BAE301: INTRODUCTION TO AEROSPACE ENGINEERING
Credit 3
LTP 300

Course Description: The course aims to equip the students with the history of aeronautics and understand basic concepts of aircrafts. To cover the basic Aerodynamics and propulsion system of an aircraft. To cover the structural materials and basic controls of an airplane.

The course includes Introduction to Aerospace Engineering, Space Vehicles, Basic Aerodynamics, Aircraft Propulsion System, Structure Design and Control System.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO1: To understand the basic flight mechanics and jet propulsion theories.

CO2: To understand the basic controls and aerodynamic forces associated with an aircraft.

CO3: To understand the material required for an aircraft structure and material properties.

Course Content

Unit I

INTRODUCTION: Pre Wright Brother's era, Wright Flyer, Conventional airplane, progress in airplane design and applications, Current status. Other kinds of heavier than air vehicles, helicopter, VSTOL machine.

Unit II

SPACE VEHICLES: Missile and its types, space vehicles and its types, reusable space vehicles, space shuttle, satellites, types of satellites and their functions

Unit III

AERODYNAMICS: Airfoil nomenclature, symmetric & cambered airfoils and the aerodynamic characteristics, angle of attack, 2-D and 3-D wing, wing as a lifting surface, types of wing plan forms and their aerodynamic characteristics, center of pressure and pressure coefficient, types of drag, lift to drag ratio as efficiency of a lifting surface, different types of flows; laminar and turbulent, effect of viscosity, concept of boundary layer, boundary layer control, high coefficient of lift devices, subsonic, transonic, supersonic and hypersonic Mach no., critical Mach no., drag divergence Mach no.

Unit IV

AIRPLANE PROPULSION: Requirement of power to fly, balance of forces, various means of producing power for forward flight, piston engines, jet propulsion-thrust equation, turbojet, turbofan, ramjet engines. Locations of such engines, Propeller and its use. Rocket Engines.

Unit V

AIRPLANE STRUCTURES AND MATERIALS: Structural arrangement of the Wright Flyer, Structural details of landing gear, wing, fuselage and tail planes, functions of ribs, skin, spars, stringers, longerons, Monocoque and semi-monocoque structures, materials for main components.

Unit VI

CONTROL SYSTEMS AND LEVEL FLIGHT: Various types of flaps, function of rudder, elevator, ailerons, flaperons, elevons, types of tail planes, condition for straight & level flight, flight path angle.

Recommended Books / Suggested Readings:

1. Fundamentals of Flight Richard S. Shevel, Prentice Hall
2. Introduction to flight- John D. Anderson
3. Mechanics of flight by A.C. Kermode
4. Flight without formulae by A.C Kermode.
5. Fundamentals of flight by Richard Shevell.

BAE302: AIRCRAFT MATERIALS
Credit 3
LTP 300

Course Description: The course aims to equip the students with the concepts related to the different types of materials used in aircraft such as Light Metal Alloys materials, dielectric materials, Aircraft materials, Jigs and Fixtures for Aircraft materials. To make the students able to understand the different metal joining process and manufacturing processes.

The course includes Introduction to metals and non-metals, Light metal alloys, Aircraft steels, Composite materials, and various joining processes.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO1: To understand the basic material properties required in an aircraft structure.

CO2: To understand the various manufacturing processes.

CO3: To understand the material required for an aircraft structure and material properties.

Course Content

Unit I

INTRODUCTION: Properties of Flight Vehicle Materials, Importance of strength/weight ratio ofmaterials for Aerospace Vehicles structures, Importance of temperature variations, factors affecting choice of material for different parts of airplane

Unit II

Light Metal Alloys: Aluminum alloys, heat treatment, High strength and high corrosion alloys. Magnesium alloys and their properties, Heat treatment, Application of these alloys to Aerospace Vehicles.

Unit III

Aircraft Steels: Classical of alloys steels, Effect of alloying elements, Carbon Steel V/S Alloys. Magnesium alloys and their properties, Heat treatment, Application to aerospace Vehicle of these alloys.

Unit IV

High Strength And Heat Resistant Alloys: Classification of heat resistant materials & Iron, Nickel and cobalt base alloys, Refractory materials, Ceramics, titanium and its alloys, properties of Inconel Monal & K-Monal, Nimonic and Super Alloys; Application to Aerospace Vehicles.

Unit V

Composite Materials: Introduction, Fibers, glass fibers, carbon fibers, Aramid fibers, Carbon Fibers, Engineering ceramics. Matrix Materials – Their functions, various types, curing of resins.

Unit VI

Metal Joining Processes: Weld-ability, standard welding practices e.g. gas welding, resistance welding. Welding of light alloys, Riveting.

Unit VII

Jigs and Fixtures: For Aircraft General design, Method of Location of cylindrical and flat surface. Design principles of wing Jig, Fuselage jig and other components.

Unit VIII

Aircraft Manufacturing Processes: Profiling, Hydroforming, man forming bending rolls, Spar milling, spark erosion and powered metal parts. Integral machining, Contour etching. High energy rate forming. Manufacture of honeycomb structures, General methods of construction of aircraft and aero engine part.

Recommended Books / Suggested Readings:

1. Workshop technology WAJ Chapman, Vol. I,II,III
2. Aircraft Material and Processes G F Titter ton, Himalayan Books, New Delhi.
3. Aircraft Production methods G B Ashmead.
4. Advanced Composite materials Lalit Gupta-Himalayan Books, New Delhi, 19.
5. Aircraft materials and processes by Tariq Siddiqui.

BME304: Engineering Thermodynamics
Credits: 3
LTP 300

Course Description: The course aims to equip the students with the knowledge of laws of thermodynamics, thermodynamic cycles, combustion and performance analysis of turbines and IC engines.

The course includes properties of steam, thermodynamic law and cycles, steam generator/ nozzles and turbines and IC Engines.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO1: Demonstrate an understanding of the concepts such as conservation of mass, conservation of energy, work interaction, heat transfer and laws of thermodynamics.

CO2: Identify closed and open systems and analyze related problems.

CO3: Analyze the performance of gas and vapor power cycles and identify methods to improve thermodynamic performance.

CO4: Apply gas laws to mixtures.

Course Content

Unit I

Properties of Steam Pure substance; Steam and its formation at constant pressure: wet, dry, saturated and super-heated steam; Sensible heat (enthalpy), latent heat and total heat (enthalpy) of steam; degree of superheat and degree of sub-cool; Entropy and internal energy of steam; Use of Steam Tables and Mollier Chart.

Unit II

Vapour Power Cycles: Carnot Cycle and its limitations, Rankine cycle, methods of improving Rankine efficiency - Regenerative Cycle, Bleeding, reheat cycle, combined reheat and regenerative cycle, Ideal working fluid – Binary vapor cycle, combined power and heating cycles.

Unit III

Steam generators: Review of steam generation process. Classification of Fire and water tube boilers, Description of Cochran, Locomotive, Lancashire Babcock and Wilcox boilers and Sterling Boiler, mountings and accessories - Economizer, super heater etc. Modern high pressure boilers, Characteristics of high pressure boilers, Advantages of forced circulation, steam accumulators, boiler performance, equivalent evaporation, boiler efficiency, Boiler Trial.

Unit IV

Steam Nozzle: Types of nozzles and their utility, Flow of steam through nozzles, Critical pressure and discharge, Area of throat and exit for maximum discharge, Effect of friction on Nozzle efficiency, Supersaturated flow.

Steam Turbines : Classification; Impulse & Reaction Steam turbines, description of components , Pressure and velocity compounding, Velocity diagram and work done, Effect of blade friction on velocity diagram, Stage efficiency and overall efficiency, Reheat factor and condition curve. Degree of reaction, blade efficiency and its derivation; calculation of blade height, backpressure and extraction turbines and cogeneration; Economic assessment. Method of attachment of blades to turbine rotor, losses in steam turbines, governing of steam turbines, Labyrinth packing.

Unit V

Condensers: Function, Elements of condensing plant, types of condensers, Dalton's law of partial pressure applied to condenser problems, condenser and vacuum efficiencies. Cooling water calculations. Effect of air leakage, Methods to check and prevent air infiltration. Description of air pump and calculation of its capacity. Cooling towers: function, types and their operation.

Unit IV

I.C. Engines: Classification of IC engines, Combustion of SI engine and CI engine, Detonation and factors affecting detonation, Performance analysis of I.C Engines, heat balance, Morse test, Octane-Cetane Rating.

Recommended Books / Suggested Readings:

1. Dynamics and Thermodynamics of Compressible Fluids, Shapiro A M, Ronald's Press, New York (1953).
2. Advanced Engineering Thermodynamics, Benson R W, Pergamum Press, London (1975).
3. Engineering Thermodynamics, P.K Nag, Tata McGraw Hill, New Delhi.
4. Applied Thermodynamics, R. Yadav, Sanjay and Rajay, Central Publishing House.
5. Thermodynamics and Thermal Engineering, J.S. Rajadurai, New Age International (P) Ltd. Publishers.
6. Heat Engineering, D.S. Kumar and V.P. Vasandani, Metropolitan Book Co. Pvt. Ltd.
7. Thermal Engineering, K. Soman, PHI Learning Pvt. Ltd.
8. Engineering Thermodynamics, G. Rogers and Y. Mayhew, Pearson.
9. IC Engines, V. Ganeshan, Tata McGraw Hill, New Delhi.

BME402: FLUID MECHANICS
Credits: 4
LTP 310

Course Description: The course aims to equip the students with the knowledge to develop an understanding of the behaviour of fluids at rest or in motion. Students learn the concepts of fluid, properties of fluid and its classification. Students have understand the concept of fluid statics and dynamics.

Course includes fundamentals of fluid mechanics fluid statics, fluid kinematics, fluid dynamics, dimensional analysis and similarity, flow through pipes, pressure and flow measurement.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO1: To find frictional losses in a pipe when there is a flow between two places.

CO2: Calculate the conjugate depths in a flow.

CO3: Analyze the model and the prototype.

CO4: Find the dependent and independent parameters for a model of fluid flow.

CO5: Explain the various methods available for the boundary layer separation.

Course Content:

Unit I

Fundamentals of Fluid Mechanics: The Concept of a Fluid, the Fluid as a Continuum, Dimensions and Units, Properties of fluid, Thermodynamic Properties of a Fluid, Viscosity and other Secondary Properties

Unit II

Fluid Statics: Pascal law and its applications, Hydrostatic Pressure Distributions, Application to Manometer, Hydrostatic Forces on Plane Surfaces, Hydrostatic Forces on Curved Surfaces, Hydrostatic Forces in Layered Fluids, Buoyancy and Stability, Pressure Distribution in Rigid-Body Motion.

Fluid Kinematics: Classification of fluid flows; Lagrangian and Euler flow descriptions; Velocity and acceleration of fluid particle; Local and convective acceleration; Normal and tangential acceleration; Path line, streak line, streamline and timelines; Flow rate and discharge mean velocity; One dimensional continuity equation; Continuity equation in Cartesian (x,y,z), polar (r,θ) and cylindrical (r,θ,z) coordinates; Derivation of continuity equation using the Lagrangian method in Cartesian coordinates; Rotational flows: rotation, vorticity and circulation; Stream function and velocity potential function, and relationship between them.

Unit III

Fluid Dynamics: Derivation of Euler's equation of motion in Cartesian coordinates, and along a streamline; Derivation of Bernoulli's equation (using principle of conservation of energy and equation of motion) and its applications to steady state ideal and real fluid flows; Representation of energy changes in fluid system (hydraulic and energy gradient lines); Impulse momentum equation; Kinetic energy and momentum correction factors; Flow along a curved streamline; Free and forced vortex motions.

Unit IV

Dimensional Analysis and Similarity: Dimension, Units, dimension reasoning, dimensional quantities, construction of relationship by dimensional analysis using the indicial methods, dimensional analysis by group methods, significant of dimensionless numbers, Geometric similarity, Dynamic similarity, similarity applied to roto dynamic machines.

Unit V

Flow Through Pipes: Laminar and Turbulent Flows: Reynolds number, critical velocity, critical Reynolds number, hydraulic diameter, flow regimes; Hagen – Poiseuille equation; Darcy equation; Head losses in pipes and pipe fittings; Flow through pipes in series and parallel; Concept of equivalent pipe; Roughness in pipes, Moody's chart.

