KUMARAGURU COLLEGE OF TECHNOLOGY, COIMBATORE – 641 049

CURRICULUM AND SYLLABUS

REGULATION 2013

B.E. AERONAUTICAL ENGINEERING

SEMESTERS III to VIII

Department of Aeronautical Engineering

CURRICULUM

SEMESTER I

Code No.	Course Title	L	T	P	C
THEORY					
U13ENT101	Technical English	2	1	0	3
U13MAT101	Engineering Mathematics – I	3	1	0	4
U13PHT101	Engineering Physics	3	0	0	3
U13CHT101	Engineering Chemistry	3	0	0	3
U13MET101	Engineering Graphics	2	0	3	3
U13CST101	Structured Programming using 'C'	3	1	0	4
PRACTICAL					
U13PHP101	Physics Laboratory	0	0	3	1
U13MEP101	Engineering Practices Laboratory	0	0	3	1
U13CSP101	Structured Programming Laboratory using 'C'	0	0	3	1
U13GHP101	Human Excellence – Personal Values-I	0	0	1	1
				Total Credits:	**24**
				Total Hours:	**32**

SEMESTER II

Code No.	Course Title	L	T	P	C
THEORY					
U13ENT201	Professional English	1	0	2	2
U13MAT201	Engineering Mathematics – II	3	1	0	4
U13PHT202	Materials Science	3	0	0	3
U13CHT202	Applied Chemistry	3	0	0	3
U13MET201	Engineering Mechanics	3	1	0	4
U13AET201	Elements of Aeronautics	3	1	0	4
PRACTICAL					
U13CHP201	Chemistry Laboratory	0	0	3	1
U13CSP211	Computing Laboratory	0	0	3	1

U13AEP201	CAD Laboratory - I	0	0	3	1
U13GHP201	Human Excellence – Personal Values-II	0	0	2	1
				Total Credits:	**24**
				Total Hours:	**32**

SEMESTER III

Code No.	Course Title	L	T	P	C
	THEORY				
U13MAT301	Numerical Methods	3	0	2	4
U13AET301	Mechanics of Fluids	3	1	0	4
U13AET302	Mechanics of Solids	3	1	0	4
U13AET303	Aero Engineering Thermodynamics	3	1	0	4
U13EET311	Basic Electrical and Electronics Engineering	3	0	0	3
U13GST001	Environmental Science and Engineering	3	0	0	3
	PRACTICAL				
U13AEP301	Fluid Mechanics and Machinery Laboratory	0	0	3	1
U13AEP302	Strength of Materials Laboratory	0	0	3	1
U13AEP303	Thermodynamics Laboratory	0	0	3	1
U13GHP301	Human Excellence – Family Values	0	0	2	1
				Total Credits:	**26**
				Total Hours:	**34**

SEMESTER IV

Code No.	Course Title	L	T	P	C
	THEORY				
U13MAT403	Modeling and Analysis of Engineering Systems	3	1	0	4
U13AET401	Aerodynamics – I	3	1	0	4
U13AET402	Mechanics of Machines	3	1	0	4
U13AET403	Aircraft Structures – I	3	1	0	4
U13AET404	Aircraft Propulsion	3	1	0	4

U13AET405	Aircraft Materials and Processes	3	0	0	3
PRACTICAL					
U13AEP401	Aerodynamics Laboratory	0	0	3	1
U13AEP402	CAD Laboratory - II	0	0	3	1
U13ENP401	Communication Skills Laboratory	0	0	3	1
U13GHP401	Human Excellence – Professional Values	0	0	2	1
				Total Credits:	**27**
				Total Hours:	**34**

SEMESTER V

Code No.	Course Title	L	T	P	C
THEORY					
U13AET501	Aerodynamics – II	3	1	0	4
U13AET502	Finite Element Methods	3	0	0	3
U13AET503	Aircraft Structures – II	3	1	0	4
U13AET504	Control Engineering	3	1	0	4
U13AET505	Aircraft Systems and Instruments	3	0	0	3
U13AET506	Aircraft Performance	3	0	0	3
PRACTICAL					
U13AEP501	Aircraft Structures Laboratory	0	0	3	1
U13AEP502	Propulsion and Combustion Laboratory	0	0	3	1
U13AEP503	Design and Simulation Laboratory	0	0	3	1
U13GHP501	Human Excellence – Social Values	1	0	1	1
				Total Credits:	**25**
				Total Hours:	**32**

SEMESTER VI

Code No.	Course Title	L	T	P	C
THEORY					
U13AET601	Digital Electronics and Microprocessor	3	0	0	3
U13AET602	Vibrations and Aeroelasticity	3	0	0	3

U13AET603	Aircraft Stability and Control	3	0	0	3
U13AET604	Computational Fluid Dynamics	3	1	0	4
U13AET605	Rocket Propulsion	3	1	0	4
E1	Elective I	3	0	0	3
	PRACTICAL				
U13AEP601	Aircraft Design Project – Phase-I	0	0	3	1
U13AEP602	Aircraft Systems Laboratory	0	0	3	1
U13AEP603	Computational Fluid Dynamics Laboratory	0	0	3	1
U13AEP604	Mini Project	0	0	3	1
U13GHP601	Human Excellence – National Values	1	0	1	1
				Total Credits:	**25**
				Total Hours:	**34**

ELECTIVE I FOR VI SEMESTER

Code No.	Course Title	L	T	P	C
U13GST003	Principles of Management	3	0	0	3
U13AEE601	Aircraft Maintenance, Repair and Overhaul	3	0	0	3
U13AEE602	Wind Tunnel Techniques	3	0	0	3
U13AEE603	Theory of Elasticity	3	0	0	3
U13AEE604	Introduction to Cryogenic Engineering	3	0	0	3
U13AEE605	Modern Flight Control Theory	3	0	0	3
U13AEE606	Introduction to Unmanned Aerial Vehicles and Micro Aerial Vehicles	3	0	0	3

SEMESTER VII

Code No.	Course Title	L	T	P	C
	THEORY				
U13GST008	Professional Ethics	3	0	0	3
U13AET701	Composite Materials and Structures	3	0	0	3
U13AET702	Avionics	3	0	0	3
U13AET703	Space Mechanics and Missile Technology	3	0	0	3

U13AET704	Flight Vehicle Design	3	0	0	3
E2	Elective II	3	0	0	3
PRACTICAL					
U13AEP701	Project Work – Phase-I	0	0	6	0
U13AEP702	Aircraft Design Project – Phase-II	0	0	3	1
U13AEP703	Avionics Laboratory	0	0	3	1
U13AEP704	Airframe and Aero Engine Maintenance Laboratory	0	0	3	1
U13GHP701	Human Excellence – Global Values	1	0	1	1
				Total Credits:	**22**
				Total Hours:	**35**

ELECTIVE II FOR VII SEMESTER

Code No.	Course Title	L	T	P	C
U13GST004	Operations Research	3	0	0	3
U13GST005	Engineering Economics and Financial Management	3	0	0	3
U13AEE701	Principles of Combustion	3	0	0	3
U13AEE702	Industrial and Experimental Aerodynamics	3	0	0	3
U13AEE703	Guidance, Navigation and Control	3	0	0	3
U13AEE704	Fatigue and Fracture	3	0	0	3
U13AEE705	Air Traffic Control and Aerodrome Design	3	0	0	3

SEMESTER VIII

Code No.	Course Title	L	T	P	C
THEORY					
E3	Elective III	3	0	0	3
E4	Elective IV	3	0	0	3
E5	Elective V	3	0	0	3
PRACTICAL					
U13AEP801	Project Work – Phase-II	0	0	18	6
				Total Credits:	**15**
				Total Hours:	**27**

ELECTIVES III, IV AND V FOR VIII SEMESTER

Code No.	Course Title	L	T	P	C
U13GST002	Total Quality Management	3	0	0	3
U13GST006	Product Design and Development	3	0	0	3
U13AEE801	Aviation, Quality Assurance, Safety Rules and Regulations, Certification Standards, Licensing	3	0	0	3
U13AEE802	Experimental Stress Analysis	3	0	0	3
U13AEE803	Hypersonic and High Temperature Gas Dynamics	3	0	0	3
U13AEE804	GPS, Inertial Navigation System and Advanced Navigation Techniques	3	0	0	3
U13AEE805	Aircraft Structural Analysis	3	0	0	3
U13AEE806	Supply Chain Management	3	0	0	3
U13AEE807	Aircraft Production Techniques	3	0	0	3
U13AEE808	Helicopter Aerodynamics	3	0	0	3
U13AEE809	Viscous Flow Theory	3	0	0	3
U13AEE810	Introduction to Multidisciplinary System Design Optimization	3	0	0	3
U13AEE811	Experimental Methods in Fluid Mechanics	3	0	0	3
U13AEE812	High Energetic Fuels and Propellants	3	0	0	3
U13AEE813	Airport Management	3	0	0	3
U13AEE814	Satellite Communications	3	0	0	3
U13AEE815	Jet Propulsion Power plants	3	0	0	3
U13AEE816	Non-destructive Testing for Aerospace Applications	3	0	0	3

SEMESTER III

Regulation 2013

		L	**T**	**P**	**C**
U13MAT301	**NUMERICAL METHODS**	**3**	**0**	**2**	**4**

Course Objectives

- To understand concepts of pseudo code and various errors.
- To solve algebraic, transcendental and system of linear equations by using various techniques.
- To understand the concepts of curve fitting, interpolation with equal and unequal intervals.
- To understand the concepts of numerical differentiation and numerical integral by various methods.
- To solve the ordinary differential equations with initial condition by numerical techniques.
- To solve the partial differential equations using numerical techniques.

Course Outcomes:

After successful completion of this course, the students should be able to

CO1 - Solve a set of algebraic equations representing steady state models formed in engineering problems

CO2 - Fit smooth curves for the discrete data connected to each other or to use interpolation methods over these data tables

CO3 - Find the trend information from discrete data set through numerical differentiation and summary information through numerical integration

CO4 - Predict the system dynamic behavior through solution of ODEs modeling the system

CO5 - Solve PDE models representing spatial and temporal variations in physical systems through numerical methods.

CO6 - Have the necessary proficiency of using MATLAB for obtaining the above solutions.

