The principle and operation of Engines, turbines, Refrigeration and Air-conditioning.

Unit I

GASES AND VAPOUR PROPERTIES: Ideal and Real Gases : Equation of state – PVT surface – Specific heat capacity - Real Gas equation Vander val's – Beattie Bridgemann equation – Law of corresponding states – Compressibility Chart

Dalton's law and Gibbs law – Volumetric analysis – Specific heat – Adiabatic mixing – Gas and vapour mixtures

Unit II

STEAM NOZZLES AND STEAM TURBINES: Flow through Nozzles – Nozzle efficiency – Metastable flow – Steam Injector

Classification of steam turbines – Types – compounding – Velocity triangles – Reheating – Steam turbine governing

Unit III

GAS AND STEAM POWER CYCLES: Carnot cycle – air standard efficiency – Otto cycle – Diesel Cycle – Dual cycle – Brayton cycle – comparison

Basic steam power cycles – Rankine, Regenerative, Reheat and Binary cycle (Explanation only)

Unit IV

FUELS AND COMBUSTION: Classification of fuels – Solid, Liquid and Gaseous fuels – basic chemistry – combustion equations – Theoretical and stoichiometric Air Fuel ratio – Volumetric and weight analysis – Exhaust gas analysis – Calorific values – Adiabatic flame temperature – Chemical equilibrium – Combustion analysis

Unit V

REFRIGERATION AND AIR-CONDITIONING: Fundamentals of Refrigeration – Air Refrigeration system – Simple vapour compression – Vapour absorption system – Comparison - Refrigerants

Air-conditioning Systems – Equipments – Components and controls – Air distribution – Load Estimation

Text Book

1. R.K.Rajput, Thermal Engineering, Laxmi Publications (P) Ltd, New Delhi, Seventh Edition, 2009.

Reference Books

1. Kothandaraman, C.P, Domkundwar S., "Engineering Thermodynamics", Dhanpat Rai & Sons, 2nd edition, 2003
2. P.K. Nag, "Basic and applied Thermodynamics", TMH, New Delhi, 2002.

12AE208 THERMAL LABORATORY

Credits: 0:0:2

Course Objective:

- To understand the working principles of the compressor, Blower, IC engines, Air-conditioning and Refrigeration set-ups
- To conduct experiments and calculations so as to estimate the performance of the system
- To analyze the system performance through theoretical calculations and graphical representations

Course Outcome:

The student will be able

- To understand the working principle of the thermal systems like Engines, compressors, blowers, Air-conditioning and Refrigeration test rigs
- To estimate the performance of the systems.

List of Experiments

1. Performance test on twin-cylinder air compressor
2. Performance test on Air blower

3. Performance test on Refrigeration test rig
4. Performance test on Air-conditioning test rig
5. Performance test on Heat pump
6. Valve timing and Port timing diagram of Engines
7. Performance test on Engine
8. Heat balance test on Engine
9. Retardation test on Diesel Engine
10. Emissivity measurement
11. Heat transfer through natural and Forced convection in Pin-Fin
12. Stefan- Boltzmann apparatus
13. Parallel and counter flow heat exchanger
14. Composite wall heat transfer
15. Guarded plate apparatus

(Any 12 experiments from the above list)

12AE209 WIND TUNNEL TECHNIQUES

Credits: 3:0:0

Course Objective:

- To study various types of wind tunnel and its techniques.
- To introduce the basic concepts of measurement of forces and moments on models during the wind tunnel testing.

Course Outcome:

By the end of the course students will be able to

- Understand the various types of wind tunnel and its techniques.
- Understand the application of different types of wind tunnel under various parameters.
- Understand the flow visualization and its measurements

Unit I

WIND TUNNELS: Wind Tunnel, layouts and nomenclature, Types of Wind Tunnels – continuous and intermittent -closed circuit and open circuit - closed jet and open jet test section – application. Special purpose tunnels - Smoke Tunnels – Water Tunnels – Spin tunnel, Important parameters of similarity. Model making.

Unit II

FLOW VISUALIZATION TECHNIQUES: Path – Streak – Stream and Timelines; Techniques: Smoke, Tuft, Streaks, Surface oil flow.

Pressure measurements: Manometers – U-Tube, Inclined and Precession. Bourdon Gauge and Pressure Transducer – Strain Gauge, Semi conductor - Absolute and Differential.

Velocity Measurements: Pitot Tube – Static and Total.

Calibration of test section: Test section flow calibration and Boundary Layers.

Unit III

MEASUREMENTS OF FORCES AND MOMENTS : Forces, moments and Reference Frames – Balances – Internal and External - Requirements and Specifications – Fundamentals off Model Installations.

Unit IV

HIGH SPEED WIND TUNNELS: **Supersonic Wind Tunnels -** Classification - Runtime - Compressors - Charging Times - nozzle Mass Flows - Starting Loads - Model Size – Calibration.

Hypersonic Wind Tunnels: Classification – Runtime – Vacuum Tanks – Vacuum pumps – Evacuation Times.

Shock Tube: Driver – driven – Vacuum Pumps – Diaphragm – Reflected Mode and Flow through Operation – Shock Speed and Initial Diaphragm Pressure Ratio.

Unit V

HIGH SPEED FLOW VISUALIZATIONS AND MEASUREMENTS: Schlieren and Shadow Graph – Pressure sensitive Paints – Temperature sensitive Paints – Force Measurements – Strain Gauge Balances – Pressure Measurements – Transducers – PIV – PLIF - LDV.

Text Books

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

Reference Books

1. John D. Anderson, Jr., "Fundamentals of Aerodynamics", Third edition, McGraw-Hill publications, 2001
2. E L Houghton and PW Carpenter, "Aerodynamics for Engineering students", Fourth edition, Edward Arnold publications, 1993.
3. L.M Miline Thomson, "Theoretical Aerodynamics", 1996

12AE210 CAD LABORATORY

Credits: 0:0:2

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 and Rocket.
- To enable Students to apply their skills in designing

Course Outcome:

By the end of the course students will be able to

- Understand the CAD packages like Solid Works.
- Understand the modeling of different components of aircraft
- Understand the basic aircraft assembly

List of Experiments

1. Typical CAD command structure - Scaling, rotation, translation, editing, dimensioning.
2. Wire frame modeling – surface modeling
3. Solid Modeling.
4. Computer aided modeling of typical aircraft wing.
5. Computer aided modeling of typical fuselage structure.
6. Computer aided modeling of landing gear.
7. Computer aided modeling of canopy.
8. Computer aided modeling of Empennage.
9. Computer aided modeling of Propellers.
10. Computer aided modeling of Wing fuselage joint.