Unit VI

Pressure and Flow Measurement: Manometers; Pitot tubes; Various hydraulic coefficients; Orifice meters; Venturi meters; Borda mouthpieces; Notches (rectangular, V and Trapezoidal) and weirs; Rotameters.

Recommended Books / Suggested Readings:

1. "Fluid Mechanics", Douglas J F, Gasionckw, and Swaffield J P, 3rd Edition Addision Wesley Longman, Inc Pitman (1999).
2. "Fluid Mechanics", Pao H F Richard, John Wiley and Sons (1995).
3. "Fluid Mechanics and Fluid Power Engineering", Kumar D S, 6th Edition SK Kataria and Sons, Delhi (1998).
4. "Introduction to Fluid Mechanics", Fay J A, Prentice Hall of India Private Limited, New Delhi (1996).
5. "A text book of Fluid mechanics and Hydraulic Machines", Bansal R K, 8th Edition, Laxmi Publications (P) Ltd., New Delhi (2002).
6. Fluid Mechanics: Fundamentals and Applications", Yunus Cengel & John Cimbala," 2nd reprint 2007, Tata McGraw Hill, New Delhi.
7. "Fluid Mechanics", F M White 6th ed., McGraw Hill, New York.
8. Fluid Mechanics, SOM &Biswas, Tata-McGraw Hill, New York.

BMT301: APPLIED MECHANICS
Credits: 3
LTP 300

Course Description: The course aims to equip the students with a capacity to predict the effect of force and motion in the course of carrying out the design functions of engineering.

The course includes two dimensional force system, trusses, centroid & moment of inertia, kinetics & kinematics of a rigid body and simple stress and strain.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO1: Understand the various effect of force and motion on the engineering design structures.

CO2: Analyze the kinetics and kinematics of rigid body.

CO3: Apply engineering principles to calculate the reactions, forces and moments.

Course Content

Unit I

Two-dimensional force systems: Basic concepts, Laws of motion, Principle of transmissibility of forces, transfer of a force to parallel position, resultant of a force system, simplest resultant of two dimensional concurrent and non-concurrent force systems, and distribution of force systems, free body diagrams, equilibrium and equations of equilibrium.
Friction: Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction – wedge friction.

Unit II

Trusses: Introduction, simple truss and solution of simple truss, methods of F-joint and methods of sections.

Unit III

Centroid and moment of inertia: Centroid of plane, curve, area, volume and composite bodies, moment of inertia of plane area, parallel axis theorem, perpendicular axis theorem, principle moment of inertia, mass moment of inertia of circular ring, disc, cylinder, sphere, and cone about their axis of symmetry.

Unit IV

Kinematics of rigid body: Introduction, plane motion of rigid body, velocity and acceleration under translational and rotational motion, relative velocity, collisions.
Kinetics of rigid body: Introduction, force, mass and acceleration, work and energy, impulse and momentum, D'Alembert's principle and dynamic equilibrium.

Unit V

Simple stress and strain: Introduction, normal and shear stresses, stress-strain diagrams for ductile and brittle material, elastic constants, one-dimensional loading of members of varying cross sections, strain energy.

Recommended Books / Suggested Readings:

1. Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).
2. Vela Murali, "Engineering Mechanics", Oxford University Press (2010).
3. A Textbook of Engineering Mechanics, R.K. Bansal, Laxmi Publications.
4. Engineering Mechanics, R.S. Khurmi, S.Chand Publishing.
5. Meriam J.L. and Kraige L.G., "Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2", Third Edition, John Wiley & Sons (1993).
6. Rajasekaran S and Sankarasubramanian G., "Engineering Mechanics Statics and Dynamics", 3 rd Edition, Vikas Publishing House Pvt. Ltd., (2005).
7. Bhavikatti, S.S and Rajashekarappa, K.G., "Engineering Mechanics", New Age International (P) Limited Publishers, (1998).
8. Engineering mechanics by Irving H. Shames, Prentice-Hall.

BMC 002: Constitution of India

Credits: 0

LTP 200

Course Description: The course aims to equip the students with the fundamental rights, duties and directive principles of state policy. The course includes the concepts of State and Union Government and its administration, role of constitution in democratic society.

Course Outcomes (CLO):

Upon successful completion of the course, the students should be able to:

CO1: Have general knowledge and legal literacy and thereby to take up competitive examinations

CO2: Understand state and central policies, fundamental duties

CO3: Understand Electoral Process, special provisions

CO4: Understand powers and functions of Municipalities, Panchayats and Co-operative Societies

Course Content:

Unit I

Introduction: Constitution' meaning of the term,, Indian Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy

Unit II

Union Government and its Administration: Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha

Unit III

State Government and its Administration: Governor: Role and Position, CM and Council of ministers, State Secretariat: Organisation, Structure and Functions

Unit IV

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati raj: Introduction, PRI: Zila Pachayat, Elected officials and their roles, CEO Zila Pachayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

Unit V

Election Commission: Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women

Recommended Books / Suggested Readings:

1. Laxmikanth, Indian Polity, McGraw Hill, 5th edition.
2. Kashyap Subhash, Indian Administration
3. Basu D.D., Indian Constitution
4. Avasthi and Avasthi, Indian Administration, Lakshmi Narain Agarwal

BAE401: AIRCRAFT PROPULSION-1
Credit 4
LTP 310

Course Description: The course aims to equip the students with the knowledge 0f fluid dynamics, thermodynamics, gas dynamics, chemistry, applied mathematics and computer programming in aerospace propulsion design. To predict the performance and conduct preliminary design of aerospace propulsion systems and their components. To demonstrate their knowledge about the specific design aspects of rocket propulsion systems and air breathing propulsion systems such as turbo-jets, turbo-fan engines, ramjets and scramjets.

The course includes modes of Heat transfer, Propeller, Aircraft piston engine, Aircraft gas turbine engine.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO1: At the end of this course student will gain knowledge of basic thermodynamic reactions and heat transfer methods.

CO2: The students will be able to understand the phenomenon of air breathing jet engines and piston engines.

CO3: The students will gain knowledge about various nozzle types and thrust augmenting methods.

Course Content

Unit I

Conduction Heat Transfer: Heat transfer process, heat conduction, thermal conductivity, general equations of heat conduction, Newton- Rikhman law, conduction problems.

Unit II

Convection And Radiation Heat Transfer: Convection process, free convection heat transfer from vertical flat plate, planes, cylinder and sphere, free convection in enclosed space, effect of laminar and turbulent flow on convection process, combined free and forced convection. Thermal radiation and emissive power, Plank distributive law, radiation properties.

Unit III

Propellers: Ideal momentum theory, blade element theory, activity factor, airscrew coefficients, numerical problems on the performance of propellers, selection of propellers, fixed, variable and constant speed propellers, material for propellers, momentum theory applied to helicopter rotor.

Unit IV

Aircraft Piston Engines: The internal combustion engine process, brief history, G.I and C.Iengines,4-stroke and 2-stroke engines, air standard cycles, various types of arrangements for multi cylinder aircraft engines ,their merits and operational efficiencies, cooling, lubricating and ignition systems, valve timing diagrams, I.H.P, B.H.P. and S.H.P., performance, effect of altitude, power required and power available, supercharging.

Unit V

Aircraft Gas Turbine Engines: Air standard Brayton cycle, actual gas turbine engine cycle, compressor and turbine efficiencies , compressor and turbine work, centrifugal and axial type of compressors, their compressive action, relative merits in operations, combustion chambers, simplex and duplex burners, expansion process, turbine materials for different components, engine intake and exhaust nozzles, afterburners, thrust augmentation, turboprop, turbo shaft and turbofan engines, multi shaft gas turbine engines, thrust equation, installed and uninstalled thrust

Recommended Books / Suggested Readings:

1. Elements of Gas Turbine Propulsion: J.D. Mattingly, McGraw Hill.
2. Rocket Propulsion Elements: George P. Sutton, Oscar Biblarz, John Wiley & Sons.
3. Gas Turbine Theory: Cohen, Rogers and Sarvanmatto, John Wiley
4. Mechanics and Thermodynamics of Propulsion: P.G.Hill& Peterson, Addison- Wesley.
5. Mechanics & Thermodynamics of Propulsion, Hill P.G. & Peterson, C.R. Addison, WesleyLongman INC, 1999.
6. Rocket Propulsion Elements, G.P Sutton & O. Biblarz, John Wiley & Son Inc., 2001.
7. Aero thermodynamics of Aircraft Engine Components, Oates G.C., AIAA Education Series, New York, 1985.
8. Gas Turbine, Jet and Rocket Propulsion, Mathur M.L. and Sharma, R.P., Standard Publishers
9. Aircraft Propulsion by Saeed Farokhi.
10. Elements of Gas Turbine by V. Ganesan.
11. Fundamentals of Aircraft and Rocket Propulsion by EL –Sayed, Ahmed F.

BAE421: AIRCRAFT PROPULSION-1 LABORATORY
Credit 1
LTP 002

Course Description: The course aims to equip the students with the exposure about piston engine anatomy. To familiarize the students about parts of turbo jet engine.

The course includes experimental work on instruments related to propulsion system such as Propeller Test Rig, study of various components of jet engine and piston engine using Tumansky R-25 and C-90 Piston engine respectively.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO1: The students will be able to identify the engine parts and role of these parts.

CO2: The students will be able to understand the phenomenon of air breathing jet engines and piston engines.

CO3: The students will get knowledge of turbo jet engines and design parameters of its parts.

Course Content

List of Practical:

1. Study of Turbo-prop Engine
2. Study of Turbo-Jet engine.
3. Study of Turbo-shaft engine.
4. Study of engine parts.

BAE402: ELEMENTS OF AERODYNAMICS
Credits 04
LTP 310

Course Description: The course aims to equip the students with basic computations of aerodynamic forces and moments acting on an aircraft in flight; Perform basic computations of propulsive forces and performance, Perform basic stability and control computations;**,** Perform basic performance calculations for the overall air vehicle; and

The course include basic of aerodynamics and fluid motion, equations of fluid motion, inviscid-incompressible flow, introduction to viscous flow and introduction to incompressible boundary layer

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1. The Students will be able to understand the basic flows and flow conditions.

CO 2. The students will get exposure to compressible and viscous flow and boundary layer formation.

Course Content

UNIT I

Introduction: Fluid statics, pascal's law, Continuum and free molecular flows, inviscid and viscous flows, incompressible and compressible flows. Newtonian and Non-Newtonian flows. Pitot static tube, measurement of air-speed, pressure coefficient. Aerodynamic force and moments. Dimensional analysis, non-dimensional parameters, M, Re, Fr etc., flow similarity.

UNIT II

Description of Fluid Motion: Lagrangian and Eulerian methods, Description of properties in a moving fluid, local and material rate of change. Streamlines, Pathlines, Streaklines, Reynolds Transport theorem, Vorticity and circulation. Laws of vortex motion. Translation, rotation and rate of deformation of fluid particles.

UNIT III

Equations of Fluid Motion: Equation of conservation of mass for control volume, special form of equation of conservation of mass, differential form of equation of conservation of mass Euler's and Navier-Stoke equations. Derivation of Bernoulli's equation for inviscid and viscous flow fields. Momentum equation and angular momentum equation in integral form.

UNIT IV

Invisid-Incompressible Flow: Condition on velocity for incompressible flow. Laplace's equations. Potential function, stream function. Basic elementary flows: Uniform flows, source flow, Doublet flow and Vortex flow. Superimposition of elementary flows. On lifting and lifting flow over a circular cylinder, comparison with real flow over circular cylinder. Kutta-Jaukowski theorem, generation of lift.

UNIT V

Introduction To Viscous Flow: Qualitative aspects of viscous flows, viscosity and thermal conductivity. Phenomenon of separation. Navier-Stokes equation; viscous flow energy equation. Some exact solutions of Navier-Stokes equations: plane Poiseuille flow, Couette flow, Hagen-Poiseuille flow and Hele-Shaw flow.

UNIT VI

Introduction To Incompressible Boundary Layer: BL concept, BL properties, derivation of Prandtl's BL equations, Blasius solution, Karman's Integral equation. Turbulent BL over a plate, skin friction drag, BL control.