Course Content

INTRODUCTION **3 Hours**

Simple mathematical modeling and engineering problem solving – Algorithm Design – Flow charting and pseudocode - Accuracy and precision – round off errors

NUMERICAL SOLUTION OF ALGEBRAIC EQUATIONS **5 Hours**

Solution of nonlinear equations - False position method – Fixed point iteration – Newton Raphson method for a single equation and a set of non- linear equations.

Solution of linear system of equations by Gaussian elimination, Gauss Jordan method - Gauss Seidel method.

CURVE FITTING AND INTERPOLATION 6 Hours

Curve fitting – Method of least squares – Regression - Newton's forward and backward difference formulas – Divided differences – Newton's divided difference formula - Lagrange's interpolation – Inverse interpolation.

NUMERICAL DIFFERENTIATION AND INTEGRATION 7 Hours

Numerical differentiation by using Newton's forward, backward and divided differences – Numerical integration by Trapezoidal and Simpson's 1/3 and 3/8 rules – Numerical double integration.

NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 10 Hours

Initial value problems - Single step methods: Taylor's series method – Truncation error – Euler and Improved Euler methods – Fourth order Runge – Kutta method – Multistep methods: Milne's predictor - corrector method.

NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS (PDEs) 14 Hours

PDEs and Engineering Practice – Laplace Equation derivation for steady heat conduction – Numerical solution of the above problem by finite difference schemes – Parabolic Equations from Fourier`s Law of Transient Heat Conduction and their solution through implicit schemes – Method of Lines – Wave propagation through hyperbolic equations and solution by explicit method. Use of MATLAB Programs to workout solutions for all the problems of interest in the above topics.

Theory: 45 Hrs **Practical: 15 Hrs** **Total Hours: 60**

REFERENCES

1. Steven C.Chapra and Raymond P. Canale, "Numerical Methods for Engineers with Programming and Software Applications", Sixth Edition, WCB/McGraw-Hill, 1998.
2. John H. Mathews and Kurtis D. Fink, "Numerical Methods using Matlab", Fourth Edition, Prentice Hall of India, 2004.
3. Gerald C. F. and Wheatley P.O, "Applied Numerical Analysis", Sixth Edition, Pearson Education Asia, New Delhi, 2002.
4. Sastry S.S, "Introductory Methods of Numerical Analysis", Third Edition, Prentice – Hall of India Pvt Ltd, New Delhi, 2003.
5. Kandasamy P., Thilagavathy K. and Gunavathy K., "Numerical Methods", S.Chand Co. Ltd., New Delhi, 2007.

Regulation 2013

U13AET301	MECHANICS OF FLUIDS	L	T	P	C
		3	1	0	4

Course Objectives

- Develop an appreciation for the properties of Newtonian fluids.
- Study analytical solutions to variety of simplified fluid flow problems.
- Understand the dynamics of fluid flows and the governing non-dimensional parameters.
- Apply concepts of mass, momentum and energy conservation to flows.
- Grasp the basic ideas of turbulence.

Course Outcomes

After successful completion of this course, the students should be able to

CO1 - Apply fundamental knowledge of mathematics to modeling and analysis of fluid flow problems in Aeronautical Engineering.

CO2 - Conduct experiments and interpreting data from model studies to prototype cases, as well as documenting them in engineering reports.

CO3 - Apply the basic equation of fluid statics to determine forces on planar and curved surfaces that are submerged in a static fluid; to manometers; to the determination of buoyancy and stability; and to fluids in rigid-body motion.

CO4 - Apply principles of dimensional analysis and similitude to simple problems and use dimensionless parameters.

CO5 - Understand the mechanics of viscous flow about immersed boundaries, as it relates to flow separation, wakes, profile drag, drag coefficients and the determination of drag forces exerted on such bodies.

Course Content

FLUID PROPERTIES **5 Hours**

Why learn Fluid Mechanics? - Some applications. Solid vs Fluid - Units and Dimensions – Mass density – Specific weight – Specific volume – Specific gravity – Viscosity – Compressibility – Surface tension – Capillarity – Vapor pressure - Numerical Problems.

FLUID STATICS **4 Hours**

Hydrostatic equation – Forces on plane and curved surfaces – Buoyancy – Metacentre – Simple and differential manometers – Pressure gauge – Relative equilibrium- Numerical Problems.

FLUID KINEMATICS **4 Hours**

Path line – Stream line – Streak line – Stream and Potential functions – Flownets - Numerical Problems.

FLUID DYNAMICS **12 Hours**

Fluid Element and properties - free vortex, source, sink, doublet, Rankine’s oval body, Lagrangian vs. Eulerian description – Governing equations: Continuity equation – momentum equation– Energy equation. Finite Volume Method. Euler's equation – Bernoulli's equation - Numerical Problems.

Case study: Drag and Friction, Losses in real fluids-Demonstration of solving Euler's and Navier-Stoke's equations.

DIMENSIONAL ANALYSIS AND MODELING **8 Hours**

Rayleigh's method – Buckingham's π theorem – Geometric, Kinematic, and Dynamic similitude – Scale effect – Dimensionless parameters-Mach Number, Reynolds Number, Prandtl Number - Numerical Problems.

VISCOUS FLOW **12 Hours**

Viscosity, Boundary layer, transition and separation, detachment and reattachment: turbulence –Navier Stoke's equation- Initial and boundary conditions-Deduction of Governing equations of boundary layer from Navier Stoke's Equation. Boundary layer thickness: Displacement, Momentum and Energy thickness - Numerical Problems.

Theory: 45 Hrs **Tutorial: 15 Hrs** **Total Hours: 60**

REFERENCES

1. Egon Krause, "Fluid Mechanics with Problems and Solutions, and an Aerodynamic Laboratory" Springer; 2005
2. R.K. Bansal – "Fluid mechanics and hydraulic machines," Laxmi Publications (P) Ltd, 2006
3. V.L. Streeter – "Fluid mechanics," McGraw-Hill, 1998
4. P.N. Modi & S.M. Seth – "Hydraulics and fluid mechanics including hydraulic machines," Standard book house, 2005
5. K.L. Kumar – "Engineering fluid mechanics," Eurasia publishing house, 1995

U13AET302	MECHANICS OF SOLIDS	L	T	P	C
		3	1	0	4

Course Objectives

- The objective of the course is to explore fundamentals of kinematics of solid bodies; displacement and strain measures, introduction to statics of solid bodies, stress tensor, equilibrium equations. Topics include analysis of columns, beams and beams on elastic foundations.

Course Outcomes

After successful completion of this course, the students should be able to

CO1 -Understand the types of structures, beams, forces acting on the structures and their reactions.

CO2 - Calculate the bending moment and shear force on structures various loading conditions.

CO3 - Understand the importance of geometry/shape of a structure.

CO4 - Calculate the response of the structures based on its geometry.

CO5 - Understanding the failure modes of structures under complex loading conditions.

Course Content

STRESS, STRAIN AND DEFORMATION OF SOLIDS **9 Hours**

Rigid and Deformable bodies – Strength, Stiffness and Stability – Stresses; Tensile, Compressive and Shear – Strain – Poisson's ratio – lateral strain – Deformation of simple and compound bars under axial load – Thermal stress – Elastic constants – Strain energy and unit strain energy – Strain energy in uni axial loads - Numerical Problems.

BEAMS – LOADS AND STRESSES **9 Hours**

Types of beams: Supports and Loads – Shear force and Bending Moment in beams – Cantilever, Simply supported and Overhanging beams – Stresses in beams – Theory of simple bending – Stress variation along the length and in the beam section – Effect of shape of beam section on stress induced shear stresses in beams – Thin walled cross section shear flow- Numerical Problems.

TORSION **9 Hours**

Analysis of torsion of circular bars – Shear stress distribution – Bars of solid and hollow circular section –Twist and torsion stiffness – Compound shafts – Fixed and simply supported shafts – Application to close-coiled helical springs – Maximum shear stress in spring section including Wahl Factor – Design of helical coil springs - Numerical Problems.

BEAM DEFLECTION **9 Hours**

Elastic curve of Neutral axis of the beam under normal loads – Evaluation of beam deflection and slope: Double integration method, Macaulay Method,–Columns – End conditions Equivalent length of a column – Euler equation – Slenderness ratio –Rankine formula for columns - Numerical Problems.

ANALYSIS OF STRESSES IN 2D STRUCTURES **9 Hours**

Biaxial state of stresses at a point – Stresses on inclined plane – Principal planes and stresses – Mohr’s circle for biaxial stresses – Maximum shear stress – Thin cylindrical and spherical shells – Deformation in thin cylindrical and spherical shells - Numerical Problems.

Theory: 45 Hrs **Tutorial: 15 Hrs** **Total Hours: 60**

REFERENCES

1. Rajput, R. K, “A textbook of Strength of Materials”, S. Chand, 2007.
2. Premalatha J. Mechanics of solids, Vignesh Publications, Coimbatore.
3. Bansal R.K. Strength of materials, Laxmi Publications, New Delhi-2007.
4. Srinath L.S. Advanced Mechanics of solids, Tata McGraw-Hill Publishing Co., New Delhi, 2003.
5. William A.Nash, Schaum’s Outline series, Theory and Problems of Strength of materials,Tata McGraw-Hill publishing co., New Delhi-2007.
6. Timoshenko, S., “Strength of Materials”, Vol. I and II, Princeton D.Von Nostrand Co, 1990.

U13AET303	AERO ENGINEERING THERMODYNAMICS	L	T	P	C
		3	1	0	4

Course Objectives

- To give a brief background of application of various laws of thermodynamics and its application in power cycles, Compressors, refrigeration and air-conditioning, jet propulsion system.

Course Outcomes

After successful completion of this course, the students should be able to

CO1 - Understand the first and second laws of thermodynamics and their application to a wide range of systems.

CO2 - Apply the principles of conservation of mass, conservation of energy, and the Second Law of Thermodynamics to thermodynamic cycles.

CO3 - Determine the efficiency, and net work of the OTTO, DIESEL, and BRAYTON cycles, and to make connections between these cycles and aircraft propulsion systems.

CO4 -Understand the components and basic assumptions for the vapor-compression refrigeration system.

CO5 - Apply the basic concepts of heat transfer to solve the various engineering problems.

Course Content

BASIC THERMODYNAMICS **9 Hours**

Systems, Enthalpy, entropy, internal energy, and specific heat relations-Zeroth Law, First Law - Heat and work transfer in flow and non- flow processes-Difference in heat capacities, Ratio of specific heats-Second law, Kelvin Planck statement - Clausius statement - Concept of entropy - entropy change in non-flow processes – T-S equations for entropy change - Numerical Problems.