11. Assembly of the Aircraft parts.
12. Three view diagram of a typical aircraft.
13. Computer aided modeling of a Rocket.
14. Three view diagram of a typical rocket.

(Any 12 experiments from the above list)

12AE211 AIRCRAFT INSTRUMENTATION AND AVIONICS

Credits: 3:0:0

Course Objective:

- To provide knowledge on the fundamentals of aircraft instrument and associated measurement techniques
- To provide a knowledge on the basics of avionics

Course Outcome:

- Students will be conversant with measurement techniques and aircraft instruments
- Students will have working knowledge of avionics, its architecture and design

Unit I

DISPLAYS AND MAN-MACHINE INTERACTION : Requirements and standards, instrument element and mechanisms, displays, panels, layouts, Head Up Display (HUD), Helmet Mounted Display, Head Down Display, Display Technology, Control and Data Entry

Unit II

AIR DATA AND AIR DATA SYSTEMS: Air Data Information and its use, Derivation of Air Data Laws and Relationships, Mach Number, Calibrated Air Speed, Static Air Temperature, True Air Speed, Pressure Error, Air Data Sensors and Computing

Unit III

FLIGHT INSTRUMENTS: Primary Flight Instruments (Attitude Indication), Heading Indicating Instruments, Remote Indicating Compasses, Effect of Aircraft Magnetism, Synchronous Data Transmission System

Unit IV

MEASUREMENT OF PARAMETERS AND ENGINE CONTROL INSTRUMENTS: Measurement of Engine Speed, Measurement of Temperature, Measurement of Pressure, Measurement of Fuel Quantity and Fuel Flow, Engine Power and Control Instruments

Unit V

AVIONICS: Introduction and Background, Data Bus Systems, Electrical, Optical and Parallel Data Bus Systems, Various Architecture, Integrated Modular Avionics Architecture, Commercial Off the Shelf (COTS)

Text Books

1. R.P.G Collinson, “Introduction to Avionics Systems” Springer; 3rd ed. edition, 2011
2. Pallett, E.B.J , : " Aircraft Instruments -Principles and applications", Pitman and sons, 1981

Reference Books

1. Sawheny, A.K. “Electrical and Electronics Measurements & Instrumentation”, Dhanpat Rai & Co., 2000
2. Collet. C. V. and Hope. A.D. ‘Engineering Measurements’ 2nd Edition ELBS.

3. S.Baskar, "Instrumentation Control System Measurements and Controls" Anuradha agencies publishers,2004
4. R.K. Jain, "Mechanical and Industrial Measurements" Khanna Publishers, 2002

12AE212 AIRCRAFT STRUCTURES

Credits: 4:0:0

Course Objective:

- To introduce the various structural components of aircrafts and aerospace vehicles
- To study their behavior under different types of loads
- To understand structural design methods for aerospace vehicles

Course Outcome:

By the end of the course students will be able to

- Understand various methods of analysis of aerospace structural members.
- Understand the buckling of plates and the concepts of shear flow
- Understand the basic structure of Composite materials

Unit I

ANALYSIS OF STATICALLY DETERMINATE AND INDETERMINATE STRUCTURES: Analysis of Perfect frames – Method of joints, 3D Truss, Clapeyron's Three Moment Equation, Castigliano's theorem, Maxwell's Reciprocal theorem, Unit load method – applications, Moment Distribution Method.

Unit II

CHARACTERISTICS OF AIRCRAFT STRUCTURES AND MATERIALS: Basic structural elements in Aircraft structures – Axial member – shear panel – Bending members – Torsion members, Load transfer – wing and fuselage, Wing structures, Fuselage Structures, Aircraft materials, Shear and bending moment distribution for semi cantilever and other types of wings and fuselage, thin webbed beam.

Unit III

FLEXURAL SHEAR FLOW IN THIN WALLED SECTIONS: Shear flow in open thin walled sections – Symmetrical and unsymmetrical thin walled section- Multiple shear flow junctions, Shear center in open section, Shear center in closed thin walled section, Statically determinate shear flow, Closed multi-cell section.

Unit IV

BUCKLING OF PLATES: Rectangular sheets under compression, Local buckling stress of thin walled sections, Crippling stresses by Needham's and Gerard's methods. Thin walled column strength. Sheet stiffener panels. Effective width, inter rivet and sheet wrinkling failures.

Unit V

COMPOSITE MATERIALS: Introduction - fiber reinforced composites - fiber and matrix materials - polymer matrix composites - glass fiber -reinforced polymer composites, carbon fiber- reinforced polymer composites, aramid fiber reinforced composites- metal matrix composites- ceramic - matrix composites- carbon –fiber carbon composites.

Text Books

1. Megson, T.M.G., "Aircraft Structures for Engineering Students", 2007.
2. G Lakshmi Narasaiah "Aircraft Structures", BS Publications.,2010

Reference Books

1. Sun C T, " Mechanics of Aircraft Structures", Wiley India,2010 (Unit V)
2. Peery, D.J., "Aircraft Structures", McGraw–Hill, N.Y., 2011.
3. Donaldson B K, "Analysis of Aircraft Structures" Cambridge Aerospace Series, 2008

12AE213 AIRCRAFT STRUCTURES LABORATORY

Credits: 0:0:2

Course Objective:

- To introduce the basic testing equipments for various structural components subjected to static loads
- To familiarize with the measuring equipment and sensors
- To familiarize with the test procedures

Course Outcome:

By the end of the course students will be able to

- Select test equipment for different types of static loading ,
- Conduct tests, analyze results and document
- Compare with analytical/theoretical results

List of Experiments

1. Tensile testing using UTM, Mech. & Optical extensometers, Stress Strain curves and strength tests for different materials
2. Deflection of cantilever beam and verification of Maxwell's Reciprocal theorem and Castigliano's theorem
3. Deflection of simply supported beam and verification of Maxwell's Reciprocal theorem and Castigliano's theorem
4. Column Testing - South well's plot.
5. Tensile testing using UTM on riveted joints and bolted joints
6. Torsion on circular shaft
7. Unsymmetrical bending of beams
8. Shear centre location for open sections
9. Bending stiffness on composite beam
10. Stresses in circular discs and beams using photo-elastic techniques
11. Vibrations of beams
12. Wagner beam – Tension field beam

12AE214 FLIGHT DYNAMICS

Credits: 4:0:0

Course Objective:

To familiarize with the concepts of

- Flight performance and to understand its parameters.
- Static and Dynamic Stability and its control of Aircraft.