Recommended Books / Suggested Readings:

1. Fundamentals of Aerodynamics : John D.Anderson(Jr.) 2ndEd.McGraw Hill
2. Fluid Mechanics and its Applications : Gupta and Gupta Wiley Eastern ,1960
3. Boundary Layer Theory H.Schlichting 6th Ed. McGraw Hill ,1986
4. Fluid Mechanics : Frank M.White 2nd Ed. McGraw Hill,1986
5. Foundations of Fluid Mechanics : S.W.Yuan Prentice Hall
6. Aerodynamics by L.J Clancy.
7. Aerodynamics for Engineering Students by E. L. Houghton and P. W. Carpenter.

BME 301: Strength of Materials
Credits: 4
LTP 310

Course Description: The course aims to equip the students with the concepts of mechanical properties, stress & strain and the behavior of materials under different loading condition.

The course includes simple/ compound/ thermal stresses & strain, bending moment & shear force diagram, torsion in circular shafts, columns & struts, theory of bending stress and slope & deflection.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO1: Apply concepts of strength of materials to obtain solutions to real time Engineering problems.

CO2: Draw and analyze shear force and bending moment diagram for different types of loading conditions.

CO3: Apply engineering principles to calculate the reactions, forces and moments.

Course Content

Unit I

Simple stresses and strains: Concept of stress and strain: St. Venants principle of stress and strain diagram, Hooke's law, Young's modulus, Poisson ratio, stress at a point, stresses and strains in bars subjected to axial loading, Modulus of elasticity, stress produced in compound subjected to axial loading, Temperature stress and strain calculations due to applications of axial loads and variation of temperature in single and compound walls.

Unit II

Compound stresses and strains: Two-dimensional system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stress, ellipse of stress and their applications, Two dimensional stress-strain system, principal strains and principal axis of strain, circle of strain and ellipse of strain, Relationship between elastic constants.

Unit III

Bending moment and shear force diagrams: Bending moment and shear force diagrams, SF and BM definitions. BM and SF diagrams for cantilevers, simply supported and fixed beams with or without overhangs and calculation of maximum BM and SF and the point of contra flexure under Concentrated loads, Uniformity distributed loads over the whole span or part of span, combination of concentrated loads (two or three) and uniformly distributed loads, uniformly varying loads, application of moments.

Unit IV

Theory of bending stresses: Assumptions in the simple bending theory, derivation of formula: its application to beams of rectangular, circular and channel sections, composite/fletched beams, bending and shear stresses in composite beams. Unsymmetrical Bending, Combined bending and torsion, bending and axial loads etc.

Unit V

Torsion: Derivation of torsion equation and its assumptions. Applications of the equation of the hollow and solid circular shafts, torsional rigidity, combined torsion and bending of circular shafts, principal stress and maximum shear stresses under combined loading of bending and torsion.

Unit VI

Columns and struts: Columns under uni-axial load, Buckling of Columns, Slenderness ratio and conditions. Derivations of Euler's formula for elastic buckling load, equivalent length, Rankine Gordon's empirical formula.

Unit VII

Slope and deflection: Relationship between moment, slope and deflection; method of integration, Macaulay's method, moment area method and use of these methods to calculate slope and deflection for the following: a) Cantilevers b) Simply supported beams with or without overhang c) Under concentrated loads, uniformly distributed loads or combination of concentrated & uniformly distributed loads.

Recommended Books / Suggested Readings:

1. Strength of Materials, Pytel A H and Singer F L, Latest Edition, Harper Collins, New Delhi (2010).
2. Mechanics of Materials, Beer P F and Johnston (Jr) E R, SI Version, Tata McGraw Hill, India (2017).
3. Engineering Mechanics of Solids, Popov E P, SI Version 2nd Edition, Prentice Hall of India, New Delhi (2003).
4. Elements of Strength of Materials, Timoshenko S P and Young D H, 5th Edition, East West Press, New Delhi (2012).
5. Strength of Materials R.S Lehri and A.S. Lehri, Kataria and Sons.
6. Strength of Materials R.K.Rajput, , Laxmi Publication
7. Strength of Materials S. Ramamrutham, Dhanpat Rai & Sons.

BTM301: TRANSFORM AND DISCRETE MATHEMATICS
Credits: 4
LTP 310

Course Description: The course aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines. It also familiarize the prospective engineers with transformation equations and discrete structures.

Course includes transform calculus, sets, relations and functions, propositional logic, algebraic structures and basic counting techniques.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO1: Use the mathematical tools needed in evaluating multiple integrals and their usage.

CO2: Implement the effective mathematical tools for the solutions of differential equations that model physical processes.

CO3: Use the tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering problems.

Course Content:

Unit I

Transform Calculus -1: Polynomials – Orthogonal Polynomials – Lagrange's, Chebysev Polynomials; Trigonometric Polynomials; Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, Application of linear transformation on circuits.

Unit II

Transform Calculus II: Fourier transforms, Z-transform and Wavelet transforms: properties, methods, inverses and their applications.

Unit III

Sets, relations and functions: Basic operations on sets, Cartesian products, disjoint union (sum), and power sets. Different types of relations, their compositions and inverses. Different types of functions, their compositions and inverses.

Unit IV

Propositional Logic: Syntax and semantics, proof systems, satisfiability, validity, soundness, completeness, deduction theorem, etc. Decision problems of propositional logic. Introduction to first order logic and first order theory.

Partially ordered sets: Complete partial ordering, chain, lattice, complete, distributive, modular and complemented lattices. Boolean and pseudo Boolean lattices.

Unit V

Algebraic Structures: Algebraic structures with one binary operation – semigroup, monoid and group Cosets, Lagrange's theorem, normal subgroup, homomorphic subgroup. Congruence relation and quotient structures. (Definitions and simple examples only).

Algebraic structures with two binary operations ring, integral domain, and field. Boolean algebra and Boolean ring (Definitions and simple examples only).

Basic counting techniques – inclusion and exclusion, pigeon-hole principle, permutation, combination, summations. Introduction to recurrence relation and generating functions.

Introduction to Graphs: Graphs and their basic properties – degree, path, cycle, subgraph, isomorphism, Eulerian and Hamiltonian walk, trees.

Recommended Books / Suggested Readings:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. Veerarajan T., Engineering Mathematics, Tata McGraw-Hill, New Delhi, 2008.
3. C. L. Liu, Elements of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 2000.
4. R. C. Penner, Discrete Mathematics: Proof Techniques and Mathematical Structures, World Scientific, 1999.
5. R. L. Graham, D. E. Knuth, and O. Patashnik, Concrete Mathematics, 2nd Ed., Addison-Wesley, 1994.
6. K. H. Rosen, Discrete Mathematics and its Applications, 6th Ed., Tata McGraw-Hill, 2007.
7. J. L. Hein, Discrete Structures, Logic, and Computability, 3rd Ed., Jones and Bartlett, 2010.
8. N. Deo, Graph Theory, Prentice Hall of India, 1974.
9. S. Lipschutz and M. L. Lipson, Schaum's Outline of Theory and Problems of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 1999.
10. J. P. Tremblay and R. P. Manohar, Discrete Mathematics with Applications to Computer Science, Tata McGraw-Hill, 1997.
11. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
12. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.

HVE001: HUMAN VALUES AND PROFESSIONAL ETHICS
Credits: 3
LTP 300

Course Description: The course aims to help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity, which are the core aspirations of all human beings. Also, to facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way. It also aims to highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with nature.

Course includes introduction of need, basic guidelines and content, process for value education, understanding harmony in the human being, harmony in myself, understanding harmony in the family and society, harmony in human and human relationship

Course Outcomes:

Upon successful completion of the course, the students should be able to:

CO1: Recognize importance of human values, harmony and ethical behaviour in real life situations.

CO2: Understand the fundamental concept of human value

CO3: Apply basic concept of harmony in his life.

Course Content:

Unit I

Introduction –Need, Basic Guidelines and Content: Understanding the need, basic guidelines, content and process for value Education, Self -Exploration – What is it? – Its content and process: 'Natural Acceptance' and Experiential Validation – as the mechanism for self-explanation, Continuous Happiness and Prosperity – A look at basic Human Aspirations.

Unit II

Process for Value Education: Right Understanding, Relationship and Physical Facilities – basic requirements for fulfillment of aspirations of every human being with their correct priority, Understanding Happiness and prosperity correctly – A critical appraisal of the current scenario, Method to fulfill the above human aspirations; understanding and living in harmony at various levels.

Unit III

Understanding Harmony in the Human Being: Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' – Sukh and Suvidha, Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer).

Unit IV

Harmony in Myself: Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Swasthya: correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Swasthya – practice exercises and Case Studies will be taken up in Practice Sessions

Unit V

Understanding Harmony in the Family and Society – harmony in Human - Human Relationship: Understanding harmony in the family – the basic unit of human interaction, Understanding values in human relationship; meaning of Nyaya and Program for its fulfillment to ensure Ubhay-tripti, Trust (Vishwas) and Respect (Samman) as the foundational values of relationship.

Recommended Books / Suggested Readings:

1. R R Gaur, R,Sangal, G.P Bagaria, 2009, A Foundation Course in value Education(English)
2. R R Gaur, R Sangal G P Bagaria, 2009, Teacher's Manual (English)
3. Subhas Palekar, 2000, How to practice natural Farming, Pracheen (Vaidik) Krishi tantra shodh, Amravati
4. Ivan IIIich, 1974, Energy& Equity, The Trinity Press, Worcester, and harper Collins, USA
5. E.F. Schumacher, 1973, small is Beautiful; a study of economics as if people mattered,Blond & Briggs, Bratain
6. Sussan George, 1076, How the other half Dies, Penguin Press, Peprinted 1986, 1991
7. PL Dhar, RR Gaur, 1990, Science and Humanism, common wealth publishers
8. A.N. Tripathy, 2003, Human values, New Age International Publisher
9. Donella H. Meadows, Dennis L. Meadows,Jorgen Randers, William W. Behrens III,1972,
10. Limits to Growth – club of Rome's report, universe Books
11. E.G. Seebauer & Robert, L BERRY, 2000, Foundationals of Ethics for Scientists & Engineers, Oxford UniversityPress
12. M. Govindrajran, S Natrajan & V.S. Senthi Kumar, Engineering Ethics (including human Values), Eastern Economy Edition, Prentice hall of India Ltd
13. B P Banerjee, 2005, Foundations of Ethics and Management, Excel books
14. B.L. Bajpai, 2004, Indian Ethos and Modern Management , New Royal book Co; Lucknow, Reprinted 2008.

BAE501: AIRCRAFT PROPULSION-2
Credits 04
LTP 310

Course Description: The course aims to equip the students with link and utilize their existing knowledge in fluid dynamics, thermodynamics, gas dynamics, chemistry, applied mathematics and computer programming in aerospace propulsion design. And predict the performance and conduct preliminary design of aerospace propulsion systems and their components.

The course include introduction to gas dynamics, inlets and nozzles, axial flow compressor, centrifugal compressors, axial flow turbine and advanced propulsion techniques.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1: At the end of this course the students will get the exposure to gas dynamics and gas flow.

CO 2: The students will be able to understand the phenomenon of various jet engine components.

CO 3: The students will get knowledge of rocket propulsion system and propellants.

Course Content

UNIT I

INTRODUCTION TO GAS DYNAMICS: Basics, simple flows, nozzle flow and design, nozzle operating characteristics for isentropic flow, shock waves in nozzle flow, Rayleigh flow and fanno flow effect of frictional duct length in subsonic and supersonic flow, numerical problems in 1-D flow. Scram jet, pulse jet and ramjet.

UNIT II

INLETS AND NOZZLES: Subsonic inlets, pressure recovery, inlet sizing, supersonic inlets and mass flow characteristics, inlet design and sizing, exhaust nozzles, thrust reversing and thrust vectoring, nozzle coefficients, nozzle performance.

UNIT III

AXIAL FLOW COMPRESSOR: Euler's turbo machinery equations, axial flow compressor analysis, cascade theory, velocity diagrams, flow annulus area stage parameters, degree of reaction, axial flow compressor coefficients, stage p pressure ratio, repeating stage-repeating row-mean line design, performance and design.