AIR CYCLES **9 Hours**

Air standard cycle approximations; Carnot, Otto, Diesel Cycles – P-V and T-S diagrams-Description-efficiency, Mean Effective Pressure - Comparison of Otto, Diesel cycles for same compression ratio and heat input -Dual cycles- P-V and T-S diagrams. Brayton cycle for open and closed systems- Efficiency of gas turbine cycle - Regenerative gas turbine cycle-Intercooling and reheating in gas turbine cycles-Numerical problems.

THERMODYNAMICS OF ONE DIMENSIONAL FLUID FLOW **9 Hours**

Application of continuity – Momentum and energy equations-Isentropic flow of ideal gases through nozzles – Simple jet propulsion system – Thrust rocket – Specific impulse - Numerical Problems.

COMPRESSORS, FANS AND BLOWERS **9 Hours**

Introduction to turbo machines - Working principle of reciprocating air compressors- work of compression with and without clearance-Isothermal and Isentropic efficiency of reciprocating air compressors-Multi-stage compressor- condition for minimum work - Transfer of energy to fluids - Performance characteristics - fan laws - Dimensionless parameters -Specific speed-Classification of compressors, fans and blowers - Numerical Problems.

HEAT TRANSFER **5 Hours**

Modes of heat transfer, Fourier's law of conduction, one dimensional steady state conduction through plane and composite walls. Free and forced convection- dimensionless numbers-heat transfer co-efficient, simple problems in fins- concept of radiation- Planck's law, Wien's displacement law, Stefan Boltzman law-Heat exchangers, LMTD - Numerical Problems.

AIR CONDITIONING **4 Hours**

Principles of refrigeration, Air conditioning -Vapour compression - Vapour absorption types –air cycle machine –humidity control - Coefficient of performance, Properties of refrigerants - Numerical Problems.

Theory: 45 Hrs **Tutorial: 15 Hrs** **Total Hours: 60**

REFERENCES

1. Van Wylen, G.J. and Sonntag, R.E., "Fundamentals of Classical Thermodynamics" Wiley 6th Ed. (2003). ISBN 0-471-15232-3.

2. Yunus A. Çengel, Michael A. Boles "Thermodynamics an Engineering Approach", Tata McGraw-Hill 7th edition (2010).

3. Nag. P.K., "Engineering Thermodynamics", Tata McGraw-Hills Co., Ltd., 5th Ed (2013).

4. Rathakrishnan, E, "Fundamentals of Engineering Thermodynamics", Prentice – Hall, India, 2000.

5. Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAA Education Series, New York, 1985.

U13EET311	**BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

- To introduce the basic concept of Electrical and Electronics theory
- To introduce the basic working principles of machines
- To introduce the basic working of fundamental Electronics circuits

Course Outcomes

After successful completion of this course, the students should be able to

CO1 - Acquire the knowledge of fundamental laws of electrical and electronics engineering.

CO2 - State the definition of magnetic circuits.

CO3 - Choose suitable motor for desired application.

CO4 - Apply the fundamental laws of magnetic circuits to electrical machines.

CO5 - Verify the truth table of digital logic gates.

Course Content

ELECTRIC CIRCUITS FUNDEMENTALS **9 Hours**

Electric current and Ohm's law – Resistance and Resistivity – Relation between Voltages, Current, Resistance and Power - Capacitance – Parallel plate capacitor – Energy stored in a capacitor.

ELECTROMAGNETISM **9 Hours**

Magnetic field - Field intensity, magnetic flux , Flux density – Permeability – Magnetic effects of electric current – Magnetic circuit – Faraday's laws of Electromagnetic Induction – Self-inductance and Mutual inductance – Energy stored in magnetic field – Magnetic Hysteresis.

AC-CIRCUITS **9 Hours**

Alternating voltages and current – Sinusoidal waveform – cycle and frequency – RMS value – vector diagram of sine waves of same frequency – Alternating current through Resistance, Inductance and Capacitance – current through series circuits – Power factor – Active and Reactive power – Generation of three phase voltage – Voltages, Currents and Power in Star and Delta connected loads.

ELECTRICAL MACHINES (Qualitative Treatment Only) 9 Hours

DC motor – Principle of operation – Back-emf and voltage equation – Torque and speed Characteristics of Series and Shunt connected motors – Transformer – Ideal Transformer relationship – Three phase induction motor – Cage rotor and Wound rotor – Principle of operation – Slip – Torque – Slip characteristics – Single phase induction motors.

ELECTRONIC CIRCUITS 9 Hours

Semiconductor diode – Half wave and Full wave rectifier – Bipolar Polar Junction transistors – circuit configurations – static characteristics – load line and biasing – simple introduction to amplifiers – Introduction to Binary logic gates – AND, OR, NOT, NAND, NOR, EX-OR & EX-NOR.

Theory: 45 Hrs Tutorial: - Total Hours: 45

REFERENCES

1. B.L. Theraja, "Fundamentals of Electrical Engineering and Electronics", S. Chand Publishing, 2012.
2. Thomas L Floyd, "Electronic Devices", 6th edition, pearson education, 2003.
3. Muthusubramanian.R, Salivahanan.S and Muraleedharan. K.A, "Basic Electrical Electronics and Computer Engineering", Tata Mcgraw Hill, second edition, 2006.

U13GST001	**ENVIRONMENTAL SCIENCE AND ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

- At the end of this course the student is expected to understand what constitutes the environment, what are precious resources in the environment, how to conserve these resources, what is the role of a human being in maintaining a clean environment and useful environment for the future generations and how to maintain ecological balance and preserve bio-diversity.

Course Outcomes

After successful completion of this course, the students should be able to

CO1 - Play a important role in transferring a healthy environment for future generations

CO2 - Analyse the impact of engineering solutions in a global and societal context

CO3 - Discuss contemporary issues that results in environmental degradation and would attempt to provide solutions to overcome those problems

CO4 - Ability to consider issues of environment and sustainable development in his personal and professional undertakings

CO5 - Highlight the importance of ecosystem and biodiversity and Paraphrase the importance of conservation of resources

Course Content

INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES

10 Hours

Definition, scope and importance – Need for public awareness – Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – Role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.

ECOSYSTEMS AND BIODIVERSITY **14 Hours**

Concept of an ecosystem – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity – Biogeographical classification of India – Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-spots of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Exsitu conservation of biodiversity.

ENVIRONMENTAL POLLUTION **8 Hours**

Definition – Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – Soil waste Management: Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

SOCIAL ISSUES AND THE ENVIRONMENT **7 Hours**

From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns, case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – Wasteland reclamation – Consumerism and waste products – Environment Production Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness

HUMAN POPULATION AND THE ENVIRONMENT **6 Hours**

Population growth, variation among nations – Population explosion – Family Welfare Programme – Environment and human health – Human Rights – Value Education – HIV/ AIDS – Women and Child Welfare – Role of Information Technology in Environment and human health – Case studies. Green aviation in Aerospace technology

Field Work

Visit to local area to document environmental assets- river / grassland / hill / mountain, visit to local polluted site- urban / rural / industrial / agricultural, study of common plants, insects, birds, study of simple ecosystems-pond, river, hill slopes etc.,

Theory: 45 Hrs **Tutorial: -** **Total Hours: 45**

REFERENCES

1. Deswal.S and Deswal.A, “ A basic course in Environmental studies” Dhanpat Rai &Co, 2006.

2. Gilbert M.Masters, Introduction to Environmental Engineering and Science, Pearson Education Pvt., Ltd., Second Edition, ISBN 81-297-0277-0, 2004.

3. Miller T.G. Jr., Environmental Science – Sustaining the earth, Wadsworth Publishing Co., 1993**.**

4. Bharucha Erach, the Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad India., 2002**.**

5. Trivedi R.K., Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol. I and II, Enviro Media. 1996

6. Cunningham, W.P.Cooper, T.H.Gorhani, Environmental Encyclopedia, Jaico Publ., House, Mumbai, 2001.

7. Wager K.D., Environmental Management, W.B. Saunders Co., Philadelphia, USA, 1998.

8. Townsend C., Harper J and Michael Begon, “Essentials of Ecology”, Blackwell Science Publishing Co., 2003**.**

9. Trivedi R.K and P.K.Goel “Introduction to Air pollution” Techno-science Pubications. 2003**.**

10. Yamuna R.T “Environmental Science” Inter Publications, 2008**.**

11. IPCC report on Climatic Change- Green Aviation/ ICAO Annex.

Regulation 2013

U13AEP301	FLUID MECHANICS AND MACHINERY LAB	L	T	P	C
		0	0	3	1

LIST OF EXPERIMENTS

1. Calibration of venturimeter
2. Pressure measurement with pitot static tube
3. Determination of pipe flow losses.
4. Verification of Bernoulli’s theorem
5. Flow visualization by Heleshaw apparatus
6. Performance test on centrifugal pumps
7. Performance test on reciprocating pumps
8. Performance test on Pelton turbine
9. Performance test on Francis turbine
10. Determination of Viscosity of a Fluid

Total: 45 hrs

List of Equipments:

S. No	Equipment Name
1	Pipe friction apparatus
2	Apparatus for minor losses
3	Venturimeter
4	Orificemeter
5	Apparatus for notches
6	Mouthpiece apparatus
7	Impact of jet on vanes
8	Apparatus for verification of Reynold's number
9	Apparatus for verification of Bernoulli's theorem
10	Metacentric height- ship model
11	Mouthpiece
12	Current meter

13	Pitot tube
14	Centrifugal pump – constant speed
15	Centrifugal pump – variable speed
16	Monoblock centrifugal pump
17	Multistage pump
18	Submersible pump
19	Turbine pump
20	Jet pump – test rig
21	Reciprocating pump
22	Gear oil pump
23	Rotameter
24	Pelton wheel turbine
25	Francis tubine
26	Kaplan turbine
27	Turgo wheel impulse turbine
28	Saybolt – visco meter
29	Redwood – visco meter
30	Haleshaw apparatus

U13AEP302	STRENGTH OF MATERIALS LAB	L	T	P	C
		0	0	3	1

Course Objectives

- To study, stresses, strains and deformation in components
- To understand the effect of size and shape on stress and deformation of the components.