Course Outcome:

By the end of the course students will be able

- To make preliminary performance estimation

- To assess various aircraft parameters and their effect of performance
- To analyze the stability of aircraft
- To assess the requirement of control forces

Unit I

DRAG ON THE AIRPLANE: Forces and moments acting on a flight vehicle - Equation of motion of a rigid flight vehicle - Different types of drag - Drag polar - Variation of thrust, power and SFC with velocity and altitudes for air breathing engines and Reciprocating engines - Power available and power required curves.

Unit II

AIRCRAFT PERFORMANCE: Performance of airplane in level flight - Maximum speed in level flight - Conditions for minimum drag and power required - Range and endurance - Climbing and gliding flight (Maximum rate of climb and steepest angle of climb, minimum rate of sink and shallowest angle of glide) -Turning performance (Turning rate, turn radius). Bank angle and load factor - Limitations of pull up and push over - V-n diagram and load factor.

Unit III

STATIC LONGITUDINAL STABILITY: Degree of freedom of rigid bodies in space - Static and dynamic stability - Purpose of controls in airplanes -Inherently stable and marginal stable airplanes – Static Longitudinal stability - Stick fixed stability - Basic equilibrium equation - Stability criterion - Effects of fuselage and wings - Stick fixed neutral point - Stick free stability-Hinge moment coefficient - Stick free neutral points- Stick force gradients - - Aerodynamic balancing.

Unit IV

LATERAL AND DIRECTIONAL STABILITY: Dihedral effect - Lateral control - Coupling between rolling and yawing moments - Adverse yaw effects - Aileron reversal - Static directional stability - Weather cocking effect - Rudder requirements - One engine inoperative condition - Rudder lock.

Unit V

DYNAMIC STABILITY: Dynamic longitudinal stability: Equations of motion - Stability derivatives - Characteristic equation of stick fixed case - Modes and stability criterion - Effect of freeing-the stick - Brief description of lateral and directional dynamic stability. Dynamic effect - Spiral, Dutch roll, auto rotation and spin.

Text Book

1. Perkins, C.D., and Hage, R.E., “Airplane Performance stability and Control”, John Wiley & Son, Inc, New York, 2000.

Reference Books

1. J D Anderson, “Aircraft performance and Design”, McGraw-Hill, , New York, 2000.
2. Etkin. B., “Dynamics of Flight Stability and Control”, Edn. 2, John Wiley, New York, 1982.

12AE215 SPACE DYNAMICS

Credits: 4:0:0

Course Objective:

- To familiarize with the performance, stability and control of rockets
- To introduce the Solar system, Reference frames and times
- To familiarize with various factors effecting the satellite orbits

Course Outcome:

By the end of the course students will be able

- To estimate the trajectory and performance of the vehicle
- To use proper reference coordinate system for space vehicle analysis
- To generate Preliminary design of inter-planetary trajectory

Unit I

PERFORMANCE: Performance of single and multistage rockets, staging, separation of stages.

Unit II

ROCKET STABILITY AND CONTROL: Definition of stability, equilibrium, definition of static and dynamic stability; Static Longitudinal Stability and Control, Lateral and directional Stability and Control, Dynamic Stability

Unit III

THE SOLAR SYSTEM: Reference frames and coordinate systems - The celestial sphere - The ecliptic - Motion of vernal equinox - Sidireal time - Solar time - Standard time - The earth's atmosphere - Space environment - Peculiarities -Effect of space environment on the selection of materials of spacecraft.

Unit IV

SATELLITES: General Aspects of satellite Injections – Satellite Orbit Transfer –Various Cases – Deviations Due to Injection Errors – Special and General Perturbations – Cowell's Method – Encke's Method – Method of vibrations of Orbital Elements – General Perturbations Approach.

Unit V

INTERPLANETARY TRAJECTORIES: Two dimensional interplanetary trajectories - Fast interplanetary trajectories - Three dimensional interplanetary Trajectories - Launch of interplanetary spacecraft, Trajectory geometry – Optimal flights - Time of flight .

Text Book

1. J.W.Cornelisse, H.F.R. Schoyer, and K.F. Wakker,"Rocket Propulsion and Spaceflight Dynamics", Pitman, 2001
2. William E.Wiesel,"Spaceflight Dynamics", McGraw-Hill, 1997

Reference Books

1. Vladimir A. Chobotov, "Orbital Mechanics", AIAA Education Series, AIAA Education Series, Published by AIAA, 2002
2. David.A. Vellado, Microcosm and Kluwer"Fundamentals of Astrodynamics and Applications", , 2001
3. Sutton, G.P. "Rocket Propulsion Elements", John Wiley, 2009.

12AE216 COMPUTATIONAL FLUID DYNAMICS

Credits: 4:0:0

Course Objective:

- To provide the knowledge of governing equations of fluid dynamics, able to discretise the equations and incorporate the boundary conditions.

- To provide the knowledge of the solution methodologies of discretised equations and incorporate the turbulence and combustion models.

Course Outcome:

- The students will have the knowledge of performing CFD Analysis.
- The students will be able to apply the boundary conditions and solve CFD problems.
- The students will be able to solve problems using turbulence and combustion models.

Unit I

GOVERNING EQUATIONS: Conservative and divergence form of Governing equation of fluid flow and heat transfer, equation of state. Navier Stokes equations. Differential and integral form of general transport equation. Classification of physical behavior, role of characteristics. Classification method of simple partial differential equations

Unit II

TURBULANCE: Turbulence. Transition from Laminar to turbulent flows. Time averaged Navier Stokes equations. Turbulence Models – Mixing length, K – ε model, assessment of performance. Overview of recent developments

Unit III

INTODUCTION TO CFD: What is CFD, How does CFD code work? Problem solving with CFD 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.

Unit IV

CONVECTION DIFFUSION PROBLEMS: Steady one dimensional convection diffusion. The central difference, upwind differencing and hybrid schemes. Properties of discretion schemes and convergence. Assessment of central difference, upwind differencing and hybrid schemes. Overview of Power law and QUICK shemes

Unit V

VARIOUS SCHEMES: Boundary Conditions – Inlet, outlet, Wall, constant pressure, symmetric and cyclic. Staggered grid and momentum equations. SIMPLE, SIMPLER and SIMPLEC algorithms. TDMA and application of TDMA to two dimensional problems

Text Books

1. Versteeg, H.K, and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", Longman, 1998
2. Anderson, J.D., "Computational fluid dynamics – the basics with applications", 1995.