UNIT IV

CENTRIFUGAL COMPRESSORS: Principle of operation, Work done and pressure rise, the diffuser, Compressibility effects, Non-dimensional quantities for plotting compressor Characteristics, Compressor characteristics, computerized design procedure.

UNIT V

COMBUSTION SYSTEMS: Operational requirements, Types of combustion system, some important factors affecting combustor design, the combustion process, Combustion chamber performance, Gas turbine emissions.

UNIT VI

AXIAL FLOW TURBINE: Introduction to turbine analysis, velocity diagrams, mean radiusstage calculations, stage parameters, loading and flow coefficients, degree of reaction, axial flow turbine stage analysis, performance and design.

UNIT VII

ADVANCED PROPULSION TECHNIQUES: Electric rocket propulsion - Ion propulsion techniques - Nuclear rocket - Types

- Solar sail- Preliminary concepts in nozzle less propulsion.

Recommended Books / Suggested Readings:

1. Elements of Gas Turbine Propulsion: J.D. Mattingly, McGraw Hill.
2. Rocket Propulsion Elements: George P. Sutton, Oscar Biblarz, John Wiley & Sons.
3. Gas Turbine Theory: Cohen, Rogers and Sarvanmatto, John Wiley
4. Mechanics and Thermodynamics of Propulsion: P.G.Hill& Peterson, Addison- Wesley.
5. Aircraft Propulsion by Saeed Farokhi.
6. Elements of Gas Turbine by V. Ganesan.
7. Fundamentals of Aircraft and Rocket Propulsion by EL –Sayed, Ahmed F.

BAE521: AIRCRAFT PROPULSION - 2 LAB
Credits 01
LTP 002

Course Description: The course aims to equip the students with thrust analysis and calculations. To make the students to go through from various stages of engine parts.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

- **CO 1**. The students will be self-abled to analyze the design parameters of engine components
- **CO 2.** The students will get exposure about calculating the thrust vectors and engine efficiencies.

Course Content

List of Experiments

i. To determine the thrust of 16" propeller with propeller test rig.

ii. To study the Tumansky R-25 turbojet engine.

iii. To study the C-90 Piston Engine.

BAE502: AEROSPACE VEHICLE STRUCTURES-1
Credit 5
LTP 410

Course Description: The course aims to equip the students with the basic understanding of aircraft structure. To provide the students an understanding on the linear static analysis of determinate and indeterminate aircraft structural components. To provide the design process using different failure theories.

The course includes Introduction to Aircraft Structure, Statically Determinate & Indeterminate Structures Energy Methods, Beams and Columns and Failure Theories.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1: At the end of this course students will be able to understand the basic aircraft structure types.

CO 2: The students will be self-able to obtain the various deflections and stresses occurred in aircraft structure.

CO 3: The students will get exposure to different theories and observations required in aircraft structural science.

Course Content

Unit I

Introduction To Aircraft Structure: Structural components of Aircraft, Monocoque, semi-monocoque and geodesic construction, typical wing and fuselage structure.

Unit II

Statically Determinate & Indeterminate Structures: Plane truss analysis – method of joints – method of sections – method of shear – 3-D trusses –principle of super position, clapeyron's 3 moment equation and moment distribution method for indeterminate beams.

Unit III

Energy Methods: Strain Energy in axial, bending, torsion and shear loadings. Castigliano's theorems and their applications. Energy theorems – dummy load & unit load methods – energy methods applied to statically determinate and indeterminate beams, frames, rings & trusses.

Unit IV

Beams And Columns: Deflection of beams-Euler's column curve – inelastic buckling – effect of initial curvature – the Southwell plot – columns with eccentricity – use of energy methods – theory of beam columns – beam columns with different end conditions – stresses in beam columns.

Unit V

Failure Theories: Ductile and brittle materials – maximum principal stress theory - maximum principal strain theory -maximum shear stress theory - distortion energy theory – octahedral shear stress theory.

Unit VI

Induced Stresses: Thermal stresses – impact loading – Fatigue – Creep - Stress Relaxation

Recommended Books / Suggested Readings:

1. Megson THG, "Aircraft Structure for Engineering students", Edward Arnold Publication.
2. Timoshenko and Gere, "Mechanics of Materials", Tata McGraw Hill, 1993
3. Understanding Aircraft Structures by John Cutler.
4. Basic Structural Theory by Jacques Heyman.
5. Aircraft Structures by David J Perry.

BAE503: AIRCRAFT PERFORMANCE
Credit 4
LTP 310

Course Description: The course aims to equip the students with the concepts of Flight performance. To understand the parameters effecting the performance. To familiarize with the various theories of propeller analysis and design

The course includes The Standard Atmosphere and Airflow, aerodynamic Drag, aerodynamic Characteristics, High Lift Systems, Airplane Performance, Airplane Performance in Accelerated Flight and Maneuvers.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO1: The Students will obtain the knowledge about standard atmospheric conditions required for flight.

CO2: The students will get familiarize about various drags and other aerodynamic forces associated with aircraft.

CO3: The students will get exposure about various flight conditions.

Course Content

Unit I

The Standard Atmosphere and Airflow: Standard atmosphere, relation between Geopotential and Geometric altitudes, pressure, temperature and density altitudes. Relation for stratosphere and troposphere. Stability of atmosphere, aero-thermodynamics. Measurement of air-speed: True airspeed, Indicated airspeed and equivalent airspeed, Airspeed indicator.

Unit II

Aerodynamic Drag: Cause of Drag, its effects, types of drag and affecting factors. Drag polar, compressibility drag, design for minimum drag, estimation of drag of complete airplane, Terminal Velocity.

Unit III

Aerodynamic Characteristics: Force and Moments coefficients from dimensional analysis. Pressure distribution over 2D airfoil, variation with angle of attack, center of pressure, aerodynamic center, problems connected with them. Lift, Drag and moment coefficients; Relations between lift and drag. Estimation of these characteristics from measured pressure distributions, variation of aerodynamic coefficients with Reynold's Number and Mach number. Effect of span, Aspect ratio, plan form, sweep, taper and twist on aerodynamic characteristics of a lifting surface. Delta wing Aerodynamics.

Unit IV

High Lift Systems: Airfoil's maximum lift coefficient, leading and trailing edge devices, effect of sweep back. The deep stall. Effect of Re, Propulsive lift, V/STOL configurations.

Unit V

Airplane Performance: In Steady Flight Straight and Level flight, stalling speed; Variation of drag with flight. Speed conditions for minimum drag, minimum power conditions; Power at other speeds. Gliding flight, shallow and steep angles of glide; Sinking speed, minimum sinking speed, time of descent. Climbing flight at shallow angles, correction for steep angles, time to flight, and maximum rate of climb.

Unit VI

Airplane Performance in Accelerated Flight: Take-off and landing, calculations of take-offground run, take off distances. Minimum ground run, assisted take-off, calculation of landing ground run. Range and endurance and problems connected with them.

Unit VII

Maneuvers: Introductory comments on spins and stalls; turning flight, maneuvers in 3D space.

Recommended Books / Suggested Readings:

1. J D Anderson 2000, 4th Edition, Introduction of Flight.
2. Fundamental of Aerodynamics, J D Anderson, 3rd Edition, 2001
3. Aircraft Performance by MaidoSaarlas published on 2007.
4. Aircraft performance by Martin E Eshelby.

BMA302: COMPUTER AIDED DESIGN - I
Credits 02
LTP 200

Course Description: The course aims to equip the students with the basics of the CAD/CAM Technology from its very basics and the students will learn about the backend techniques involved in handling of the graphics of the CAD software's.

The course includes introduction, graphics hardware, CAD software and geometric modeling with wireframe modeling.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1. The students would be able to explain the whole product development cycle in detail.
CO 2. The students will learn the basics of the graphics hardware and software to run a CAD/CAM system.
CO 3. The students would be able to explain about the various geometric modeling techniques.
CO 4. The students can employ the geometric transformations on the basic entities.
CO 5. To design the various 3D models in CAD software.
CO 6. The students can explain the different representation techniques of curve and surfaces.

Course Content

UNIT-I

Introduction: Product Development Cycle, introduction to CAD/CAM, concept of a workstation, advantages of CAD/CAM.

Graphics Hardware: Input/output devices, memory, graphic cards, networking and networking architectures.

UNIT-II

CAD Software: Standards, Basic Definitions – Data Structure, Database, DBMS, Database Coordinate System, Working Coordinate System, Screen Coordinate System, Modes of Operations, User Interface, Software Modules – OS Module, Applications Module, Programming Module, Communications Module, Modelling and Viewing.

UNIT-III

Geometric Modeling: Introduction to 2D, $2\frac{1}{2}$ and 3D modeling, Types – Wireframe modeling, surface modeling and solid modeling.

Wireframe Modeling: Wireframe entities and its types, Analytic and synthetic entities, representation of wireframe entities- parametric and non-parametric and its benefits, advantages and limitations of wireframe modeling.

UNIT-IV

Curves: Analytic and synthetic curves, parametric representation of the synthetic curves and its advantage, Hermite cubic spline, Bezier curve and B-spline curve and their properties, Introduction about NURBS, Degree of the curves, control of curves, curve manipulations.

Recommended Books / Suggested Readings:

1. Ibrahim Zeid and R. Sivasubramaniam, 2nd Edition, CAD/CAM – Theory and Practice, Tata McGraw Hill, India, 2009
2. M. Groover and E. Zimmers, CAD/CAM: Computer Aided Design and Manufacturing, Pearson Education, 2007
3. Chennakesava R. Alavala, "CAD/CAM: Concepts and Applications", PHI Learning Pvt. Ltd.

BMA322: COMPUTER AIDED DESIGN - I LABORATORY
Credits 02
LTP 004

Course Description: The course aims to equip the students with the various graphics input and output devices and to make the students learn about 3D Solid Modeling and use various operations used in it

The course includes basic concept of computer, 2D sketching and solid modeling.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1. The students can employ the geometric transformations on the basic entities.
CO 2. To design the various 3D models in CAD software.
CO 3. The students can explain the different representation techniques of curve and surfaces.

Course Content

UNIT I

Basic Concepts: Basic fundamentals of computer hardware and software, discussion about parametric concept, fundamentals of application software, discussion and advantages about CAD/CAM technology.

UNIT II

2D Sketching: Basic of sketching, practice on sketching profile (line, circle, rectangle, arc, spline etc.), practice on editing tool (fillet, chamfer, delete segment, corner, modify), discussion about constraining concepts, discussion about different types of constraints, various dimensioning methods: absolute dimensioning, incremental dimensioning, linear, radial, diameter, angular, slanted dimensions.

UNIT III

Solid Modeling: Discussion about solid modelling, advantage of solid modeling, discussion about finding mass properties, density, volume, density of different engineering materials, various tools used in solid modelling: Extrude, revolve tool, modification tools: Round, chamfer, various types of datum features, rib tool, advantage of draft tool, advantage of shell tool, mirror tool, copy & paste special tool, hole, pattern tool, sweep, blend, swept blend, variable section sweep, helical sweep, product development with Conceptual Design, solidify tool with its advantages, section tool with its types.

List of Practical's:

1. Modeling of pressure die casting component choke cover.
2. Modeling of forging component flange forging.
3. Modeling of forging component rottle forging.
4. Modeling of forging component idler arm.
5. Modeling of casting component gear box.

BAE601: AIRCRAFT STABILITY AND CONTROL
Credits 04
LTP 310

Course Description: The course aims to equip the students with the concept of Stability and control of Aircraft. With various Aircraft motions and related stability and with the concept of dynamic stability of Aircraft

The course include stick fixed static longitudinal stability, control surfaces and aerodynamic balancing, stick free static longitudinal stability, maneuvering flight, directional stability and controls

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1. The students will be self-abled to determine the aircraft stability conditions.

CO 2. The students will get to know the various theorems used in aircraft stability and control.

CO 3. The students will be get to know the role of static stability and dynamic stability in aircraft motion.

Course Content

UNIT I

Stick Fixed Static Longitudinal Stability: Introduction to stability of airplane, stick fixed longitudinal stability, effect of power, Neutral point, Centre of gravity limits. In flight measurement of stick fixed neutral point.