LIST OF EXPERIMENTS

1. Hardness Test – Brinell
2. Impact Test - Charpy
3. Fatigue test - Rotating Beam
4. Verification of Maxwell’s Reciprocal theorem and principle of superposition
5. Preparation of southwell’s plot
6. Determination of buckling of metals using column test apparatus
7. Preparation of Riveted Joints and testing for joint efficiency.
8. Determination of Young’s modulus and fracture strength of steel using electronic extensometers
9. Determination of Young’s modulus and fracture strength of aluminum using electronic extensometer
10. Preparation of Stress Strain curve for various engineering materials.

Total: 45hrs

LIST OF EQUIPMENTS (For a batch of 30 students)

Sl. No.	Equipments	Quantity
1.	Brinell’s Hardness Testing Machine	1
2.	Charpy Impact Testing Machine	1
3.	Fatigue Tester – Rotating Beam	1
4.	Beam Test set up with various end conditions	1
5.	Column Test Apparatus	1
6.	Universal Testing Machine	1

7.	Electrical stain gauge	10
8.	Stain indicator	1
9.	Dial Gauges	12
10.	Mechanical Extensometer	2
11.	Weight 1 Kg	10
12.	Weight 2 Kg	10
13.	Weight Pans	6

U13AEP303 THERMODYNAMICS LAB

L	T	P	C
0	0	3	1

LIST OF EXPERIMENTS

1. Performance test on a 4-stroke engine
2. Valve timing of a 4 – stroke engine and port timing of a 2 stroke engine
3. Determination of effectiveness of a parallel flow heat exchanger
4. Determination of effectiveness of a counter flow heat exchanger
5. Determination of the viscosity coefficient of a given liquid
6. COP test on a vapour compression refrigeration test rig
7. COP test on a vapour compression air-conditioning test rig
8. Study of a Gas Turbine Engine.
9. Determination of Conductive Heat Transfer Coefficient.
10. Determination of Thermal Resistance of a Composite wall.

Total: 45 hrs

LIST OF EQUIPMENTS

1.4-Stroke KIRLOSKAR Diesel Engine

2. Cut Section of KIRLOSKAR 4 - Stroke Engine and 2-Stroke Java Engine
3. Parallel flow heat exchanger
4. Counter flow heat exchanger
5. Redwood viscometer
6. Vapour compression refrigeration test rig
7. Vapour compression air conditioning test rig
8. Jet engine model
9. Conduction apparatus
10. Composite Wall Structure.

U13GHP 301 FAMILY VALUES

L	T	P	C
1	0	1	1

Course Objectives

- To inculcate the basic need for family life and peace in it.
- To lead spiritual development through good family life.
- To respect womanhood and live disease free life.
- To live with sound health.
- To reach Intuition.

Course Outcomes

After successful completion of this course, the students should be able to

CO1 –Develop skills in maintaining harmony among the family members.

CO2 –Acquire skills in traditional yogasanas leading to sound health.

CO3 –Behaves as a family member and leading to a blissful family life.

CO4 –Learnt Food is Medicine.

Course Content

Restraint in family **4 Hours**

Definition - Greatness of life force & mind. Introduction - Kayakalpa yoga -aim - maintaining youthfulness – sex & spirituality – ten stage of mind – mental frequency-method of concentration – kayakalpa philosophy - physical body – sexual vital fluid – life force – bio-magnetism - mind –food transformation into seven minerals – postponing the ageing process – death – importance of kayakalpa training.

Spiritual development through good Family life **4 Hours**

Kayakalpa exercise – methods –aswinimudhra – ojus breathing – explanations – benefits – practices – Responsibility of men and women – introduction a good education – need of morality – spiritual development.Revision of previous physical exercises. Introduction – hints & caution – body massaging – accu-pressure –relaxation.

Peace in Family. **4 Hours**

Family value – meaning – Introduction – values – benefits of blessings – effect of vibrations – make blessings a daily habit – greatness of friendship – individual & family peace – reason for misunderstanding in the family – no comment – no command – no demand – no ego – peace of mind.

Greatness of womanhood & Food is Medicine **4 Hours**

Good–cultured behavioral patterns – love and compassion - Greatness of womanhood – Food is medicine (healthy food habits)

Simplified physical exercises **7 Hours**

Simplified physical exercises – Kaya Kalpa Yoga (Benefits related to the Patient, Tolerance, Sacrifice)

Meditation & Yogasanas **7 Hours**

Thuriya meditation – introduction – practice – benefits. Asanas– ashtanga yoga – pathanjali maharishi –hints & cautions – posture - movement – involvement – standing asanas: thadasana – ekapathasana – chakrasana(side) – uthkatasana – trikonasana. Sittingasanas: thandasana – padmasana – vajrasana – suhasana – siddhasana – parvathasana – yogamudhra.Downward lying asanas: makkarasana – bhujangasana – salabhasana – navukasana– dhanurasana. Upward lying asanas: savasana - arthapavanamukthasana– pavanamukthasana – utthanapathasana – navasana& Surya namaskara.

Total: 30 Hours

References Books:

1. Yoga for Modern Age ---- Vethathiri Maharishi

2. The Man making Messages ---- Swami Vivekananda
3. Manavalakalai Part- 1&2&3 ---- Vethathiri Maharishi
4. Value Education for Health & Happiness and Harmony. ---- Vethathiriyam

SEMESTER IV

U13MAT403	MODELING AND ANALYSIS OF ENGINEERING SYSTEMS	L	T	P	C
		3	1	0	4

Course Objectives

- To identify systems, their inputs and outputs
- To apply laws of physics to derive models for simple dynamic systems
- To evaluate the dynamic response of systems of interest with selected excitation signals
- To analyze signals through their frequency components using Fourier series and Fourier transforms
- To appreciate the frequency response characteristics of linear systems and its usefulness in specifying system dynamic behavior.

Course Outcomes

After successful completion of this course, the students should be able to

CO1 - Attempt modeling real life systems of interest in order to predict its dynamic behavior

CO2 - Use simulation tools to determine dynamic response of system following external inputs

CO3 - Use Fourier analysis to identify the different frequency components in signals used for monitoring system health

CO4 - Use frequency response techniques to appreciate inherent dynamics of linear systems and design suitable feedback controllers

CO5 - Take up advanced courses on system dynamics, monitoring and control with familiarity on terminology and techniques employed in the above.

Course Content

FUNDAMENTAL MODELING CONCEPTS: 7 Hours

Systems, Modeling and Analysis – Abstraction of physical behaviour using laws of physics – Linearity and Superposition – Lumped system dynamic behaviour represented by ordinary differential equations – Conservation laws to form dynamic equations

MODELING ELEMENTARY SYSTEMS: 10 Hours

Modeling Translational Mechanical Systems, RLC Electrical Circuit, Electrical Analogues for Mechanical System Parameters, Modeling of rotational mechanical systems, hydraulic systems and thermal systems, Model Representation of time delay

SYSTEM DYNAMIC RESPONSE: 10 Hours

Obtaining dynamic response of first order and second order linear systems for step inputs through analytical solution of governing equations – Transient response specifications – Delay time, rise time, peak overshoot, undamped natural frequency, damping factor, settling time – Experimental determination of above parameters. Dynamic response of general (including non - linear) system models through numerical integration of ODEs using MATLAB.

FOURIER ANALYSIS OF SIGNALS: 8 Hours

Obtaining trigonometric Fourier series – Exponential Fourier Series – Fourier Spectra – Parseval's Theorem – Fourier Transform pairs and equations relating them – Magnitude and Phase Spectra from Fourier Transforms

FREQUENCY RESPONSE OF LINEAR TIME–INVARIANT SYSTEMS: 10 Hours

Excitation and response signals of systems – Transfer functions – The sinusoidal steady state – Magnitude and phase response – Bode plots from transfer functions – Contributions from first order poles and zeros and complex conjugate pole pairs in frequency response – Frequency filtering characteristics of simple electrical and mechanical systems.

Theory: 45 Hrs **Tutorial: 15 Hrs** **Total Hours: 60**

REFERENCES

1. P.D. Cha, J.J. Rosenberg & C.L. Dym, `Fundamentals of Modeling and Analyzing Engineering Systems', Cambridge University Press, 2000.
2. Mrinal Mandal and Amrit Asif, `Continuous and Discrete Time Signals and Systems', Cambridge University Press, 2007 (for Unit IV only)
3. Y. Jaluria, `Design and Optimization of Thermal Systems', Mc Graw Hill, 1998
4. A. K. Chopra, `Dynamics of Structures: Theory and Applications to Earthquake Engineering', Pearson, 2007.
5. W. F. Phillips, `Mechanics of Flight', John Wiley & Sons, 2010.
6. B. Brockman,` Introduction to Engineering : Modeling and Problem Solving', John Wiley & Sons,2009.

U13AET401	AERODYNAMICS – I	L	T	P	C
		3	1	0	4

Course Objectives

- The objective for this course is to develop an understanding of low-speed aerodynamics and an introduction to compressible flows.
- To understand the basics of airflow and concepts of forces and moments on flying vehicles under various flight regimes
- To understand concepts in incompressible airfoil theory, including symmetric and cambered airfoils using analytical and numerical approaches. The course also covers incompressible wing theory, including down wash, lifting-line theory, elliptic wings, general twisted wings, application of fundamentals to the design of a wing to meet given performance criteria. Students should be able to use knowledge gained in this course to solve aerodynamic design problems.

Course Outcomes

After successful completion of this course, the students should be able to

CO1 - Understand the behavior of airflow over bodies with particular emphasis on airfoil sections in the incompressible flow regime.

CO2 - Apply airfoil theory to predict airfoil performance.

CO3 - Analyze and optimize wing performance.

CO4 - Apply the concepts of aerodynamics to the design of aerospace systems.

CO5 - Understand the compressible flow regime and apply propeller theory to predict blade performance.

Course Content

INTRODUCTION TO AERODYNAMICS 9 Hours

International Standard Atmosphere, Importance of Aerodynamics, Aerodynamic forces and moments, Pressure distribution on an airfoil, Types of drag, Flow similarity, Types of flow, Continuity, momentum and energy equations, Incompressible-inviscid flow, Irrotational flow, Circulation and Vorticity, Euler’s equation, Bernoulli’s Equation, Pitot tube: Measurement of airspeed, Pressure Coefficient- Numerical Problems.