Reference Books

1. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw-Hill Publishing Company Ltd., 1998.
2. Muralidhar, K and Sundarajan .T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.
3. Bose, T.K., "Numerical Fluid Dynamics", Narosa publishing House, 1997.
4. Patankar, S.V., "Numerical Heat Transfer and Fluid Flow", McGraw-Hill, 1980. Ane-Books2004 Indian Edition.

12AE217 CFD LABORATORY

Credits: 0:0:2

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
- To define the body shape in a CFD code
- To derive aerodynamic quantities from computed data

Course Outcome:

- The students will have the knowledge of performing CFD Analysis.
- The students will be able to apply the boundary conditions and solve CFD problems.
- The students will be able to solve problems using turbulence and combustion models.

List of Experiments

1. Laminar Pipe Flow
2. Turbulent Pipe Flow
3. Modeling 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. Flow past a Sphere
13. Compressible Flow in a Nozzle

(Any 12 experiments from the above list)

Software Used: Modeling software: GAMBIT 2.3**,** FLUENT.Inc : 6.3

12AE218 AEROSPACE PROPULSION

Credits: 4:0:0

Course Objective:

- To familiarize with Principles of Aerospace Propulsion
- To familiarize with the concept of Combustion in aircraft engines and Rocket motors
- To introduce working of Propulsion systems of Aircraft and Rockets

Course Outcome:

Ability to

- To assess the performance of different Propulsion cycles.
- To assess the performance of various sub-systems of the propulsion system
- To understand the causes of under-performance and remedial measures

Unit I

BASICS OF PROPULTION AND COMBUSTION: Propulsion, Operational Envelopes, Air breathing engines, Aircraft Engines, Rocket Engines; Combustion --Fuels & Oxidisers, Reaction Rates, Inflammability, ignition, flame propagation, combustion in Rocket motors, Operational requirements, some important factors affecting combustor design.

Unit II

COMPRESSOR AND TURBINES: Centrifugal Compressors: Basic concepts, Principle of operation, Work done and pressure rise, Axial flow Compressors: Basic operation & Elementary theory. Factors affecting static pressure ratio, Degree of reaction, Axial and Radial flow Turbines: Elementary theory, Vortex theory, Estimation of Stage performance. Overall Turbine Performance.

Unit III

JET ENGINES: Aircraft Gas turbine Engines -- Thrust Equation, Propulsive Efficiency, Engine Components, Analysis of Ideal Engines – Turboprop, Turbojet, Turbojet with Afterburner, Turbofan, Turbofan with bypass, Turbofan with Afterburner, Ram jet

Unit IV

ENGINE PERFORMANCE: Engine Performance Analysis – Gas Generator, Turbojet, Turbojet with Afterburner, Turbofan, Turbofan with bypass, Turbofan with Afterburner, Ram jet, Subsonic and Supersonic- inlets and exhaust nozzles

Unit V

ROCKET MOTORS: Rocket Motors – Thrust Equation, Relation between thrust and nozzle parameters, Thrust coefficient, Specific Impulse, Nozzle Shapes, Characteristic velocity**,** Solid motors -- Components, design of propellant grain, Design of Thrust profile, Liquid Propellant Motors -- Components, Chamber design, Introduction to cryogenic system.

Text Books

1. Mukunda, H S, Understanding Combustion, Universities Press, 2009
2. Jack .D Mattingly, Elements of Gas Turbine Propulsion, Tata McGraw Hill Publishing Co. 2005
3. Sutton, G.P., et al., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 2004

Reference Books

1. V. Ganesan, Gas Turbines, Tata Mc Graw - Hill Publishing Company Ltd 1999.
2. Rolls Royce Plc, The Jet Engine, 1996, ISBN 090212235
3. E. Irwin Treager, Aircraft Gas Turbine Engine Technology, 3rd Edition 1995 'ISBN-00201828
4. H. Cohen & F.C Rogers and H.I.H Saravanmuthu, Gas Turbine Theory, Edition, Longman 2001.
5. Marcel Barrere, Rocket Propulsion, Elsevier,1960

12AE219 PROPULSION LABORATORY

Credits: 0:0:2

Course Objective:

- To understand the basic concepts and carryout experiments in Aerospace Propulsion.
- To understand the space propulsion system.

Course Outcome:

Ability to

- Understand various propulsive systems

- Understand the performance of aircraft engines, propellers and other components
- Understand the ignition systems

List of Experiments

1. Study of an aircraft jet engine –various components, their functions and operating principles.
2. Study of performance of a propeller.
3. Study of open jet.
4. Study of free jet.
5. Cascade testing of a model of axial compressor blade row.
6. Study of forced convective heat transfer.
7. Calorific value estimation.
8. Ignition Delay studies.
9. Study regarding injector calibration.
10. Storage losses in an insulated liquid oxygen tank.
11. Impingement and cooling requirement of a Rocket exhaust over a "J" type jet deflector, thermal response of the deflector.
12. Measurement of nozzle heat flux in a convergent-divergent nozzle

12AE220 GAS DYNAMICS

Credits: 4:0:0

Course Objective:

- To familiarize with behavior of compressible gas flow
- To understand the difference between subsonic and supersonic flow
- To familiarize with high speed test facilities

Course Outcome:

Ability

- To distinguish between various flow regimes
- To analyse the flow under different flow conditions
- To assess the flow behavior and consequent loads due to flow

Unit I

ONE DIMENSIONAL COMPRESSIBLE FLOW: Compressibility, Velocity of sound, Adiabatic steady state flow equations, Normal shock, Prandtl equation and Rankine – Hugoniot relation, Normal shock equations, Flow through converging-diverging passages, Performance under various back pressures, Pitot static tube, corrections for subsonic and supersonic flows.

Unit II

OBLIQUE SHOCKS AND EXPANSION WAVES: Oblique shocks and corresponding equations, Hodograph and pressure turning angle, shock polars, Flow past wedges and concave corners, Strong, weak and detached shocks, Rayleigh and Fanno Flow. Flow past convex corners, Reflection and interaction of shocks and expansion waves, Families of shocks, Method of Characteristics,

Unit III

DIFFERENTIAL EQUATIONS OF MOTION FOR STEADY COMPRESSIBLE FLOWS: Energy, Momentum, continuity and state equations, Small perturbation potential theory, solutions for

supersonic flows, Mach waves and Mach angles, Prandtl-Glauert affine transformation for subsonic flows.