UNIT II

Control Surfaces And Aerodynamic Balancing: Control surface hinge moments, floating and restoring tendencies, different types of tabs used on airplanes. Frise Aileron, Spoiler Controls.

UNIT III

Stick Free Static Longitudinal Stability: Effect of free elevator on airplane stability, Elevator Control force, sticks force gradients, Neutral point, Controls free center of gravity limit in flight measurement of stick free neutral point.

UNIT IV

Maneuvering Flight: Effect of acceleration on airplane balancing, Elevator angle per g, and stick force per g, Maneuver margins.

UNIT V

Directional Stability and Controls: Asymmetric flight, Weather cock stability, contribution of different parts of Airplane, Rudder Fixed and Rudder free static directional stability, rudder lock.

UNIT VI

Lateral Stability and Control: Dihedral Effect. Contribution of different, Parts of airplane controls in Roll, Aileron control power, cross coupling of lateral and directional effects.

UNIT VII

Dynamic Stability: Introduction to dynamics, spring-mass system. Equations of motion without derivation, stability derivatives, Longitudinal Dynamic Stability, Lateral and Directional Dynamic Stability, analysis of different stability modes.

Recommended Books / Suggested Readings:

1. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley· SonInc, New York, 1988.
2. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 2007.
3. Bandu N. Pamadi, `Performance, Stability, Dynamics and Control of Airplanes`, AIAA 2nd Edition Series, 2004.
4. Barnes W. McCormick, `Aerodynamics, Aeronautics, and Flight Mechanics`, John Wiley & Sons, Inc. 1995.
5. Thomas R. Yechout, `An introduction to Aircraft Flight Mechanics`, AIAA educational Series; 2003.
6. Airplane Performance, Stability and Control Book by Courtland D. Perkins and Robert E. Hage.

BAE602: ADVANCED AERODYNAMICS
Credits 04
LTP 310

Course Description: The course aims to equip the students with various flow conditions occur during flight and give exposure about various wing types and aerodynamics related to it. Also familiarize students about shock waves during high speed flight.

The course include one dimensional flows, incompressible flow over airfoils, incompressible flow over finite wings, oblique shocks and expansion waves , subsonic compressible flow over airfoil

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1. At the end of this course the students will be able to obtain relations about various flow conditions.

CO 2. The students will be self-abled to determine the effect of geometry on high speed flight.

CO 3. The students will get to know the concept of temperature, compressible flows over wings.

Course Content

UNIT I

ONE DIMENSIONAL FLOWS: Isentropic process for closed system/flow processes. Velocity of sound. Mach number, flow regimes. Governing equations of inviscid compressible flow. Continuity, Momentum and Energy equations in Integral and Differential form. Stagnation conditions.

UNIT II

INCOMPRESSIBLE FLOW OVER AIRFOILS: Glauert's thin airfoil theory, symmetrical airfoil, cambered airfoil, flapped airfoil, determination of mean camber line shapes for uniform & linear distribution of circulation. Description of flow about multi-element airfoils.

UNIT III

INCOMPRESSIBLE FLOW OVER FINITE WINGS: Downwash & induced drag, Biot-Savart's law and Helmholtz's theorem, Prandtl's classical lifting line theory, fundamental equations. Elliptic and general lift distribution over finite upswept wings, effect of aspect ratio, Drag polar ,Correlation of Cl distribution over other aspect ratios, Lifting Surface theory, Formation Flying, Ground effect.

UNIT IV

OBLIQUE SHOCKS AND EXPANSION WAVES: Oblique shock relations. Supersonic flow over a wedge, M relations strong and weak shock solutions / Shock polar. Regular reflection from a solid boundary. Intersections of shock wave. Expansion waves. Prandtl – Meyer Expansion.

UNIT V

SUBSONIC COMPRESSIBLE FLOW OVER AIRFOIL: Introduction - Velocity potential equation – Transonic small perturbation equation - Prandtl-Glauert compressibility corrections - Critical Mach number - Drag divergence Mach number - Area rule - Supercritical airfoil.

UNIT VI

SUPERSONIC FLOW: Linearized supersonic flow- Linearized supersonic flow over airfoil and wings. Shock Expansion theory. Detached shock. Axi-symmetrical flows-flow past slender bodies of revolution, conical flows-Numerical integration procedure.

UNIT VII

HYPERSONIC FLOWS: Qualitative aspects of hypersonic flow. Newtonian theory. Flat plate at an angle of attack. Hypersonic shock wave relations. Lift and drag of wings at hypersonic speeds. Recent advances in hypersonic flows and testing techniques.

Recommended Books / Suggested Readings:

1. Fundamentals of Aerodynamics : John D.Anderson,2nd Ed. McGraw Hill,1991
2. Elements of Gas Dynamics : Lieppmann and Rosheko ,John Wiley 1957
3. Aerodynamics for Engineers : Bertin and Smith,Prentice Hall,1989
4. Modern compressible Flow with historical perspective: John D. Anderson
5. Experimental Methods in Hypersonic flows: J. Lucasiewisz.
6. Aerodynamics by L.J Clancy.
7. Aerodynamics for Engineering Students by E. L. Houghton, P. W. Carpenter.
8. The Illustrated Guide to AerodynamicsBook by Hubert C. Smith.

BAE622: ADVANCED AERODYNAMICS LABORATORY
Credits 01
LTP 002

Course Description: The course aims to equip the students with real time flow visualization and give exposure of calculation of aerodynamic forces.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

- **CO 1.** The students will be self-abled to calculate the aerodynamic moments.
- **CO 2.** The students will deal with real time flow past over bodies.

List of Experiments

i. Flow visualization on symmetrical airfoil, cylinder, flapped airfoil at various angles of attack.

ii. To find airspeed in the low speed wind tunnel.

iii. To find pressure coefficient distribution on symmetrical airfoil.

iv. To find pressure coefficient distribution on cambered airfoil.

v. To determine boundary layer thickness over a flat plate.

vi. To determine pressure coefficient distribution over a delta wing at different angles of attack.

BAE603: AEROSPACE VEHICLE STRUCTURES-2
Credits 05
LTP 410

Course Description: The course aims to equip the students with different structural types, give exposure of advance theorems used to calculate shear flow and stresses. Also to give the exposure about bending occurring in different types of structures.

The course include load diffusion in stiffed panels, sheet stringer combinations, stability of panels, shear flow in open sections subjected to pure bending, stress analysis of wing and fuselage, torsion bending of open tubes, and inhibition of axil constraint stress.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

- **CO 1.** The students will be able to find out the stresses occurring in the structures.
- **CO 2**. At the end of this course the students will be self-abled to calculate the shear flow.
- **CO 3.** The students will get exposure to finite element analysis concept.

Course Content

UNIT I

LOAD DIFFISION IN STIFFNED PANELS: Wagner's theory of beams. Shear carrying capabilities of panels and introduction to Tension field webs. Semi tension and complete tension field beams. Monocoque and semi-Monocoque structures.

UNIT II

SHEET STRINGER COMBINATIONS: Axial Load flow diagrams for boom in stiffened panels. Simple illustrative examples of A/C sheet stringer elements through free body diagrams. Load diffusion in thin walled panels with oblique stiffeners.

UNIT III

STABILITY OF PANELS: Stability of stiffened panels. Effective width concept. Simple estimations of load carrying capability of stressed skins of Aircraft wing shells.

UNIT IV

SHEAR FLOW IN OPEN SECTIONS SUBJECTED TO PURE BENDINGS: Thin walled beams - Shear center and Elastic axis Concept of shear flow beams with one axis of symmetry, Unsymmetrical box beam with effective and ineffective skins.

UNIT V

STRESS ANALYSIS OF WING AND FUSELAGE: Procedure - Shear and bending moment distribution for semi cantilever and other types of wings and fuselages - Thin webbed beam with parallel and non-parallel flanges - Shear resistant web beams.

UNIT VI

TORSION BENDING OF OPEN TUBES: Torsion bending phenomena. Torsion bending constant and specific torsion bending strength Simple derivation of torsion bending equation. The phenomena of warping. Stresses in cantilever, I-beam by solution of general differential equation for torsion beam.

UNIT VII

INHIBITION OF AXIL CONSTRAINT STRESS: Torsion of thin walled beams with open sections effect of axial constraints. Primary and Secondary warping phenomena. Computation of torsion bending constant for open tubes with cross sections such as Channel, T and Angle.

UNIT – VIII

AIRCRAFT SKIN STIFFNERS: Methods of improving torsion bending strength by lipping, as an effective means of improving torsion bending constant. Computation of improvement of specific torsion bending strength in lipped Channel, T, I, L, sections over the unclipped counter parts.

Recommended Books / Suggested Readings:

1. Aircraft Structures for Engineering Students, Megson, T.M.G., Edward Arnold, 1985.
2. Mechanics of Elastic Structures, J.T. Oden, McGraw-Hill. 1967
3. Airplane Structural Analysis and Design, Scheler.E.E and Dunn L.G, John Wiley & Sons.1963
4. Aircraft Structures, Peery, D.J, and Azar, J.J., 2 /e, Mc Graw-Hill, N.Y., 1993.
5. Theory and Analysis of Flight Structures, Rivello, R.M., McGraw Hill, 1993.
6. Analysis and Design of Flight Vehicles Structures, Bruhn. E.H, Tri - state off set company, USA, 1965.

BAE623: AEROSPACE VEHICLE STRUCTURES-2 LABORATORY
Credits 01
LTP 002

Course Description: The course aims to equip the students with aerospace vehicle structural analysis and calculate the deflections and stresses in aerospace structural materials.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1. The students will be self-abled to calculate the stresses induces in aircraft structure.

CO 2. The students will get exposure with instruments and tools used to analysis the structural material.

Course Content

List of Experiments

i. To determine the deflection of a beam with beam test apparatus.

ii. To measure the deflection of a column with the help of column test apparatus.

iii. To determine static equilibrium by using Wagner beam apparatus.

iv. To measure strain in a beam by using strain gauge test apparatus.

v. To balance the masses statically and dynamically of a single rotating mass system.

BAE701: AIRCRAFT SYSTEM AND INSTRUMENTATION
Credits 03
LTP 300

Course Description: The course aims to equip the students with aeronautical skills and experience necessary to meet there requirements for an Airplane Category Instrument Rating and with various systems which are required for flight control and students with dependency of flight instruments for efficient flight.

The course include flight control systems, engine control systems, pitot static instruments & systems, aircraft landing gear systems, aircraft fuel systems, auxiliary systems.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1.The students will get exposure towards mechanical linkages used as flight control devices.

CO 2. At the end of this course the students will get to know about instruments which are used in flight to control the aircraft.

CO 3. The students will get exposure about hydraulic and pneumatic system and its need in flight.

CO 4. The students will get familiarize about various navigational aids used in aircrafts.

Course Content

UNIT I

FLIGHT CONTROL SYSTEMS: Primary and secondary flight control, flight control linkage systems, push-pull control rod system, cable and pulley systems, high lift control systems, flight control actuation, inner actuator, mechanical actuator, mechanical screw jack actuator, direct drive actuation, fly-by-wire actuator, electro-hydrostatic actuator, electro-mechanical actuator.

UNIT II

ENGINE CONTROL SYSTEMS: Engine technology and principle of operation, fuel flow control, airflow control, control systems, control system parameters, input signals, output signals, example systems, engine starting, fuel control, ignition control, engine rotation, throttle levers, starting sequence, engine oil systems.

UNIT III

PITOT STATIC INSTRUMENTS & SYSTEMS: Pitot-static system, air speed indicator, altimeter, Mach meter, Mach/airspeed indicator, vertical speed indicator.

UNIT III

AIRCRAFT LANDING GEAR SYSTEMS: Landing gear configurations, classification of landing gears, steering systems, retraction systems, tires and wheels, design and operation of brake assemblies, aircraft brake systems, brake maintenance.

UNIT V

AIRCRAFT FUEL SYSTEMS: Requirements for Fuel systems, Fuel Tanks, Fuel System Components, Types of Fuel Systems, Typical Aircraft fuel systems, Inspection –Maintenance and repair of fuel systems.