TWO DIMENSIONAL FLOWS 9 Hours

Elementary flows- Uniform, Source, Sink, Doublet and vortex flow, Combination of a uniform flow with a source and sink, Non lifting flow over a circular cylinder, Lifting flow over a cylinder, Kutta Joukowski theorem and Generation of lift, Flow over a flat plate, D’Alembert Paradox, Magnus effect- Numerical Problems

CONFORMAL TRANSFORMATION **8 Hours**

Joukowski transformation and its application to fluid flow problems, Blasius theorem, Joukowski, and Karman - Trefftz Profiles.

AIRFOIL AND WING THEORY **12 Hours**

Airfoil Nomenclature, Airfoil characteristics, NACA airfoils and Modern airfoils, Kutta condition - Thin airfoil theory and its applications. Aerodynamic Center, Horse shoe vortex, Vortex filament, Biot and Savart law, Downwash and induced drag, Helmholtz theorems, Lifting line theory and its limitations

PROPELLER THEORY **7 Hours**

Froude momentum and Blade element theories, Propeller coefficients, Performance of fixed and variable pitch propeller, Introduction to Compressible flow.

Theory: 45 Hrs **Tutorial: 15 Hrs** **Total Hours: 60**

REFERENCES

1. Anderson, J.D., “Fundamentals of Aerodynamics”, 5th Edition, McGraw-Hill Book Co., New York, 2012.
2. E. L. Houghton , P. W. Carpenter , Steven H Collicott, and Daniel T Valentine, Aerodynamics for Engineering Students, Sixth Edition, Butterworth-Heinemann; 2012.
3. Clancy, L.J., “Aerodynamics”, Pitman, 1986
4. A.M. Kuethe and C-Y Chow, ‘Foundations of Aerodynamics: Bases of Aerodynamic Design’, 5th Edition, Wiley 1997

Regulation 2013

U13AET402	**MECHANICS OF MACHINES**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives

- To know different machine elements and mechanisms.
- Understand kinematics and dynamics of different machines and mechanisms.
- Select Suitable drives and mechanisms for a particular application.
- Appreciate the concept of balancing and vibration and Develop ability to come up with innovative ideas.

Course Outcomes

After successful completion of this course, the students should be able to

CO1 - Analyze and understand the dynamic (position, velocity, acceleration, force and torque) characteristics of mechanisms such as linkages and cams.

CO2 - Design and optimize mechanisms to perform specified task.

CO3 - Identify mechanisms and predict their motion and calculate the degrees of freedom of mechanisms.

CO4 - Design mechanisms to fulfill motion generation and quick return requirements.

CO5 - Balance simple rotating objects and pin-jointed four bar linkages and select suitable drives and mechanisms for a particular application.

Course Content

MECHANISMS **9 Hours**

Machine Structure – Kinematic link pair and chain – Constrained motion – Degrees of freedom -Slider crank mechanism – Inversions – Applications – Kinematic analysis of simple mechanisms – Determination of velocity and acceleration, Gyroscope –Principle and application - Numerical Problems.

FRICTION **9 Hours**

Friction in screw and nut – Pivot and collar – Thrust bearing – Plate and disc clutches – Belt – flat and V belt drives. Ratio of tensions – Effect of centrifugal and initial tension – Condition for maximum power transmission – Open and crossed belt drive - Numerical Problems.

GEARING AND CAMS **9 Hours**

Gear profile and geometry –Gear trains: Simple, compound gear trains and epicylic gear trains - Determination of speed and torque, Cams –Types of cams – Design of profiles – Knife edged follower with and without offsets for various types of follower motions - Numerical Problems.

VIBRATION **9 Hours**

Free, forced and damped vibrations of single degree of freedom systems – Force transmitted to supports – Vibration isolation – Vibration absorption – Torsional vibration of shaft – Single rotor system – Critical speed of shaft - Numerical Problems.

BALANCING **9 Hours**

Static and dynamic balancing – Single and lumped masses in different planes – Balancing of reciprocating masses- primary balancing and concepts of secondary balancing – Single and multi cylinder inline engines - Numerical Problems.

Theory: 45 Hrs **Tutorial: 15 Hrs** **Total Hours: 60**

REFERENCES

1. Rattan.S.S, "Theory of Machines", Tata McGraw–Hill Publishing Co, New Delhi,2004.
2. Ballaney.P.L, "Theory of Machines", Khanna Publishers, New Delhi, 2002.
3. Rao, J.S and Dukkipati, R.V, "Mechanism and Machine Theory", Second Edition,Wiley Eastern Ltd., 1992.3. Malhotra, D.R and Gupta, H.C., "The Theory of Machines", Satya Prakasam,Tech. India Publications, 1989.
4. Gosh, A. and Mallick, A.K., "Theory of Machines and Mechanisms", Affiliated East West Press, 1989.
5. Shigley, J.E. and Uicker, J.J., "Theory of Machines and Mechanisms", McGraw-Hill, 1980.

U13AET403	AIRCRAFT STRUCTURES – I	L	T	P	C
		3	1	0	4

Course Objectives

- The objective of the course is to enable the students to apply standard methods to calculate the stress and displacement of thin walled beam-like components subjected to static loads. This will be achieved by deriving form first principles the mathematical laws which relate stresses and displacements to the applied loads. The theory developed will then be applied to analyze structures subjected to different loading conditions: bending, shear, torsion and compression. The limitations of the methods presented will also be discussed, and the place of thin-walled beam theory within the broader field of aircraft structural analysis will be emphasized.

Course Outcomes

After successful completion of this course, the students should be able to

CO1 - Understand the difference between statically determinate and indeterminate structures.

CO2 -Calculate the response of statically indeterminate structures under various loading conditions.

CO3 - Calculate the reactions of structures using strain energy concept.

CO4 - Create a structure to carry the given load.

CO5 - Understand various failure theories exists

Course Content

STATICALLY DETERMINATE STRUCTURES **9 Hours**

Analysis of plane truss – Method of joints – 3 D Truss - Matrix Displacement method for Trusses. Simple beams, stiffened shear webs, Idealized beams: Torsional and shear loading - Numerical Problems.

STATICALLY INDETERMINATE STRUCTURES **9 Hours**

Composite beam - Clapeyron's Three Moment Equation - Moment Distribution Method - Numerical Problems.

ENERGY METHODS **9 Hours**

Strain Energy due to axial, bending and torsional loads - Castigliano's theorem for displacements and moments- Maxwell's reciprocal theorem, Unit load method - application to beams, trusses, frames, rings, etc. - Numerical Problems.

COLUMNS **9 Hours**

Columns with various end conditions – Euler's Column curve – Rankine's formula - Column with initial curvature - Eccentric loading – South well plot – Beam column. Numerical Problems.

FAILURE THEORIES **9 Hours**

Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum strain energy theory – Application to aircraft structural problems. Numerical Problems.

Theory: 45 Hrs **Tutorial: 15 Hrs** **Total Hours: 60**

REFERENCES

1. Howard D. Curtis., “Fundamentals of Aircraft Structural Analysis”, McGraw Hill School Education Group, 1997.

2. T.H.G.Megson. “Aircraft Structures for Engineering Students” 4th Edition, Elsevier Aerospace Engineering Series, 2007.

3. Timoshenko, S., “Strength of Materials”, Vol. I and II, Princeton D. Von Nostrand Co, 1990.

U13AET404	AIRCRAFT PROPULSION	L	T	P	C
		3	1	0	4

Course Objectives

- The objectives of this course are to develop an understanding of how air-breathing engines produce thrust; an ability to do overall engine performance analysis calculations; an ability to carry out performance calculations for individual engine components; an understanding of elementary overall engine design considerations.

Course Outcomes

After successful completion of this course, the students should be able to

CO1 - Analyze thermodynamics of an aircraft jet engine and calculate the performance measures, such as thrust and specific fuel consumption in terms of design requirement.

CO2 -Estimate the best possible engine performance as a function of principal design parameters, such as maximum engine temperature, pressure ratio, and flight speed

CO3 - Analyze the internal mechanisms of gas turbine engine components and understand the factors that limit the practical performance of inlets, combustion chambers, and nozzles.

CO4 - Evaluate the operating characteristics of compressors and turbines in terms of given blade shapes, angles, and direction of rotation.

CO5 -Design a gas turbine engine using the understanding of the relationship between components, at least at the level of selecting the number of spools and stages.

Course Content

FUNDAMENTALS OF AIR-BREATHING ENGINES 9 Hours

Review of thermodynamic principles, Principles of aircraft propulsion, Types of power plants, Working principles of internal combustion engine, Two – stroke and four – stroke piston engines, Gas- turbine engines, Cycle analysis of reciprocating engines and jet engines. Illustration of working of gas turbine engine – The thrust equation – Factors affecting thrust – Effect of pressure, velocity and temperature changes of air entering compressor – Methods of thrust augmentation – Characteristics of turboprop, turbofan and turbojet – Performance characteristics. Numerical Problems.

INLETS: SUBSONIC AND SUPERSONIC INLETS FOR JET ENGINES 9 Hours

Internal flow and Stall in subsonic inlets – Boundary layer separation – Major features of external flow near a subsonic inlet – Relation between minimum area ratio and eternal deceleration ratio – Diffuser performance – Supersonic inlets – Starting problem on supersonic inlets – Shock swallowing by area variation – External deceleration – Mode of inlet operation. Numerical Problems.

COMPRESSORS 9 Hours

Principle of operation of Axial and Centrifugal compressors. Work done and pressure rise – Velocity diagrams – Diffuser vane design considerations. Concepts of prewhirl, Rotation stall. Elementary theory of axial flow compressor. Velocity triangles – Degree of reaction. Centrifugal and Axial compressor performance characteristics. Numerical Problems.

COMBUSTION CHAMBERS: 9 Hours

Classification of combustion chambers – Important factors affecting combustion chamber design – Combustion process – Combustion chamber performance – Effect of operating variables on performance – Flame tube cooling – Flame stabilization – Use of flame holders and after burners - Numerical problems.

TURBINE AND NOZZLES 9 Hours

TURBINES: Types of turbines – Design considerations – Performance parameters - Basics of blade design principles. Impulse and reaction blading of gas turbines – Velocity triangles and power output – Elementary theory – Vortex theory – Choice of blade profile, pitch and chord – Estimation of stage performance – Limiting factors in gas turbine design- Overall turbine performance – Methods of blade cooling – Matching of turbine and compressor – Numerical problems.