Unit IV

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,

Unit V

HIGH SPEED FLOW OVER FINITE WING: Finite wing, tip effects, Characteristics of swept wings, Effects of thickness, camber and aspect ratio of wings, Transonic area rule,

Text Books

1. Rathakrishnan, E., "Gas Dynamics", Prentice Hall of India, 2008
2. Shapiro, A.H., "Dynamics and Thermodynamics of Compressible Fluid Flow", Ronald Press, 1982

Reference Books

1. Liepmann H W and Roshko A, "Elements of Gasdynamics", John Willey & Sons .
2. Zucrow, M.J. and Anderson, J.D., "Elements of Gas Dynamics", McGraw-Hill Book Co., NY, 1989.
3. Mc Cornick. W.,"Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, NY, 1979
4. Anderson Jr., D., – "Modern compressible flows", McGraw-Hill Book Co., New York 1999.

12AE221 HEAT AND MASS TRANSFER

Credits: 4:0:0

Course objective:

- To understand the basic concepts of conduction, convection and radiation heat transfer.
- To understand how to formulate and be able to solve one and two dimensional conduction heat transfer problems.
- To understand the fundamentals of the relationship between fluid flow, convection heat transfer and mass transfer.

Course Outcome:

- Students will be able to understand about Conduction, convection, radiation, heat transfer during boiling and condensation.
- Students will be able to design the heat exchangers.

Unit I

CONDUCTION HEAT TRANSFER: Introduction to conduction heat transfer, Fourier's law of Conduction, Thermal Conduction equation – Derivation in Cartesian, Cylindrical and Spherical coordinates. One dimensional steady state conduction in plane wall and composite wall. Thermal contact resistance variable conductivity, thermal resistance, electrical analogy, radial systems – cylinder, sphere. Overall heat transfer coefficients, critical thickness of insulation. Heat generation in plane wall, cylinder and sphere, Extended surfaces

Unit II

STEADY AND UNSTEADY STATE CONDUCTION HEAT TRANSFER: Steady State Conduction-Two dimensional Heat Conduction, Conduction Shape Factor, Numerical Method of

Analysis. Unsteady state conduction – Lumped Heat Capacity System, Significance of Biot and Fourier Numbers, Transient Heat flow in a Semi-Infinite Solid, Use of Heisler and Grober Charts.

Unit III

CONVECTIVE HEAT TRANSFER: Principles of Convection-Thermal boundary layers. Significance of Non-Dimensional Numbers, Dimensional Analysis for Free and Forced convection. Forced Convection –Heat Transfer Over a Flat Plate, Empirical Relations for Pipe and Tube Flow, Flow Across Cylinders and Spheres. Free Convection – Empirical Relations for Free Convection, Heat Transfer on a Vertical, Horizontal and Inclined Surfaces.

Unit IV

RADIATION HEAT TRANSFER AND MASS TRANSFER: Radiation Heat Transfer –Nature of Thermal Radiation, Black Body Concepts, Gray body, Radiation Shape Factor , Radiation Heat Transfer Between Two Surfaces. Electrical analogy, Re-radiating Surface, Radiation Shields.
Mass Transfer – Fick's Law of Diffusion, Equi-Molar Counter Diffusion, Mass Transfer Coefficient, Evaporation process in the Atmosphere.

Unit V

APPLICATION OF HEAT TRANSFER PROBLEMS IN AEROSPACE ENGINEERING: Heat Transfer Analysis in Injectors, Gas Turbine Combustion Chamber and Nozzles-Heat Transfer Distribution, Cooling Thrust Chambers, Cooling with Steady and Transient Heat Transfer, Thermal Insulation, Rocket Thrust Chambers - Aerodynamic Heating -Ablative Heat Transfer.

Text Books

1. Holman J.P., 'Heat Transfer', SI Metric Ed., Mc Graw Hill, ISE, 8th Ed.-1997.
2. Sutton, G.P., " Rocket Propulsion Elements ", John Wiley and Sons, 5th Edn.1986

Reference Books

1. Lienhard, J.H., " A Heat Transfer Text Book ", Prentice Hall Inc., 1981.
2. Mathur, M.and Sharma, R.P., " Gas Turbine and Jet and Rocket Propulsion " , Standard Publishers, New Delhi 1988.
3. Beyazitogly Yildiz., Ozisik, M.Necati., 'Elements of Heat Transfer', McGraw Hill, 1956.
4. Sachdeva, S.C., " Fundamentals of Engineering Heat and Mass Transfer " , Wiley Eastern Ltd., New Delhi, 1981

12AE222 FINITE ELEMENTS ANALYSIS

Credits: 4:0:0

Course Objective:

- To equip the students with the Finite Element Analysis fundamentals.
- To enable the students to formulate the design problems into FEA.
- To introduce basic aspects of finite element technology, including domain discretization,

Course Outcome:

By completing this course, the students will be able to:

- Identify mathematical model for solution of common engineering problems.
- Formulate simple problems into finite elements.
- Use professional-level finite element software to solve engineering problems in Solid mechanics, fluid mechanics and heat transfer.

Unit I

INTRODUCTION: Basic concepts- General applicability of the method to structural analysis, heat transfer and fluid flow problems- general approach of finite element method with case studies in stress analysis, classical analysis techniques-finite element packages - Solution of Finite Equations: Solution of equilibrium problems- Gauss elimination techniques, Choleski method solution of Eigen value problem , Jacobi method, power method, subspace interaction method- Solution of propagation problems, numerical solutions.

Unit II

GENERAL PROCEDURE: Discretization of Domain- basic element shapes- interpolation polynomials- natural coordinates- formulation of element characteristic matrices and vectors- direct approach –variational approach and weighted residual approach. Formulation of one dimensional, two-dimensional, three-dimensional elements, continuity conditions- isoparametric elements- curve sided elements- numerical integration.

Unit III

SOLID AND STRUCTURAL MECHANICS: Basic equations of solid mechanics- Static analysis- formulation of equilibrium equations analysis of trusses and frames- analysis of plates- Solid of revolution. Dynamic analysis –dynamic equations of motion- consistent and lump mass matrices- Free vibration analysis – dynamic response calculation.

Unit IV

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

Unit V

HEAT TRANSFER AND OTHER PROBLEMS: Basic equations of heat transfer derivation using finite element Method for 1D problems. Fluid mechanics problems: Basic equations- Solutions procedure- compressible flows- Galerkin approach. Boundary Element Method (BEM): Introduction, Types, Advantages & Disadvantages of BEM-Types of Boundary Elements-Infinite Boundary Element

Text Books

1. Rao. S.S. “The Finite element method in Engineering”, IInd Ed., Pergamon Press, Oxford, 2003
2. J.Ramachandran, “Boundary and Finite Element Theory and Problems”, Narosa Publishing House, 2000.