UNIT VI

AUXILIARY SYSTEMS: Fire protection systems, Ice protection systems, rain protection systems, water and waste systems, position and warning systems, auxiliary power units

Recommended Books / Suggested Readings:

1. Aircraft Maintenance and Repair, Seventh Edition – Michael J Kroes, William A. Watkins, Frank Delp, Ronald Sterkenburg – Mc Graw Hill Edition 2014
2. Aircraft systems - Ian Moir and Allan Seabridge.
3. Aircraft instruments – E H J Pallet.
4. Aircraft Instrumentation and Systems Book by S. Nagabhushana.

BAE721: AIRCRAFT SYSTEM AND INSTRUMENTATION LABORATORY
Credits 01
LTP 002

Course Description: The course aims to equip the students with Hydraulic system and Pneumatic system. And give exposure of fly-by-wire system.

The course include Hydraulic system, pneumatic system, electric system, fly by wire ad fuel system used I aircraft.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1. The students will be self-abled to deal with hydraulic and Pneumatic system.

CO 2. The students will get exposure about jet engine fuel system.

List of Experiments

i. Study of Hydraulic system

ii. Study of Mechanical system

iii. Study of Pneumatic system

iv. Study of Electrical system

v. Study of Fly-by-wire system

vi. Study of Fuel system

BAE741: AIRCRAFT DESIGN
Credits 04
LTP 310

Course Description: The course aims to equip the students with implement the design process for aerospace systems. To conduct open-ended, iterative tasks associated with aircraft/engine design and airframe/engine integration. To properly integrate a variety of systems and sub-systems within aircraft to demonstrate design feasibility.

The course includes Preliminaries Air Loads in Flight Airplane Weight Estimation Wing Design Considerations Structural Layout and Integration Landing Gears Airframe Power Plant Integration.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1. The student will be able to demonstrate design viability through testing, both real and virtual.
CO 2. Use formal, structured design methods to develop superior products that meet or surpass customer expectations.
CO 3. Students will be able to estimate airplane weight design considerations.

Course Content

UNIT I

Preliminaries: Aircraft design, requirements and specifications, airworthiness requirements. Weight: It's importance. Aerodynamic and structural design considerations. Classifications of airplane, Concept of configuration, features of special purpose airplanes. Unmanned aerial vehicles and their features.

UNIT II

Air Loads In Flight: Classical methods of estimating symmetrical maneuvering loads on a wing in flight, basic flight loading conditions, Load factor, V-n diagram, gust loads, estimation of gust loads, structural effects, use of panel methods to estimate air load distribution on a wing.

UNIT III

Airplane Weight Estimation: Estimation of airplane weight based on airplane type / mission and material used, trends in wing loading, iterative approach.

UNIT VI

Wing Design Considerations: Factors influencing selection of airfoil and plan form. Span wise air loads variation with span and platform, stalling, take-off and landing considerations. BM and SF. Design principles for the structure of all metal, stressed skin wing (Civil & Military airplane).estimation of wing drag, effect of flaps.

UNIT V

Structural Layout and Integration: Structural layout of straight, tapered swept (fwd and aft) wings. Fuselage, empennage, Engine locations, Cockpit and passenger cabin layout, layout of flight and engine controls. Wing-fuselage jointing methods, all metal airplane considerations, use of composite materials. Preparation of 3-views CG location.

UNIT VI

Landing Gears: Requirement of landing gears, different arrangements, mechanism for retraction into fuselage and wing. Absorption of landing loads, calculations of loads.

UNIT VII

Airframe Power Plant Integration: Estimation of Horizontal and vertical tail volume ratios, number of engines, location for inlets and considerations their off. Revised CG location.

Recommended Books / Suggested Readings:

1. Airplane Design- A Conceptual Approach: Daniel P Raymer. AIAA Education Series USA,1999
2. The Design of Airplane : D.Stinton GRANADA,UK,2000
3. Fundamentals of Aircraft Design : L.M.Nikolai,Univ. of Dayton Ohio,1975
4. Aerodynamics for Engineers : Bertin and Smith,Prentice Hall,1989

BAE841: SPACE DYNAMICS
Credits 04
LTP 310

Course Description: The course aims to equip the students with understanding of aircraft flight dynamics. To understand celestial and orbital mechanics and be able to apply this understanding to realistic satellite orbits. To comprehend the fundamentals of spacecraft attitude dynamics

The course includes Introduction 2-D Rocket Motion in Vacuum, Two Body Problem Launching of Satellite, and the Earth Satellite Operations Satellite Attitude Dynamics Ballistic Missile Trajectories

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

- **CO 1.** The student will be able to describe launch vehicle trajectories
- **CO 2.** The student will be able to understand concept behind multi stage rockets
- **CO 3**. The student will be able to comprehend satellite operations.

Course Content

UNIT I

Introduction: Introduction to spacecraft, rockets and missiles, their basic functions and features, elements of rocket propulsion.

UNIT II

2-D Rocket Motion in Vacuum: equations of motion, rocket motion in free space, Tsiolkovsky's equation, rocket parameters, multistage rockets, ideal velocity of multistage rocket.

UNIT III

Two Body Problem: Orbit equation, Kepler's laws, circular orbit, elliptical, hyperbolic orbit, orbital elements.

UNIT VI

Launching Of Satellite: Launch vehicle ascent trajectories, injection of satellite and its general aspects, dependence of orbital parameters on in-plane injection parameters.

UNIT V

The Earth Satellite Operations: The Hohmann transfer, inclination-change maneuver, launch to rendezvous, decay life time, earth oblateness effect, low thrust orbit transfer.

UNIT VI

Satellite Attitude Dynamics: Torque –Free-axisymmetric Rigid body, The general torque free rigid body, semi-rigid space craft, attitude control: Spinning and Non spinning space craft. The Yo-Yo mechanism, gravity gradient satellite, the dual spin space craft.

UNIT VII

Ballistic Missile Trajectories: Introduction, boost phase, ballistic phase, trajectory geometry, reentry trajectory.

Recommended Books / Suggested Readings:

1. Space Flight Dynamics : William E. Wiesel , Mcgraw Hill 1989
2. Rocket Propulsion & Spaceflight Dynamics: J W Cornelisse,H F R Schoyer,K F Wakker, Pitman Publishing ltd.

OPR001: OPERATION RESEARCH
Credits: 3
LTP 3 0 0

Course Description: The course aims to equip the students with the theory of optimization methods and algorithms developed for solving various types of optimization problems. To develop and promote research interest in applying optimization techniques in problems of Engineering and Technology To apply the mathematical results and numerical techniques of optimization theory to concrete Engineering problems.

The course includes Overview, Transportation Problem, Sequencing Models, Queuing Theory, Game Theory

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO1: Explain the meaning of operations research

CO2: Know the various techniques of operations research

CO3: Apply the techniques used in operations research to solve real life

CO4: Select an optimum solution with profit maximization.

Course Content

UNIT I

Overview: Introduction, Definition, characteristics and scope of O.R., Objectives of O.R.,Phases and models in O.R. Linear Programming: Introduction, Concept of linear programming, Graphical method, Simplex method, Big M method, Dual simplex method, Two-phase method, Duality in linear programming.

UNIT II

Transportation Problem: Introduction, Mathematical models for T.P., Formulation and solution of balanced and unbalanced T.P., Transshipment models.
Assignment Models: Definition, Comparison with transportation model, Mathematical representation of assignment models, Formulation and solution of assignment models, Variations of the assignment problem and alternate optimal solutions.

UNIT III

Sequencing Models: Processing n jobs through two machines, processing n jobs through three machines, processing two jobs through m machines, processing n jobs through m machines, travelling salesman problem.
Inventory Control: Purchase model with instantaneous replenishment and with and without shortages, manufacturing model with and without shortages, Quantity discount.

UNIT IV

Queuing Theory: Introduction, Terminologies of queuing system, Empirical queuing models, Replacement Models: Replacement of items that deteriorate with time, Replacement of items that fail suddenly, Individual and group replacement.

UNIT V

Game Theory: Introduction and terminologies of game theory, games with pure and mixed strategies. CPM and PERT: Basics steps in PERT and CPM, PERT and CPM computations, Cost analysis, Contracting and Updating, Resource Scheduling.

Recommended Books / Suggested Readings:

1. Panneerselvam R, "Operations Research", PHI, 2002.
2. Tulsian P.C., Pandey Vishal, "Quantitative Techniques", Pearson Education, 2002.
3. Wagner, "Principles of Operations Research", Prentice-Hall India, 2000.

BME321: Strength of Materials Laboratory
Credits: 1
LTP 002

Course Description: The course aims to equip the students with the experience of material testing procedures.

The course includes measuring strength, hardness, toughness and fatigue of material.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO1: Perform various tests on UTM machine.

CO2: Calculate the torsion strength of materials.

CO3: Calculate the impact strength of the materials.

List of Practical

1. Draw Stress Strain curve for Ductile and Brittle material in tension.
2. Draw Stress Strain curve for Ductile and Brittle material in compression.
3. Draw shear stress, shear strain curve for ductile and brittle material in torsion strength testing
4. Draw load deflection curve for spring in loading and unloading conditions.
5. To determine the hardness of the given material by Rockwell and Brinell hardness testing machine.
6. To determine the fatigue strength of the material.
7. To determine the impact strength by Izod and Charpy test.

BME422: FLUID MECHANICS LABORATORY
Credits: 1
LTP 002

Course Description: The course aims to equip the students with the knowledge of properties of fluid, types of fluid and types of flow. Also teach students about flow measuring devices such as orifice meter and venture, and also about flow through pipes.

This course includes the description of concept of Bernoulli's theorem, calibration of orifice meter, venturimeter. It also includes the description of the flow through pipes and velocity distribution for pipe line flow with a pitot static probe

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO1: Analyze various flow problems and fluid characteristics.

CO2: Determine the losses of flow through various mediums like pipes.

CO3: Apply the concept of fluid mechanics to design various systems.

List of Experiments:

1. To determine the metacentric height of a ship model.
2. To verify Bernoulli's theorem.
3. To calibrate a venturimeter and to determine its coefficient of discharge.
4. To calibrate an orifice meter and study the variation of the coefficient of discharge with the Reynolds number.
5. To study the flow over v notch (weir) and to find the coefficient of discharge.
6. To determine the hydraulic coefficient of discharge of a mouth piece.
7. To determine the coefficient of friction of pipes of different diameters.
8. To determine the head loss in a pipe line due to sudden expansion / sudden contraction/ bend.
9. To determine the velocity distribution for pipe line flow with a pitot static probe.

List of Professional Elective Course in B.Tech Aerospace Engineering

LIST OF PROFESSIONAL ELECTIVES COURSES

***Elective –I**

Course Code	Course Title
BAE641	Composite Materials
BAE642	Air Transportation And Maintenance
BAE643	Rockets Propulsion

****Elective –II**

Course Code	Course Title
BAE742	Computational Fluid Dynamics
BAE743	Fatigue and Fracture Mechanics
BAE744	Vibrations and Aeroelasticity

*****Elective – III**

Course Code	Course Title
BAE842	Helicopter Engineering
BAE843	Automatic Flight Control
BAE844	Avionics

BAE641: COMPOSITE MATERIALS
Credits 03
LTP 300

Course Description: The course aims to equip the students with imparting knowledge in the analysis of Multi-layered composite laminated plates using Micromechanics properties of composites materials and with mechanical behavior of composite materials. Students will get an overview of the methods of manufacturing composite materials, it also explains Stresses in Classical and laminated plates with symmetric, anti-symmetric and un-symmetric layered composites

The course include introduction of composite materials, its properties, and its manufacturing, different methods of analysis with stress-strain relation of materials.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1. Students will be able to determine composite mechanical properties from constituent fiber and matrix material properties including longitudinal and lateral moduli, Poisson's ratio, and shear modulus.
CO 2. Students will be able to determine the generalized stiffness and compliance matrix relating in-plane stresses to strains for a composite layer assuming plane stiffness.
CO 3. Students will be able to fabricate composite laminates and built-up composite structures such as I-beams, box beams, or model-scale aircraft wings using a composite manufacturing procedure.
CO 4. Students will be able to synthesize structures for environmental effects.
CO 5. Students will be able to analyze economic aspects of using composites.

Course Content

UNIT I

INTRODUCTION: Introduction to laminated composite plates, Mechanical Properties of constituent materials such as Matrix and Filaments of different types. Netting analysis of composite materials, determination of properties of laminates with fibres and matrices.