NOZZLES: Theory of flow in isentropic nozzles – Convergent / Convergent – divergent nozzles; Nozzle throat conditions – Nozzle efficiency – Losses in nozzles – Over expanded and under – expanded nozzles - Thrust reversal. Numerical Problems.

Theory: 45 Hrs **Tutorial: 15 Hrs** **Total Hours: 60**

REFERENCES

1. Hill, P.G. & Peterson, C.R. “Mechanics & Thermodynamics of Propulsion” 2nd Edition, Pearson Education, 1999.
2. Cohen, H., Rogers, G.F.C. and Saravanamuttoo, H.I.H., “Gas Turbine Theory”, 4th edition, Pearson Education, 1989.
3. Jack D Mattingly “Elements of Gas Turbine & Rocket Propulsion”, Tata McGraw-Hill Education Series, 2005.

U13AET405	AIRCRAFT MATERIALS AND PROCESSES	L	T	P	C
		3	0	0	3

Course Objectives

- To study the different type of materials and alloys used in aircraft, its properties, its failure and its prevention.

Course Outcomes

After successful completion of this course, the students should be able to

CO1 - Understand different properties and various testing of aircraft materials

CO2 - Remembering the Heat treatment and surface treatment process of various alloys

CO3 - Study some of the important materials used in aerospace

CO4 - Understand the different types of failures and its prevention.

CO5 - Apply the knowledge on selecting the materials for different parts of the aircraft

INTRODUCTION TO AIRCRAFT MATERIALS **8 Hours**

General properties of materials, Definition of terms, Requirements of aircraft materials, Testing of aircraft materials, Inspection methods (NDT), Application trends in aircraft structures and engines, Introduction to smart materials and Nano-materials - Selection criteria of materials for use in aircraft.

AIRCRAFT METAL ALLOYS AND SUPERALLOYS **12 Hours**

Aluminum alloys, Magnesium alloys, Titanium alloys, Plain carbon and Low carbon Steels, Corrosion and Heat resistant steels, Maraging steels, Copper alloys, Producibility and Surface treatments for each of the above.

Super alloys, Nickel based super alloys, Cobalt based super alloys, and Iron based super alloys, manufacturing processes associated with super alloys, Heat treatment and surface treatment of super alloys.

ABLATIVE AND SUPER CONDUCTING MATERIALS **9 Hours**

Ablation process, ablative materials and applications in aerospace; Phenomenon of super conduction, super conducting materials and applications in aerospace.

AIRCRAFT COMPOSITE MATERIALS & NON METALLIC 9 Hours

Composite materials - GFRP, CFRP, MMC, GLARE. Classification and properties of wood, plywood and applications, Characteristics and definition of terminologies pertaining to aircraft fabrics, matrix materials and their applications, Purpose of Doping, Adhesives; Aircraft paints, Rubber and Rubber materials,

MATERIAL FAILURES AND PREVENTIVE STEPS 7 Hours

Corrosion- types- various methods used for removal of corrosion from common aircraft metals and methods employed to prevent corrosion. Fatigue-creep-fracture-Mechanism-testing.

Theory: 45 Hrs **Tutorial: -** **Total Hours: 45**

REFERENCES

1. Titterton G F, "Aicraft Material and Processes", English Book Store, New Delhi, 2004.
2. Parker E.R., "Materials for Missiles and Spacecraft", McGraw-Hill Book Co. Inc., 1982,
3. C G Krishnadas Nair, "Handbook of Aircraft materials", Interline publishers, Bangalore, 1st Edition 1993.

Regulation 2013

U13AEP401 AERODYNAMICS LAB

L	T	P	C
0	0	3	1

LIST OF EXPERIMENTS

1. Calibration of subsonic wind tunnel.
2. Pressure distribution over smooth and rough cylinder.
3. Pressure distribution over symmetrical airfoils.
4. Pressure distribution over cambered airfoils
5. Force measurement using wind tunnel balancing set up.
6. Force measurement on symmetrical airfoil.
7. Force measurement on cambered airfoil.
8. Flow over a flat plate at different angles of incidence
9. Flow visualization studies in low speed flows over cylinders
10. Flow visualization studies in low speed flows over airfoil with different angle of incidence

Total: 45 hrs

LIST OF EQUIPMENTS

S. No.	Name of the equipment	Quantity Required
1	Subsonic Wind Tunnel	1 No
2	Airfoil sections (Symmetrical & cambered airfoils)	2 Nos
3	Angle of incidence changing mechanism	1 No
4	Multi tube Manometer	1 No
5	U-Tube Manometers	3 Nos
6	Pitot-Static Tubes	1 No
7	Cylinder models (Rough & Smooth)	2 Nos
8	Wind Tunnel balances (3 or 6 components)	1 No
9	Pressure Transducers with digital display	1 No
10	Smoke Generator	1 No
11	Water flow channel	1 No

Regulation 2013

		L	T	P	C
U13AEP402	**CAD LAB-II**	**0**	**0**	**3**	**1**

LIST OF EXPERIMENTS:

1. Study of modeling software
2. Part modeling of simple components-I
3. Part modeling of simple components-II
4. Part modeling of simple components-III
5. Part modeling of simple components-IV
6. Modeling of aircraft wing structure
7. Assembly of Plummer block
8. Assembly of Knuckle joint
9. Assembly of hydraulic cylinder for landing gear
10. Surface modeling of aerofoil

Total: 45 hrs

U13ENP401	COMMUNICATION SKILLS LABORATORY	L	T	P	C
		0	0	3	1

Course Objectives

- To impart communicative ability to exhibit the individual's subject knowledge
- To achieve the desirable communicative competence by the students to meet the expectation of corporate
- To show the need for a comprehensive link language to share subject expertise
- To offer adequate exposure to soft skills needed for the corporate.
- To sensitize towards corporate culture.

Course Outcomes

After successful completion of this course, the students should be able to

CO 1- Imparting the role of communicative ability as one of the softskills needed for placement

CO 2- Developing communicative ability and softskills needed for placement

CO 3:- Making students Industry-Ready through inculcating team-playing capacity

Course Content

PC based session (Weightage - 40%) **24 periods**

I. English Language Lab (18 Periods)

1. **Listening Comprehension** **6hrs**
   Listening – Listening and sequencing of sentences – Filling in the Blanks – Listening and answering the question

2. **Reading Comprehension and Vocabulary** **6hrs**
   Filling in the blanks – Cloze Exercises –Vocabulary building – Reading and Answering questions

3. **Speaking:** **6hrs**
   Phonetics:

   Intonation – Ear Training – Correct Pronunciation – Sound Recognition exercises – Common Errors in English

   Conversations:

   Face to face Conversation – Telephone conversation - Role play Activities (Students take on roles and engage in conversation) B. Career Lab (6 Periods) **(Samples are available to learn and practice in the class room session)**

1. **Resume / Report Preparation / Letter Writing (1)**
   Structuring the resume / report – Letter writing / E-mail communication – Samples

2. **Presentation Skills (1)**
   Elements of an effective presentation – Structure of a presentation –Presentation Tools – Voice Modulation – Audience analysis – Body Language

3. **Soft Skills (2)**
Time Management – Articulateness – Assertiveness – Innovation and Creativity – Stress Management & Poise

4. **Group Discussion (1)**
Why is GD part of selection process? – Structure of a GD- Moderator-led and Other GDs – Strategies in GD – team work – Body Language –Mock GD

5. Interview Skills

Kinds of Interviews –Required Key Skills – Corporate culture- Mock Interviews

II. Class Room Session (welghtage-60%) 24 periods

1. **Resume / Report Preparation /Letter writing:**
Students prepare their own resume and report. (2)

2. **Presentation Skills:**
Students make presentations on given topics. (8)

3. **Group Discussion:**
Students participate in group discussions (8)

4. **Interview Skills**:
Students participate in Mock Interviews. (8)

Note:
Classroom sessions are practice sessions

REFERENCES

1. Meenakshi Raman and Sangeetha Sharma, Technical Communication-Principles and Practice, Oxford University Press. New Delhi (2004).
2. Barker. A – Improve your communication skills – Kogan page India Pvt Ltd.New Delhi (2006).
3. Adrian Doff and Christopher Jones- Language in Use (Upper- Intermediate). Cambridge University Press. First South Asian Edition (2004).
4. John Seely, the Oxford Guide to writing and speaking, Oxford University Press, New Delhi (2004).
5. Customize yourself to corporate life Dr. K. Devadoss & P.Malathy Inder Publications, Coimbatore (2007).

CD's

1. Train2sucess series 1.Telephone Skills.2. Interviewing Skills 3. Negotiation

   Skills by Zenith Global Consultants Ltd. Mumbai.

2. BEC Series.

3. Look Ahead by Cambridge University Press.

Total Hours : 45

U13GHP 401 PROFESSIONAL VALUES

L	T	P	C
1	0	1	1

Course Objectives

- To know the 5 Cs (Clarity, courage, confidence, commitment, compassion)
- To Know the 5 Es(Energy, Enthusiasm, Efficiency, Enterprise, Excellence)
- To Practice the IQ Questions and given to the result
- To Learn about Professional Ethics
- To know the examples for Self Control

Course Outcomes

After successful completion of this course, the students should be able to

- Acquire knowledge on the Clarity, courage, confidence, commitment, compassion for a good Professionalize
- Demonstrate Skills of IQ test
- Contribute to the better Management of Time
- Behave a good Professionalism from Quality Enhancement

Course Content

Personality concepts - 5C's & 5E's **5 Hours**

Personality-concepts, definition,-types of personality-personality development activities- how to develop a good personality factors affecting personality development tools of improve personality-steps to a dynamic personality-5 C's and 5 E's

Time Management **5 Hours**

Self-development – importance of self development – how to develop oneself – continuous learning – laser focus +persistence – working a plan – sound mind follows sound body – complete responsibility – practice – those who make it, made it – never give-up – meditation – ten commandments of self development – self control technique for teenagers.

Leadership traits **5 Hours**

Leadership traits – style – factors of leadership – principles of leadership - time management – importance of time management – benefits – top five time sucks of the average Human –time management for college students. Passion for excellence – what is passion? – Why passion? – Value of life – index of life – fuel for fulfillment – secret of physical & spiritual fitness – improves learning ability.