Reference Books

1. K.J. Bathe, ‘ Finite Element Procedures in Engineering Analysis”, Prentice hall, Engle Wood chiffs, 1981.
2. C.S. Desai and J.P. Abel. “ Introduction to Finite Element Method” Affiliated East West Press, 1972.
3. Belagundu, “Finite Element Methods in Engineering”, PHI, 2002

12AE223 GUIDANCE AND CONTROL OF AEROSPCAE VEHICLES

Credits: 4:0:0

Course Objective:

- To introduce the concepts of Navigation, guidance and control
- To familiarize with various ways in which aerospace vehicles are guided and controlled

Course Outcome:

Ability to

- Appreciate how complex aerospace vehicles navigate in air and space
- Analyse the control systems which assist in maneuvering these vehicles

Unit I

NAVIGATION: Introduction, Basic Principles and Definitions; Dead reckoning and Position Fixing, Celestial, Radio, Inertial Navigation; Principle and Construction of Accelerometers, Mechanical Gyros and Ring Laser Gyros, Inertial Measurement Units, Navigation Equations, Sensor Error Models, Kalman Filter, Attitude Heading Reference System, GPS, Terrain Reference Navigation

Unit II

GUIDANCE: Optimal Terminal Guidance of Interceptors, Optimal Terminal Guidance - planar and non-planar, Robust and Adaptive Guidance, Guidance with State Feedback , Guidance with Normal Acceleration Input , Minimum Energy Orbital Transfer

Unit III

GUIDANCE AND CONTROL OF AIRCRAFT: Powered Flying Controls, Helicopter Flight Controls, Fly-by-Wire Flight Control, Control laws, Redundancy and Failure Survival, Digital Implementation, Fly-by-Light Flight Control, Auto Pilot, Flight Management Systems, Unmanned Aerial Vehicles

Unit IV

CONTROL TECHNIQUES/ CONTROL OF ROCKETS AND MISSILES: Open-loop and Closed Loop Control Systems, Multi-variable Optimization, Optimal Control of Dynamic Systems, Hamiltonian and Minimum Principle and Jacobi-Bellman Equation, Linear Time-Varying System with Quadratic Performance Index, Closed-Loop Attitude Control, Roll Control System, Pitch Guidance and Control System of Rockets, Adaptive Pitch Control System, Yaw Control of Rockets, Guidance and Control of Missiles

Unit V

CONTROL OF SPACECRAFT: Launch of Satellite/ Spacecraft, Terminal Control of Spacecraft Attitude, Optimal Single-Axis Rotation of Spacecraft, Multi-axis Rotational Maneuvers of Spacecraft, Spacecraft Control Torques, Rocket Thrusters, Reaction Wheels, Momentum Wheels and Control Moment Gyros, Torques - Magnetic Field -Environmental -Gravity-Gradient.

Text Books

1. Tewari, A."Advanced Control of Aircraft, Spacecraft and Rockets", John Wiley & Sons, Ltd, Chichester, UK, 2011
2. R.P.G Collinson, "Introduction to Avionics Systems", Springer; 3rd ed. edition, 2011

Reference Books

1. Noton,M. "Spacecraft navigation and Guidance", Springer-Verlag, Germany, 1998.
2. Richard H. Battin "An Introduction to the Mathematics and Methods of Astrodynamics", AIAA, 1999.
3. Nagrath. M. and Gopal. I.J. "Control Systems Engineering", Wiley eastern Ltd.,.2001

4. Nagoorkani.A "Control Systems", RBA publications, first edition ninth reprint 2002

12AE224 AIRCRAFT/SPACECRAFT DESIGN PROJECT

Credits: 0:0:2

Course Objective:

- To familiarize with inputs required for Aircraft design
- To familiarize with methodology for aerodynamic design of aircraft
- To select proper power plant to meet performance requirements
- To familiarize with methodology for structural design of aircraft

Course Outcome:

By the end of the project, the student will be able to

- Design a aircraft/Spacecraft with given configuration
- Estimate the design parameters required for its better performance

Works to be carried out:

1. Comparative study of the different type of the aircrafts / spacecrafts and their specifications and performance details.
2. Preliminary weight estimations, selection of main parameters, Power plant selection, In case of Aircraft: Aerofoil selection for Wing, Tail and Control surfaces
3. Preparation of lay out of balance diagram and three view drawings
4. Detailed performance calculation and Stability Estimates, V-n diagram

Reference Books

1. Jan Roskam - Airplane Design Part I-VIII, DAR Corporation, 2000
2. John P Fielding – Introduction to Aircraft Design, Cambridge University Press, 2005

12AE225 FATIGUE AND FRACTURE MECHANICS

Credits: 4:0:0

Course objective:

- To familiarize with the structural fatigue and its behavior
- To familiarize with the physical aspects of fatigue and the failure mechanism of components
- To familiarize the concept of fail-safe design process

Course outcome:

By the end of the course, the student will be able to

- Understand the concepts of fatigue behavior in statistical and physical aspects
- Understand the principles of fracture mechanics and fail-safe design
- Know the importance of fracture mechanics in aerospace structures

Unit I

FATIGUE OF STRUCTURES: S.N. curves - Endurance limits - Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams - Notches and stress concentrations - Neuber's stress concentration factors - Plastic stress concentration factors - Notched S.N. curves.

Unit II

STATISTICAL ASPECTS OF FATIGUE BEHAVIOR: Low cycle and high cycle fatigue - Coffin - Manson's relation - Transition life - cyclic strain hardening and softening - Analysis of load histories - Cycle counting techniques -Cumulative damage - Miner's theory - Other theories.

Unit III

PHYSICAL ASPECTS OF FATIGUE: Phase in fatigue life - Crack initiation - Crack growth - Final Fracture - Dislocations - fatigue fracture surfaces.

Unit IV

FRACTURE MECHANICS: Strength of cracked bodies - Potential energy and surface energy - Griffith's theory - Irwin - Orwin extension of Griffith's theory to ductile materials - stress analysis of cracked bodies - Effect of thickness on fracture toughness - stress intensity factors for typical geometries.

Unit V

FAIL-SAFE DESIGN AND AEROSPACE APPLICATION: Safe life and Fail-safe design philosophies - Importance of Fracture Mechanics in aerospace structures - Application to composite materials and structures.

Text Books

1. Prasanth Kumar – "Elements of fracture mechanics" – Wheeter publication, 1999.
2. Barrois W, Ripely, E.L., "Fatigue of aircraft structure", Pergamon press. Oxford, 1983.