UNIT II

MANUFACTURING OF COMPOSITE MATERIALS: Lamina- assumptions, macroscopic viewpoint, generalized Hooke's law, reduction of homogeneous orthotropic lamina, isotropic limit case, orthotropic stiffness matrix, commercial material properties, rule of mixtures, transformation matrix, and transformed stiffness. Manufacturing of composite materials, bag moulding, compression moulding, pultrusion, filament welding, other manufacturing processes

UNIT III

PROPERTIES OF MATERIALS: Stress-Strain relations of Isotropic, Orthotropic and Anisotropic materials, transformation of material properties for arbitrary orientation of fibres.

UNIT IV

METHODS OF ANALYSIS: Mechanics of materials approach to determine Young's modulus, Shear Modulus and Poisson's ratio, brief mention of elasticity approach and Macro mechanics of laminates. Analysis of laminated plates- equilibrium equations of motion, energy formulation, static bending analysis, buckling analysis, free vibrations, natural frequencies.

UNIT V

STRESS STRAIN RELATIONS: Anisotropic elasticity, stress –strain relations in material coordinates - Transformation of geometric axes, strength concepts, biaxial strength theories, Maximum stress and Maximum strain.

UNIT VI

TYPES OF COMPOSITES: Classical plate theory, Classical lamination theory – Special cases of single layer, symmetric, anti-symmetric & unsymmetrical composites with cross ply, angle ply layup. Deflection analysis of laminated plates. Analysis laminated beam and plates.

UNIT VII

THEORIES AND ANALYSIS OF PLATES: Shear deformation theories for composite laminated beams, plates. Buckling analysis of laminated composite plates with different orientation of fibres. Tsai-wu criteria and Tsai – Hill Criteria.

Recommended Books / Suggested Readings:

1. Gibson R.F. Principles of Composite Material Mechanics, second edition, McGraw Hill, 1994.
2. Mechanics of Composite Materials, Jones R.M., McGrawHill
3. Mechanics of Composite Materials and Structures Mudhujith
4. Hyer M.W., Stress Analysis of Fiber- Reinforced Composite Materials, McGraw Hill, 1998
5. Analysis and performance of fibre composites, Agarwal B. D, Broutman. L. J., John Wiley and sons – New york, 1980.
6. Advanced Composite Materials, Lalith Gupta, Himalayan book, New Delhi, 1998.
7. Composite Materials, Kishan K. Chawla, Springer Intrl.Edition.

BAE642: AIR TRANSPORTATION AND MAINTENANCE
Credits 03
LTP 300

Course Description: The course aims to equip the students with the knowledge about air transportation, its economic principles and scheduling and monitoring of aircraft maintenance, and aircrafts maintenance requirements and familiarize about current issues and trends in air transportation

The course include introduction of air traffic control with industrial safety, accident preventions and management. Also introduce the airlines and maintenance requirements in airports.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1. Students will be able to understand the organization details in air-transportation
CO 2. Students will be able to to study the principles of airline scheduling
CO3. Students will be able to to understand the airline maintenance schedule and monitoring.

Course Content

UNIT I

AIR TRAFFIC CONTROL: Principles of Air Navigation and Air Traffic Control, Overview of CNS & ATM, Separation standards, Radar and Non-radar separation, wake turbulence longitudinal separation minima, Precision approaches for landing, Radar systems for ATC

UNIT II

INTRODUCTION TO INDUSTRIAL SAFETY, ACCIDENT PREVENTIONS AND MANAGEMENT: History and development of Industrial safety: Implementation of factories act, Formation of various councils, Safety and productivity, Safety organizations. Safety committees, safety committee structure, Roll of management and roll of Govt. in industrial safety, Safety analysis**.**

UNIT III

AIRLINES: Introduction to airline industry and economics, determination of operating costs, Airline route selection and scheduling, flight plan and flight operations, special topics in airline operations, Emergence of LCC.

UNIT IV

MAINTENANCE REQUIREMENTS IN AIRPORTS: Civil Aviation Rules and Regulation, Human Factor, Study of Instrument System Electrical System Radio & Navigation System, in Light aircraft Piston Engine Heavy Aircraft Jet Engine Rotary aircraft.

UNIT V

CURRENT ISSUES AND TRENDS IN AIR TRANSPORTATION: Modeling & Simulation of ATC systems, Estimation of airway Capacity & Delay, Human Factors and Controller Workload, Performance Based Navigation, Free Flight, Conflict Detection and resolution, Environmental effects of Aviation, Modeling air transport systems.

UNIT V

MAINTENANCE SCHEDULES: Maintenance of aircraft, its components, systems and sub-systems. Types of maintenance schedules, Mandatory schedules, Inspection of aircraft and components: Types of Inspections, Various Aircraft Manuals, Service Letters, Service Bulleting, Advisory Circulars, Repair, Modifications, Alteration, Reconditioning, History Record Sheet

UNIT VI

MAINTENANCE OF STRUCTURE AND VARIOUS SYSTEMS: Maintenance of aircraft structure, propeller, power-plant, undercarriage, hydraulic system, fuel system, air-conditioning system.

Recommended Books / Suggested Readings:

1. Aircraft Maintenance and Repair :Kroes et.al GLENCOE ,1993
2. Air Transportation: A Management Perspective, 6th Edition, John G. Wensveen, Ashgate Publishing, Ltd., UK, 2007
3. Fundamentals of Air Traffic Control, 4th Edition, Michael S. Nolan, Thomson Brooks/Cole, USA, 2004.
4. Planning and Design of Airports, 4th Edition, Robert Horonjeff & Francis X. McKelvey, Mcgraw Hill Professional Publishing, 1993.
5. Airline Route Planning, John H. H. Grover, BSP Professional Books, Blackwell Scientific Publications, Oxford, UK, 1990.

BAE643: ROCKETS PROPULSION
Credits 03
LTP 300

Course Description: The course aims to equip the students with computation and analyze the various forces and moments acting on a rocket, formulate the equations of motions for flight and separation phases and understand the combustion and propulsion systems in rocket.

The course includes rocket dynamics, solid propulsion and liquid propulsion and its control system. Also include multi-staging rocket engine with its materials and testing.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1. Students will be able to analyze the fluid flow in a rocket nozzle
CO 2. Students will be able to perform preliminary heat transfer calculations in a rocket nozzle.
CO 3. Students will be able to Design various rocket motor systems to satisfy a wide range of applications
CO 4. Students will be able to perform a preliminary calculation for the propellant budget of a launch vehicle in powered flight
CO 5 .Perform analyses on solid-core nuclear thermal rockets, arc jets, and ion thrusters

Course Content

UNIT I

ROCKET DYNAMICS: Classification of launch vehicles and missiles – Rocket systems – Airframe components - Forces and moments acting on a rocket – Propulsion, aerodynamics, gravity – inertial and non-inertial frames – coordinate transformation – Equations of motion for three dimensional motion through atmosphere and vacuum, earth's atmosphere, numerical problems

UNIT II

SOLID PROPULSION AND PYROTECHNICS: Solid propellant rockets - classification, components and their design considerations, propellant grain design - grain mechanical properties, ballistics and burn rate design issues - igniter design - types of nozzles and thrust vector control, pyrotechnic devices and systems-classification, mechanisms and application of pyrotechnic devices in rockets and missiles. Design problems in rocket systems.

UNIT III

LIQUID PROPULSION AND CONTROL SYSTEMS: Liquid propellant rockets – classification and components - thrust chamber, feed systems, propellant tanks, turbo-pumps, types of valves and applications- their design considerations. Different bipropellant systems like cryogenics and their characteristics, pogo and sloop engine gimbals systems and thrusters for control. Spacecraft propulsion and control systems-Design problems.

UNIT IV

MULTI-STAGING OF ROCKET AND SEPARATION DYNAMICS: Navigation and guidance systems in rockets and missiles - aerodynamic control systems of missiles- multi-staging of rockets - vehicle optimization techniques - stage separation system – dynamics, separation techniques - rocket flight dispersion, numerical problems.

UNIT V

DESIGN, MATERIALS AND TESTING OF ROCKETS: Design requirements and selection, performance evaluation and assessment, space environment on the selection of materials for rockets and spacecraft, material selection for specific requirements, advance materials-super alloys and composite materials. Qualification of rocket and missile systems, types of testing and evaluation of design and function.

Recommended Books / Suggested Readings:

1. Ramamurthi. K.: Rocket Propulsion. Macmillan Publishers India first edition. 2010.
2. Sutton.G.P. and Biblarz.O: Rocket Propulsion Elements.7th edition. Wiley India Pvt Ltd.2010.
3. Cornelisse, J.W, Schoyer H F R, and Wakker K F, "Rocket Propulsion and Space Dynamic", Pitman Publishing Co., 1979.
4. Ronald Humble, Henry and Larson. Space Propulsion Analysis and Design. McGraw-Hill. 1995

BAE742: COMPUTATIONAL FLUID DYNAMICS
Credits 03
LTP 300

Course Description: The course aims to equip the students with the concepts related to computational fluid dynamics and enable to solve and apply various types of equations for the computational analysis of flow also generate various types of grid and apply panel method for solving flow problems

The course includes governing equations of fluid dynamics, shock fitting and shock capturing, impact of partial differential equations on cfd, discretization, and transformations.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1. The student will demonstrate the ability to use modern CFD software tools to build flow geometries, generate an adequate mesh for an accurate solution, select appropriate solvers to obtain a flow solution, and visualize the resulting flow field.
CO 2. The student will demonstrate the ability to analyze a flow field to determine various quantities of interest, such as flow rates, heat fluxes, pressure drops, losses, etc., using flow visualization and analysis tools.
CO 3. The student will demonstrate the ability to simplify a real fluid-flow system into a simplified model problem, to select the proper governing equations for the physics involved in the system, to solve for the flow, to investigate the fluid-flow behavior, and to understand the results.
CO 4. The student will demonstrate an ability to describe various flow features in terms of appropriate fluid mechanical principles and force balances.

Course Content

UNIT I

BASICS: Introduction to computational fluid dynamics – Research tool – Design Tool, Finite control volume, infinitesimal fluid element, substantial derivatives, divergence of Velocity

UNIT II

GOVERNING EQUATIONS OF FLUID DYNAMICS: The continuity equation, the momentum equation, the energy equation, physical boundary conditions.

UNIT III

SHOCK FITTING AND SHOCK CAPTURING: Form of Governing equation suited for CFD - Conservation form – shock fitting and shock capturing.

UNIT IV

IMPACT OF PARTIAL DIFFERENTIAL EQAUTIONS ON CFD: Introduction, Classification of Quasi-Linear Partial differential equation, The Eigen value method, General behaviour of different classes of Partial differential equation – elliptic, parabolic and hyperbolic.

UNIT V

DISCRETIZATION: Introduction, Finite differences, difference equations, Explicit and implicit approaches, Errors and an analysis of stability.

UNIT VI

TRANSFORMATIONS: Introduction, transformation of the governing partial differential equations, Matrices and the Jacobian of transformation.

UNIT VII

GRID GENERATIONS: Grid Generation techniques, Elliptic Grid Generator – Simply connected, Coordinate system control – Grid Point clustering, Introduction to Hyperbolic Grid Generation techniques and parabolic grid generator. Domain –doubly connected domain

Recommended Books / Suggested Readings:

1. Computational Fluid Dynamics, John .D. Anderson McGraw Hill
2. Computational Fluid Dynamics for Engineers, Hoffmann, K.A: Engineering Education System, Austin, Tex., 1989
3. Computation as Fluid Dynamics, Jiyuess and others, Elsevier, 2008.
4. Introduction to Computational Fluid Dynamics, Chow CY, John Wiley, 1979

BAE743: FATIGUE AND FRACTURE MECHANICS
Credits 03
LTP 300

Course Description: The course aims to equip the students with understanding of fracture behaviour of materials, fatigue design and testing

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1. Students will gain knowledge about behavior of materials having microscopic flaws.
CO 2. Students will learn the component design methods in fracture mechanics taking fracture toughness into account.
CO 3. Students will learn fracture toughness test methods and examination of macroscopic and microscopic fracture surfaces.