Empowerment of Mind **5 Hours**

IQ, - Factors affecting the intelligence quotient – IQ and the brain – sex – race – age – relationship between IQ & intelligence – how to develop good intelligence quotient power – exercise can improve IQ – food plan to increase IQ – meditation – reading – playing – try right with opposite hands – learn new things - the IQ tests. EQ – emotional Intelligence – list positive & negative emotions. SQ – spiritual quotients – definition – basic science of spiritual quotient – how to build SQ? – Relationship between IQ, EQ, SQ.

Meditation **3 Hours**
Panchendhriya meditation – Introduction – practice – benefits.

Simplified Physical Exercise& Yogasanas **7 Hours**

Asanas – revision of previous asanas–standing asanas: natarasana –virabhadrasana – pathangusthasana– ardhachandrasana–utthithatrikonasana–parsvakonasana.

Total : 30 Hours

REFERENCES

- Personality & Self Development –ICFAI University
- Leadership-Dr.A Chandra Mohan
- Intelligence-Swami Vivekananda
- Ways to make every second valuable- Robert W. Bly
- Manavalkkalai Part-II-Vethathiri Maharishi
- Professional Ethics& Human Values-D.R Kiran&S.Bhaskar
- Extraordinary performance from ordinary people- Keith Ward& Cliff Bowman,
- Mind-Vethathiri Maharishi.
- Manavalkkalai Part-I-Vethathiri Maharishi,
- Self Cotrol-Russell Kelfer

SEMESTER V

U13AET501	AERODYNAMICS – II	L	T	P	C
		3	1	0	4

Course Objectives

- To understand the behavior of airflow both internal and external in compressible flow regime with particular emphasis on supersonic flows.
- To familiarize students with the concept of normal, oblique shock waves and expansion waves.
- To familiarize students with the subsonic compressible flow over aerofoils and simplified methods of analysis using the linearized supersonic theory.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Calculate the compressible flow through a duct of varying cross section.

CO2: Use quasi one-dimensional theory to analyze compressible flow problems.

CO3: Estimate fluid properties in Rayleigh and Fanno type flows.

CO4: Estimate the properties across normal and oblique shock waves.

CO5: Predict the properties of hypersonic flows.

Course Content

REVIEW OF BASIC PRINCIPLES **10 Hours**

Aerodynamics variables and flow physics – Surface pressure and surface shear stress – Brief Review of Thermodynamics – Governing equations – Definition of compressible flow – Adiabatic steady state flow equations – Equation of State – Speed of sound and Mach Number, Area-velocity relation – Choked flow – Numerical Problems.

COMPRESSIBLE FLOW **7 Hours**

Integral form of continuity, momentum and energy equations – Euler's equations, Integral forms of the conservation equations for inviscid flows – Alternative forms of energy equations – Quasi-one dimensional flow – Isentropic flow of a calorically perfect gas through variable-area ducts.

ONE DIMENSIONAL FLOW **10 Hours**

One dimensional flow equations – Normal Shock relations – Prandtl relation for normal shocks – Hugoniot equation – One dimensional flow with heat transfer and friction – Raleigh and Fanno Flow – Flow physics of shock waves – Flow with a shock wave inside a convergent-divergent nozzle – Methods of Characteristics – Pitot static tube – corrections for subsonic and supersonic flows – Supersonic wind tunnels – Numerical Problems using gas tables.

OBLIQUE SHOCK AND EXPANSION WAVES **10 Hours**

Source of Oblique waves – Introduction of Oblique shock waves – Oblique shock relations – Comparison between the wave angle and the Mach angle – Attached and detached shocks – Supersonic flows over wedges and cones – Shock polar – Prandtl-Meyer expansion wave – Introduction to viscous flow – Introduction to boundary-layers – shock wave boundary-layer interaction.

LINEARIZED FLOW **8 Hours**

Small perturbation potential theory – Perturbation-velocity potential equation – Linearized pressure coefficient – Compressibility corrections – Linearized two dimensional supersonic flow theory – Critical Mach number, Lower and upper critical Mach numbers, Lift and drag divergence, Characteristics of swept wings, Transonic area rule, Tip effects – Supersonic airfoils – Introduction to hypersonic flows.

Theory: 45 Hours **Tutorial: 15 Hours** **Total Hours: 60**

REFERENCES

1. John D. Anderson, 'Modern Compressible Flow', Fourth Edition, McGraw-Hill Book Co., New York, 2007.
2. S. M. Yahya, 'Fundamentals of Compressible Flow', Third Edition, New Age International, 2003.
3. Shapiro, A.H., 'Dynamics and Thermodynamics of Compressible Fluid Flow', Ronold Press, 1982.
4. Zucrow, M.J. and Anderson, J.D., 'Elements of Gas Dynamics', McGraw-Hill Book Co., New York, 1989.
5. Barnes W. McCormick, 'Aerodynamics, Aeronautics and Flight Mechanics', Second Edition, John Wiley, New York, 1994.
6. Rathakrishnan, E., 'Gas Dynamics', Prentice Hall of India, 2003.
7. Kuethe, A.M., and Chow, C.Y., 'Foundations of Aerodynamics', John Wiley and Sons, 1982.

U13AET502	FINITE ELEMENT METHODS	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the mathematical and physical principles underlying the FEM as applied to solid mechanics, dynamics, thermal analysis and fluid mechanics.
- To analyse more complex problems (in solid mechanics or thermal analysis) using the commercial FEM code ANSYS.
- Develop finite element formulation of engineering problems from a variety of application areas including, stress heat transfer and vibration analysis.
- To enable the students to formulate the design problems into FEA.
- To understand the fundamentals of isoparametric elements.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Identify and formulate mathematical model for solution of common engineering Problems using FEM approach.

CO2: Calculate stress, strain, and displacement value of simple 1-D problems by applying FEM concept.

CO3: Perform dynamic analysis on simple 1-D bar elements and Solve structural, thermal, fluid flow problems under various loading conditions using ANSYS software.

CO4: Calculate the stress, strain, value for isoparametric elements under various loading condition.

CO5: Solve complex axisymmetric problems under various boundary conditions.

Course Content

INTRODUCTION **6 Hours**

Review of various approximate methods – Rayleigh Ritz’s, Galerkin and finite difference methods – Governing equation and convergence criteria of finite element method.

DISCRETE ELEMENTS **12 Hours**

Bar element with uniform section and varying section – Mechanical and thermal loading – Truss analysis – Beam element – problems for various loading and boundary conditions – longitudinal and lateral vibration – Use of local and natural coordinates.

CONTINUUM ELEMENT **10 Hours**

Plane stress, Plane strain and axisymmetric problems – Constant and linear strain Triangular elements – stiffness matrix – axisymmetric load vector.

ISOPARAMETRIC ELEMENT **8 Hours**

Introduction to isoparametric elements – Shape function for 4, 8 and 9 nodal quadrilateral elements – Stiffness matrix and consistent load vector – Gaussian Integration.

FIELD PROBLEMS **9 Hours**

One dimensional Heat transfer problems – Steady state heat transfer in fin – Derivation of element matrices for two dimensional problems – Torsion problems.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Tirupathi.R. Chandrupatla and Ashok D. Belegundu, 'Introduction to Finite Elements in Engineering', Fourth Edition, Prentice Hall India, 2011.
2. Robert D Cook, David S Malkus, and Michael E Plesha, 'Concepts and Applications of Finite Element Analysis', Fourth Edition, John Wiley and Sons, Inc., 2008.
3. Reddy J. N., 'An Introduction to Finite Element Method', Third Edition, McGraw-Hill, 2005.
4. Larry J. Segerlind, 'Applied Finite Element Analysis', Second Edition, John Wiley and Sons, Inc., 1985.

U13AET503 AIRCRAFT STRUCTURES – II

L	T	P	C
3	1	0	4

Course Objectives

- To introduce the various structural components of aircrafts and aerospace vehicles and study their behaviour under various types of loads.
- To familiarise with different section of beams subjected to various types of loading.
- To know the theoretical and methodological approaches to design aircraft structures.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Analyze the response of structures due to unsymmetrical bending.

CO2: Analyze stresses and deflections of flat plates.

CO3: Identify and analyze structural problems commonly encountered in aircrafts.

CO4: Identify various types of structural components and their loading pattern.

CO5: Analyze bending, shear and torsion of open and closed thin-walled sections.

Course Content

UNSYMMETRICAL BENDING **8 Hours**

Bending stresses in beams of unsymmetrical sections (K-method, Neutral axis method and Principle axis Method) – Bending of symmetric sections with skew loads.

SHEAR FLOW IN OPEN SECTIONS **10 Hours**

Thin walled beams – Concept of shear flow – shear centre – Elastic axis – one axis of symmetry – wall effective and ineffective in bending – unsymmetrical beam sections.

SHEAR FLOW IN CLOSED SECTIONS **10 Hours**

Bredt-Batho formula – Single and Multi-cell structures – approximate methods – Shear flow in single, multi-cell structures under torsion – Shear flow in single and multi-cell under bending with walls effective and ineffective.

BUCKLING OF PLATES **10 Hours**

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

STRESS ANALYSIS IN WING AND FUSELAGE **7 Hours**

Shear resistant web beams – Tension field web beams (Wagner Beam) – Shear and bending moment distribution for cantilever and semi-cantilever types of beams – loads on aircrafts – lift distribution – V-n diagram – Gust loads.

Theory: 45 Hours **Tutorial: 15 Hours** **Total Hours: 60**

REFERENCES

1. Megson, T.H.G., ‘Aircraft Structures for Engineering Students’, Fifth Edition (Rev.), Butterworth-Heinemann, 2012.
2. G. Lakshmi Narasaiah, ‘Aircraft Structures’, CRC Press, 2011.
3. Bruhn. E.H., ‘Analysis and Design of Flight vehicles Structures’, Tri-state off set company, USA, 1985.
4. Peery, D.J., and Azar, J.J., ‘Aircraft Structures’, Second Edition, McGraw-Hill, 1993.
5. Rivello, R.M., ‘Theory and Analysis of Flight Structures’, McGraw-Hill, 1993.
6. Megson, T.H.G., ‘An Introduction to Aircraft Structural Analysis’, Second Edition Butterworth-Heinemann, 2013.

U13AET504	**CONTROL ENGINEERING**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives

- To understand the basic concepts of feedback control.
- To learn the modeling of physical systems.
- To study the response of physical systems in time domain and frequency domain.
- To learn the fundamentals of stability analysis of dynamic systems.
- To study the design of classical controllers and compensators.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Obtain the transfer function of mechanical and electrical systems.