Reference Books

1. Sin. C.G., "Mechanics of fracture" Vol. I, Sijthoff and w Noordhoff International Publishing Co., Netherlands, 1989.
2. Knott, J.F., "Fundamentals of Fracture Mechanics", Buterworth & Co., Ltd., London, 1983

12AE226 AIR TRAFFIC CONTROL AND AERODROME DETAILS

Credits: 4:0:0

Course objective:

- To understand the scope and purpose of ATC
- To study the procedure of the formation of aerodrome and its design and air traffic control.

Course outcome:

By the end of the course, the student will be able to

- Know the basic concepts of ATS and its services.
- Understand the flight operations between destinations.
- Understand the concepts of Aerodrome layouts and its design.

Unit I

BASIC CONCEPTS: 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.

Unit II

AIR TRAFFIC SERVICES: 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

Unit III

FLIGHT INFORMATION SERVICE: Radar service, 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.

Unit IV

AERODROME DATA: 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.

Unit V

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 Book

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

Reference Books

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.

12AE227 INTRODUCTION TO COMPOSITE MATERIALS & STRUCTURES

Credits: 4:0:0

Course objective:

- To understand the structural analysis of the composite materials.
- To know the design and fabrication process of composite materials & structures.

Course outcome:

By the end of the course, the student will be able to

- Understand the physical and mechanical properties of Composite materials and its structure
- Know the various method of structural analysis of the materials
- Understand the various fabrication processes involved in it.

Unit I

STRESS STRAIN RELATION: Introduction- Advantages and application of composite materials, reinforcements and matrices – Generalized Hooke's Law – Elastic constants for anisotropic, orthotropic and isotropic materials.

Unit II

METHODS OF ANALYSIS: Micro mechanics – Mechanics of materials approach, elasticity approach to determine material properties – Macro Mechanics – Stress-strain relations with respect to natural axis, arbitrary axis – Determination of material properties. Experimental characterization of lamina.

Unit III

LAMINATED PLATES: Governing differential equation for a general laminate, angle ply and cross ply laminates. Failure criteria for composites.

Unit IV

SANDWICH CONSTRUCTION: Basic design concepts of sandwich construction - Materials used for sandwich construction - Failure modes of sandwich panels.

Unit V

FABRICATION PROCESS: Various Open and closed mould processes. Manufacture of fibers – Types of resins and properties and applications – Netting analysis.

Text Book

1. Jones, R.M., "Mechanics of Composite Materials", McGraw-Hill, Kogakusha Ltd., Tokyo, 2010.

Reference Books

1. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites", John Wiley and sons. Inc., New York, 1995.
2. Lubin, G., "Handbook on Advanced Plastics and Fibre Glass", Von Nostrand Reinhold Co., New York, 1989.

12AE228 CRYOGENIC PROPULSION

Credits: 4:0:0

Course Objective:

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

Course outcome:

By the end of the course, the student will be able to

- Understand the thermal, physical and fluid dynamic properties of cryogenic propellant.
- Know the various method of cryogenic insulations, its storage and instrumentation
- Understand the various cryogenic equipments used in Aerospace application.

Unit I

INTRODUCTION TO CRYOGENIC ENGINEERING: Thermo physical and fluid dynamic properties of liquid and gas hydrogen, Thermo physical and fluid dynamic properties of liquid and gas helium, Liquefaction systems of hydrogen and helium gases, Liquefaction systems of hydrogen and helium gases, Refrigeration and liquefaction principals; Joule Thomson effect and inversion curve; Adiabatic and isenthalpic expansion with their comparison

Unit II

PROPERTIES: Cryogenic fluids, Solids at cryogenic temperatures; Superconductivity, Recuperative – Linde – Hampson, Claude, Cascade, Heylandt, Kapitza, Collins, Simon; Regenerative – Stirling cycle and refrigerator, Slovay refrigerator, Gifford-McMahon refrigerator, Vuilleumier refrigerator, Pulse Tube refrigerator; Liquefaction of natural gas

Unit III

CRYOGENIC INSULATION : Vacuum insulation, Evacuated porous insulation, Gas filled Powders and fibrous materials, Solid foams, Multilayer insulation, Liquid and vapour Shields, Composite insulations.

Unit IV

STORAGE AND INSTRUMENTATION OF CRYOGENIC LIQUIDS: Design considerations of storage vessel; Dewar vessels; Industrial storage vessels; Storage of cryogenic fluids in space; Transfer systems and Lines for cryogenic liquids; Cryogenic valves in transfer lines; Two phase flow in Transfer system; Cool-down of storage and transfer systems, Measurement of strain, pressure, flow, liquid level and Temperature in cryogenic environment; Cryostats.

Unit V

CRYOGENIC EQUIPMENT: Cryogenic heat exchangers – recuperative and regenerative; Variables affecting heat exchanger and system performance; Cryogenic compressors, Pumps, expanders; Turbo alternators; Effect of component inefficiencies; System Optimization, Magneto-caloric refrigerator; 3He-4He Dilution refrigerator; Cryopumping; Cryogenic Engineering applications in energy, aeronautics, space, industry, biology, preservation Application of Cryogenic Engineering in Transport

Text Book

1. 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. Barron , "Cryogenic Systems", Oxford University Press, 1985
3. R.W. Vance and W.M. Duke , "Applied Cryogenic Engineering" , John Wiley & sons., 1962

12AE229 INTRODUCTION TO NON DESTRUCTIVE TESTING

Credits: 4:0:0

Course Objective:

- To study the various processes involved in non destructive testing.
- To know its application in Aerospace maintenance field.

Course outcome:

By the end of the course, the student will be able to

- Know the introduction about the non – destructive testing, its scope and purpose.
- Understand the different NDT process.

Unit I

INTRODUCTION: Introduction to NDT, concern in NDT, History, NDT vs. Destructive, Conditions for NDT, Personal Considerations, Certification, Primary production of metal, castings, cracks,

welding discontinuities, corrosion induced discontinuities, fatigue cracking, creep, brittle fracture, geometric discontinues.

Unit II

VISUAL TESTING: Penetrate Testing- Introduction, History and Development, Theory and Principles, Penetrate Equipment and Materials, Penetrant Procedures, Penetrate Testing Applications, Quality Control Considerations, Advantages and Limitations, Glossary of Penetrate Testing Terms, Magnetic Particle Testing - History and Development, Theory and Principles, Equipment and Accessories, Techniques, Variables, Evaluation of Test Results and Reporting, Applications, Advantages and Limitations.