Course Content

UNIT I

FATIGUE OF STRUCTURES: S.N. Curves - Endurance limit - Effect of mean stress, Goodman, Gerber and Soder berg 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 BEHAVIOUR: 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

FATIGUE DESIGN AND TESTING: Safe Life and Fail safe design philosophies Importance of Fracture Mechanics in aerospace structure - Application to composite materials and structures

Recommended Books / Suggested Readings:

1. Barrels, W., and Ripley, E.L., "Fatigue of Aircraft Structures", Pergamon Press, Oxford, 1983.
2. Knott, J.F., "Fundamentals of Fracture Mechanics", Butterworth & Co., (Publishers) Ltd., London, 1983.
3. Sih, C.G., "Mechanics of Fracture", Vol.1 Sijthoff and Noordhoff International Publishing Co., Netherlands, 1989.
4. T.L Anderson. "Fracture Mechanics: Fundamentals and Applications", Fourth Edition 1991

BAE744: VIBRATIONS AND AEROELASTICITY
Credits 03
LTP 300

Course Description: The course aims to equip the students with aero-elasticity and to introduce them to aero elastic concepts such as "the flexible aircraft" and structural dynamic/aerodynamic interaction and stability; provide an understanding of complex structural dynamics and aero elasticity by use of simple Lagrangian models of aircraft wing, fuselage, and rotor systems; To give the student a wide range of tools to model the structural dynamics of aircraft and helicopters; To demonstrate the diverse nature of aero elasticity problems by bringing together aspects of previous courses, such as dynamics, structures, mathematics and aerodynamics.

The course includes introduction of undammed free and transient vibration, damped vibration, forced vibration with single degree of freedom. And introduction of aero-elasticity with its problem.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1. Students will understand fundamentals of vibration such as natural frequencies and modes, resonance, and effect of mass, stiffness and damping on vibration characteristics
CO 2. Students will understand dynamic aero-elastic instability due to interactions among aerodynamics, structure and inertia effect such as flutter
CO 3. Understand fundamentals of modeling and analysis techniques, including the energy approach

Course Content

UNIT I

Introduction And Undammed Free And Transient Vibrations: Definitions and terminology, simple harmonic motion ,combinations of two simple harmonic motions, solution of second order differential equations, complex numbers, classical solution, energy solution, summery of procedures for determining natural frequency, transient, response, equivalent systems.

UNIT II

Damped Free and Transient Vibrations-Single Degree Of Freedom: Introduction, viscous damping, critical damping, over damping, under damping, equivalent dampers, coulomb damping.

UNIT III

Study State Forced Vibrations –Single Degree Of Freedom Introduction, sources of excitation, impressed harmonic force, impressed force due to unbalance excitation, transverse critical speed of a single disk, motion excitation, transmissibility and isolation, summary of simple harmonic excitation, commercial isolator materials.

UNIT IV

Introduction to Aero-elasticity: Definition and historical background, static and dynamic aero elastic phenomenon, integration of aerodynamic, elastic and inertia forces, influence of aero elastic phenomenon on aircraft design, comparison of critical speeds.

UNIT V

Divergence Of Lifting Surfaces: The phenomenon of divergence, divergence of 2-D wing section, divergence of an idealized cantilever wing, solution based on semi-rigid assumptions, solution to generalized co-ordinates method of successive approximation, use of numerical methods.

UNIT VI

Study State Aero-elastic Problems In General: Loss and reversal of aileron control,2-D and general case, lift distribution on a rigid and elastic wing, effect on static longitudinal stability of airplane, flutter and buffeting.

Recommended Books / Suggested Readings:

1. Mechanical Vibrations: V.P.Singh, Dhanpat Rai and Co. Pvt. Ltd., Delhi
2. An introduction to the Theory of Aeroelasticity: Y.C.Fung, Dover Publications
3. Aeroelasticity: R.L.Bisplingh off Holt Ashley R.L.Halfman, Addison Wesley Publishing Co. Reading, Mass
4. Mechanical vibrations: Austin H. Church, John Wiley & sons.

BAE842: HELICOPTER ENGINEERING
Credits 03
LTP 300

Course Description: The course aims to equip the students with major helicopter components, characteristics and configurations, major issues involved in forward flight rotor theory with special power estimates

The course includes elements of helicopter aerodynamics, ideal rotor theory, power estimates, lift, propulsion and control of vistol aircraft

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1. Students will be able to enhance ability to apply knowledge of mathematics, science and engineering through analysis of helicopter flights.
CO 2. Students will be able to enhance understanding of professional and ethical responsibilities by discussion of effects of helicopter safety.
CO 3. Students will be able to improve life-long learning abilities by introducing advanced concepts which will allow students to access technical literature on helicopter operation, flight, and control.
CO 4. Improve knowledge of aerodynamics, helicopter operations and helicopter controls.
CO 5. Improve ability to identify, formulate and solve engineering problems.

Course Content

UNIT I

ELEMENTS OF HELICOPTER AERODYNAMICS: Configurations based on torque reaction-Jet rotors and compound helicopters- Methods of control — Collective and cyclic pitch changes - Lead - Lag and flapping hinges.

UNIT II

IDEAL ROTOR THEORY: Hovering performance - Momentum and simple blade element theories – Figure of merit - Profile and induced power estimation - Constant chord and ideal twist rotors.

UNIT III

POWER ESTIMATES: Induced, profile and parasite power requirements in forward flight-Performance curves with effects of altitude- Preliminary ideas on helicopter stability

UNIT IV

LIFT, PROPULSION AND CONTROL OF VISTOL AIRCRAFT: Various configuration - Propeller, rotor, ducted fan and jet lift - Tilt wing and vectored thrust - Performance of VTOL and STOL aircraft in hover, transition and forward motion.

UNIT V

GROUND EFFECT MACHINES: Types - Hover height, lift augmentation and power calculations for plenum chamber and peripheral jet machine - Drag of hovercraft on land and water. Applications of hover-craft.

Recommended Books / Suggested Readings:

1. Gessow, A., and Myers, G,C., "Aerodynamics of Helicopter", Macmillan &Co., N.Y 1987
2. McCormick, B,W., "Aerodynamics of V/STOL Flight", Academic Press, 1987
3. Johnson, W., "Helicopter Theory," Princeton University Press, 1980.
4. McCormick, B,W., "Aerodynamics, Aeronautics and Flight Mechanics"John Wiley, 1995.
5. Gupta, L., "Helicopter Engineering", Himalayan Books, 1996.

BAE843: AUTOMATIC FLIGHT CONTROL
Credits 03
LTP 300

Course Description: The course aims to equip the students with the essential knowledge and skills they need to be able to do conceptual and preliminary design of various flight control systems. The course begins with some introductory definitions and classifications followed by aerodynamic considerations in control system design. Then the performance of different control methods is compared. Flight actuators and sensors are introduced including their mathematical modeling.

The course includes Introduction to Control System Design Introduction to Flight Control Systems Control System Performance Linearization and Transfer Functions of Flying Vehicles Design of Aerodynamic Control System for Missiles Aircraft Control System Design Miscellaneous Topics

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1. The student will be able to describe various types of feedback control systems
CO 2. Students can analyze various types of responses of feedback control system corresponding to input signals.
CO 3. Students can design automatic flight control systems for auto pilot and fly-by-wire.
CO 4. Students can determine stability of the closed loop and open loop systems.
CO 5. Students can analyze time domain and frequency domain responses for various feedback systems.

Course Content

UNIT I

Introduction to Control System Design: Open vs. Closed Loop Control, Analogue, Digital and Logical Control, Industrial Controllers, Control System Design Objectives, Control System Design Cycle.

UNIT II

Introduction to Flight Control Systems: History Guidance, Navigation and Control**,** Flight Control Channels**,** Flight Control Methods**,** SAS vs. Autopilot**,** Aerodynamic Considerations of Flight Control Systems**,** Static and Dynamic Stability**,** Stability and Maneuverability**,** Static Margin**,** Variations of the Center of Pressure**,** Hinge Moment**,** Aero elastic Effects**.**

UNIT III

Control System Performance: Canard Control**,** Wing Control**,** Tail Control**,** Fin Configuration Effects**,** Side Jet Control**,** Thrust Vector Control**,** Variation of Mass and CG**,** Flight Control Actuators**,** Servomechanism**,** Reversible vs. Irreversible mechanisms**,** Hydraulic Actuators**,** Pneumatic Actuators**,** Electric Actuators**,** Flight Control Sensors**,** Accelerometers**,** Gyroscopes**,** Angle of attack vane**,** Other sensors**,** Sensor Selection**,** An Overview of Controller Design Objectives**,** Design Using Frequency Response**,** Design Using Root Locus, Pole Placement Method.

UNIT IV

Linearization and Transfer Functions of Flying Vehicles: Coordinate Systems**,** Equations of Motion**,** Roll, Pitch and Yaw Transfer Functions.

UNIT V

Design of Aerodynamic Control System for Missiles: STT vs. BTT**,** Lateral Control System Design for STT**,** Roll Control**,** Control System Design for BTT**,** MIMO Based Design**,** Design of Single Channel Flight Control Systems**.**

UNIT VI

Aircraft Control System Design: Longitudinal Control**,** Lateral Control**,** Attitude Control Systems**,** Flight Path Control Systems**,** Active Control Systems**,** Thrust Vector Control, Classifications and Applications**,** Mathematical Modeling**,** Control Architectures**,** Controller Design.

UNIT VII

Miscellaneous Topics: Sensitivity Analysis**,** Man in the Loop considerations**,** Parameter Optimization**,** Digital Control Systems.

Recommended Books / Suggested Readings:

1. Garnell, P., "Guided Weapon Control Systems", 2nd Edition, Pergamon Press, 1980
2. McLean, D., "Automatic Flight Control Systems", Prentice Hall International (UK) Ltd, 1990
1. Blakelock, J. H.; Automatic Control of Aircraft and Missiles, 2nd Edition, John Wiley & Sons, 1990.
2. Benjamin C. Kuo, "Automatic Control Systems," Prentice Hall of India, 1992

BAE844: AVIONICS
Credits 03
LTP 300

Course Description: The course aims to equip the students with aircraft avionics system. Students will acquire a good understanding of the major airborne avionic functions and systems and will be able to select appropriate technologies and products for a broad range of functional requirements.

The course includes Basics, Flight Deck and Display Systems, Ranging and Landing Systems Positioning System, Surveillance System, Auto Flight Systems.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO 1. The student will be able to describe flight deck and display systems
CO 2. The student will be able to understand aircraft positioning systems
CO 3. The student will be able to comprehend surveillance and auto flight system.

Course Content

UNIT I

Basics: Basic principles of Avionics – Typical avionics sub system in civil/ military aircraft and space vehicles

UNIT II

Flight Deck and Display Systems: Flight deck display technologies – CRT, LED, LCD, Touch screen – Head up display – Electronic instrumentation systems. Aircraft audio systems basic – audio transmitter and receiver principles – VHF communication system – UHF communication systems.

UNIT III

Ranging And Landing Systems: VHF Omni range – VOR receiver principles – distance maturity equipment – principles of operation – Instrument landing system – localizer and glide slope

UNIT VI

Positioning System: Global positioning system principles – triangulation – position accuracy – applications in aviation. Principle of Operation of INS – navigation over Earth – components of inertial Navigation systems – accelerometers – gyros and stabilized platform.

UNIT V

Surveillance System: ATC surveillance systems principles and operation interrogation and replay standards – Collision avoidance system – ground proximity warning system.

UNIT VI

Auto Flight Systems: Automatic flight control systems – fly by wire and fly by light technologies – flight director systems – flight management systems. Integrated DATA TRANSFER methodology by use of MILS – STD – 1553/ ARINC – 429.

Recommended Books / Suggested Readings:

1. Elements of electronic navigation, N.S.Nagaraja, Tata Mc Graw Hill,
2. Avionic systems Operation and maintenance, Janes W.Wasson,Jeppesen Sandersen Training products (Sterling Book House, Mumbai),1994.
3. Principle of Avionics, Albert Hel frick, Avionics Communications
4. Aircraft Instrumentation and Integrated systems EHJ Pallet, Longman Scientific Technical (Sterling Book House, Mumbai) 1996.1992