Unit III

RADIOGRAPHIC TEST: History and Development, Theory and Principles, Radiographic Equipment and Accessories, Variables, Techniques and Procedures, Radiographic Evaluation, Applications, Advantages and Limitations of Radiography, Compendium of Radiographs

Unit IV

ULTRASONIC TESTING: History, Theory and Principles, Equipment for Ultrasonic Applications, Techniques, Variables, Evaluation of Test Results, Applications, Advantages and Limitations, Eddy Current Testing- History and Development, Theory and Principles, Alternating Current Principles, Eddy Currents, Test Equipment, Eddy Current Applications and Signal Display, Advantages and Limitations, Other Electromagnetic Test Techniques

Unit V

OTHER METHODS: Thermal Infrared Testing - History and Development, Theory and Principles, Equipment and Accessories, Techniques, Variables, Data Storage, Applications, Advantages and Limitations, Acoustic Emission Testing - History and Development, Principles of Acoustic Emission Testing, Advantages and Limitations of Acoustic Emission Testing.

Text book

1. P. E. Mix, "Introduction to non-destructive testing", Wiley Interscience,, John Wiley & Sons, Inc, Publ., 2005

Reference book

1. C. Hellier, "Handbook of Nondestructive Evaluation", McGraw-Hill, 1994.

12AE230 BOUNDARY LAYER THEORY

Credits: 4:0:0

Course Objective:

- To familiarize the students with viscous flow phenomena.
- To know the laminar and thermal boundary layer equations.

Course outcome:

By the end of the course, the student will be able to

- Know the fundamental theory of Boundary layer
- Understand the various equations involved in boundary layer theory
- Understand the different kinds of Boundary Layer control

Unit I

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 and Equation of motion ,Stokes Hypothesis.

Unit II

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

Unit III

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

Unit IV

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

Unit V

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.

Text Book

1. "Boundary Layer Theory" by H.Schlichting and K.Gersten, 8th edition, Enlarged Edition-Springer, 2000

Reference book

1. Ian. J. Sobey, "Introduction to interactive Boundary Layer Theory", Oxford University Press, USA, 2001

12AE231 BASICS OF AEROSPACE ENGINEERING

Credits: 3:0:0

Course Objective:

- To introduce the basic concepts of aircrafts, rockets, satellites and their application
- To familiarize with the basic parts and their function and construction

Course Outcome:

By the end of the course students will be able to understand

- Nature of aerospace technologies,
- Principles of flight, power plants used and fundamentals of structures.

Unit I

HISTORICAL EVOLUTION: Early airplanes, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

Unit II

AIRCRAFT CONFIGURATIONS: Components of an airplane and their functions. Different types of flight vehicles, classifications. Conventional control, Powered control, Basic instruments for flying, Typical systems for control actuation. Introduction to Avionics and its components.

Unit III

PRINCIPLES OF FLIGHT: Physical properties and structure of the atmosphere, Temperature, pressure and altitude relationships, Evolution of lift, drag and moment. Aerofoils, Mach number, Maneuvers..

Unit IV

AEROSPACE STRUCTURES: General types of Aircraft construction, Monocoque, semi-monocoque and geodesic construction, Aerospace materials, metallic and non metallic materials, typical wing and fuselage structure. Landing Gear Structure

Unit V

AEROSPACE POWER PLANTS: Basic ideas about piston, turboprop and jet engines, Use of propeller and jets for thrust production. Comparative merits, 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, NewDelhi, 5th Edition, 2009.

Reference Books

1. A.C Kermode, “Flight without Formulae” , Pearson Education,5th Edition, 2008.
2. Course material of Faculty Enablement Programme on “Introduction to Aircraft Industry”, conducted by Infosys, Mysore through Campus connect programme.

LIST OF SUBJECT

Sub. Code	Name of the Subject	Credits
12AE232	Space Dynamics	4:0:0

12AE232 SPACE DYNAMICS

Credits: 4:0:0

Objective:

- To familiarize with the performance and stability of rockets
- Solar System and basics of orbital mechanics
- To familiarize with various factors effecting the satellite orbits

Outcome:

By the end of the course students will be able

- To estimate the trajectory and performance of the vehicle
- To use proper reference coordinate system for space vehicle analysis
- To generate Preliminary design of inter-planetary trajectory

Unit I

ROCKET VEHICLE DYNAMICS: Equations of motion, the thrust equation, Rocket performance, Restricted staging in field-free space, Optimal staging, Definition of stability, Static and dynamic stability of rockets.

Unit II

SOLAR SYSTEM AND SOME BASICS OF ORBITAL MECHANICS: Solar System, Reference frames, Coordinate Systems, Time Systems, The celestial sphere - The ecliptic, Motion of vernal equinox, Position and Velocity as a Function of Time, Solution of Kepler's equation, Coordinate transformation, Preliminary orbit determination.

Unit III

ORBIT PREDICTIONS: A General Overview of Orbit Perturbations, Special and General Perturbations- Cowell's Method –Encke's Method – Method of variations of Orbital Elements, Lagrange planetary equations, General Perturbations Approach, Lambert's problem.

Unit IV

APPLICATIONS OF ORBIT PERTURBATIONS AND SPACE DEBRIS: Earth's Oblateness (J2) Effects, Critical Inclination, Sun-Synchronous Orbits, Frozen Orbits, Earth's Triaxiality Effects and East-West Station keeping, Atmospheric Drag Effects- Orbital lifetime, Introduction to Space Debris, Methods of Debris Control.

Unit V

INTERPLANETARY TRAJECTORIES: Single Impulse Maneuvers, Hohmann transfers, Rendezvous opportunities, Sphere of influence, Method of patched conics, Departure and arrival, Planetary flyby, Two-dimensional interplanetary trajectories, Gravity assist trajectories.

Text Books

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, 2005.

Reference Books

1. J.W.Cornelisse, H.F.R. Schoyer, and K.F. Wakker,”Rocket Propulsion and Spaceflight Dynamics”, Pitman, 2001
2. William E.Wiesel,”Spaceflight Dynamics”, McGraw-Hill, 1997.
3. David.A. Vellado, Microcosm and Kluwer”Fundamentals of Astrodynamics and Applications”, , 2001
4. Sutton, G.P. “Rocket Propulsion Elements”, John Wiley, 2009.
5. Anderson,Jr, John D., Introduction to Flight, Tata McGraw Hill Education Private Limited, 2010, Sixth Edition.
6. Adventures in celestial mechanics, Second Edition, Victor G. Szebehely, Hans Mark, Wiley-VCH Verlag GmbH & *Co.* KGaA, 2004.