CO2: Analyze time response and frequency response of various control systems.

CO3: Improve the stability of dynamic systems by analyzing using MATLAB.

CO4: Design lead-lag compensators for a given specification using MATLAB.

CO5: Design and tune PID controllers for dynamic systems using MATLAB.

Course Content

SYSTEMS AND THEIR REPRESENTATION **9 Hours**

Basic elements in control systems – Open and closed loop systems – Laplace Transforms – Mathematical modeling of physical systems: Transfer function model of Mechanical and Electrical systems, Servo motors and small aircrafts – Electrical analogue of mechanical systems – Block diagram reduction techniques – Signal flow graphs – State Space Model – Control System components: Synchros – Potentiometer – Gyroscopes – Accelerometers.

TIME RESPONSE ANALYSIS **9 Hours**

Time response – Types of test input: step, ramp, impulse and parabolic inputs – First order system response for step, ramp and impulse input – Second order system Response for step input – Time domain specifications – Error coefficients – Generalized error series – Steady state error.

FREQUENCY RESPONSE ANALYSIS **7 Hours**

Frequency response – Frequency domain specifications – Correlation between frequency domain and time domain specifications – Bode plot analysis – Determination of closed loop response from open loop response.

STABILITY ANALYSIS **7 Hours**

Definition of Stability – Stability and roots of characteristics equation in s-plane – Routh-Hurwitz stability criterion – Root Locus analysis – Effect of pole, zero addition – Nyquist Stability criterion.

COMPENSATOR DESIGN **4 Hours**

Performance Criteria – Lag, Lead and Lead-Lag compensators – Compensator design using Bode plots – Compensator design using Root locus.

CLASSICAL CONTROLLER DESIGN **9 Hours**

Generalized control problem – Proportional control – Proportional plus Integral (PI) control – Proportional plus Derivative (PD) control – Proportional plus Integral plus Derivative (PID) control – Ziegler-Nichols methods for tuning PID controllers – Design example with aircrafts – Introduction to Digital PID control – Difference equation and Tustin Transformation.

Theory: 45 Hours **Tutorial: 15 Hours** **Total Hours: 60**

REFERENCES

1. Norman S. Nise, ‘Control Systems Engineering’, Sixth Edition, John Wiley and Sons Inc., 2011.
2. Roland S. Burns, ‘Advanced Control Engineering’, Butterworth-Heinemann Publishers, 2001.
3. Ajit K. Mandal, ‘Introduction to Control Engineering – Modeling, Analysis and Design’, New Age International Publishers, 2006.
4. John J. D’Azzo, Constantine H. Houpis, and Stuart N. Sheldon, ‘Linear Control System Analysis and Design with MATLAB’, Fifth Edition, Marcel Dekker, Inc., 2003.
5. Derek Atherton, ‘Control Engineering: An Introduction with the use of MATLAB’, Ventus Publishing, 2009.
6. Donald McLean, ‘Automatic Flight Control Systems’, Prentice Hall International, 1990.
7. Robert H. Bishop, ‘Modern Control Systems Analysis and Design Using MATLAB’, Addison Wesley, 1993.

U13AET505	AIRCRAFT SYSTEMS AND INSTRUMENTS	L	T	P	C
		3	0	0	3

Course Objectives

- To describe the principle and working of aircraft systems and instruments.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Compare the features of various flight control systems.

CO2: Describe the principle and working of different aircraft systems.

CO3: Analyze the performance of various aircraft engine systems.

CO4: Acquire and interpret data from various aircraft instruments.

CO5: Identify the various cockpit controls.

Course Content

CONVENTIONAL AIRCRAFT SYSTEMS **10 Hours**

Conventional flight control system – Hydraulic and Pneumatic systems – Electrical Power generation and distribution system – Environmental control system – De-icing and anti-icing systems – Landing gear system – Aircraft fuel systems.

CONVENTIONAL ENGINE CONTROL SYSTEMS **8 Hours**

Fuel systems of Piston engine and Jet engine – Main engine components and functions of jet engines – Engine lubrication systems – Accessory gear box and accessories driven – Engine starting system – Main and After burner fuel control systems – Thrust reversing and thrust vector control.

ADVANCED TECHNOLOGY SYSTEMS **10 Hours**

Autopilot system – Advanced flight control systems – Flight Management System – Communication and Navigation systems – Radar and weapon control systems – Full Authority Digital Engine Control (FADEC) system.

AIRCRAFT INSTRUMENTS **10 Hours**

Flight instruments, Navigation and Communication instruments, Gyroscope, Accelerometers, Airspeed indicator, Mach meter, Electronic horizontal situation indicator, Horizontal situation indicator, Multi-Function Display, Attitude director indicator, Primary Flight Display, Engine instruments and display – Operation and principles, Flight Data Recorder (FDR), Cockpit Voice Recorder (CVR).

COCKPIT LAYOUT **7 Hours**

Ergonomic layout – Controls and Indications – Display systems – Self test and Built-In Test Equipment (BITE) – Cockpit air-conditioning and pressurization – Challenges posed by cockpit to the designer – Failure warning system.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. E. H. J. Pallett, ‘Aircraft Instruments – Principles and Applications’, Second Edition, Longman House, 1981.
2. E. H. J. Pallett and S. Coyle, ‘Automatic Flight Control’, Fourth Edition, Blackwell Science Ltd, 1993.
3. Irwin Treager, ‘Aircraft Gas Turbine Engine Technology’, Third Edition, McGraw-Hill, 1997.
4. James Powell, ‘Aircraft Radio Systems’, Shroff Publishers, 2006.
5. Ian Moir and Allan Seabridge, ‘Aircraft Systems – Mechanical, electrical and avionics subsystems integration’, Second Edition, Professional Engineering Publishing Limited, 2001.
6. Ian Moir and Allan Seabridge, ‘Civil Avionics Systems’, Professional Engineering Publishing Limited, 2003.
7. “General Hand Book of Airframe and Powerplant Mechanics”, U.S. Dept. of Transportation, Federal Aviation Administration, English Book Store, New Delhi, 1995.

U13AET506	**AIRCRAFT PERFORMANCE**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

- To familiarize students with the lift, drag and wing performance.
- To familiarize the performance characteristics of propeller and jet propulsion systems.
- To familiarize the impact of aircraft design characteristics on performance.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Predict the aerodynamic characteristics of the airplane, the engine performance and how flight altitude affects the airplane performance.

CO2: Calculate the performance of an airplane, mainly for non-accelerating flight states, but also in some simple accelerating cases such as take-off and landing.

CO3: Calculate the aerodynamic and engine data that is needed to perform a performance analysis.

CO4: Design aircraft parameters according to the mission requirement.

CO5: Identify, formulate, and solve engineering problems. This will be accomplished by discussing some open-ended problems in estimating the aircraft performance.

Course Content

LIFT AND DRAG ON FLIGHT PERFORMANCE **10 Hours**

Measurement of speed – True, Indicated and Equivalent air speed – Streamlined and bluff bodies – Various Types of drag in airplanes, Drag polar, Methods of drag reduction in airplanes – Drag polars of vehicles from low speed to high speeds – Effects of Reynold's number on skin friction and pressure drag.

STEADY FLIGHT **10 Hours**

Steady level flight, Thrust/power available and required with altitude for jet and propeller engine aircrafts, Estimation of maximum level flight speed, conditions for minimum drag and minimum power required.

GLIDING, CLIMBING PERFORMANCE **12 Hours**

Maximum range, Minimum rate of sink in a glide, Shallow angle of glide, Rate of climb, time to climb, Service and absolute ceiling, Climb hodograph, Maximum climb angle and Maximum Rate of climb, Accelerated rate of climb (Energy method).

MANEUVERING PERFORMANCE **6 Hours**

Level turn – minimum radius, maximum load factor and turn rate – Pull up, Pull down, V-n diagram.

SPECIAL PERFORMANCE **7 Hours**

Range and endurance of jet and propeller type of airplanes, Estimation of take-off and landing distance, High lift devices.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. John David Anderson, Jr., 'Aircraft Performance and Design', First Edition, Tata McGraw Hill, 2010.
2. Jan Roskam and Chuan-Tau Edward Lan, 'Airplane Aerodynamics and Performance', DAR Corporation, USA, 1997.
3. L. J. Clancy, 'Aerodynamics', Pitman, 1986.
4. E. L. Houghton, P. W. Carpenter, Steven H Collicott, and Daniel T Valentine, 'Aerodynamics for Engineering Students', Sixth Edition, Butterworth-Heinemann, 2012.
5. Houghton, E. L., and Caruthers, N. B., 'Aerodynamics for Engineering Students', Edward Arnold Publishers, 1988.
6. Barnes W. McCormick, 'Aerodynamics, Aeronautics and Flight Mechanics', Second Edition, John Wiley, New York, 1994.

U13AEP501	AIRCRAFT STRUCTURES LABORATORY	L	T	P	C
		0	0	3	1

LIST OF EXPERIMENTS

1. Unsymmetrical bending of beams.
2. Shear centre location for open sections.
3. Shear centre location for closed sections.
4. Constant strength beam.
5. Combined bending and torsion.
6. Calibration of Photoelastic materials.
7. Stresses in circular discs and beams using photo elastic techniques.
8. Determination of Stress concentration factor for a flat plate with hole using photoelasticity.
9. Vibration of beams.
10. Wagner beam – Tension field beam.

Total Hours: 45

LIST OF EQUIPMENTS

S. No.	Name of the equipment	Quantity Required
1	Beam Test setup	2 Nos.
2	Unsymmetrical sections like 'I' sections, 'C' sections, and 'Z' sections	2 Nos.
3	Channel section and Angle section	2 Nos.
4	Dial gauges	12 Nos.
5	Photoelastic apparatus	1 No.
6	Vibration of Beam Setup	1 No.
7	Wagner beam	1 No.

U13AEP502	PROPULSION AND COMBUSTION LABORATORY	L	T	P	C
		0	0	3	1

LIST OF EXPERIMENTS

1. Study of an aircraft piston engine (Includes study of assembly of sub Systems, Various components, their functions and operating principles).
2. Study of an aircraft jet engine (Includes study of assembly of sub systems, various components, their functions and operating principles).
3. Determination of heat transfer coefficient for a forced convection heat transfer over a flat plate.
4. Determination of heat transfer coefficient for a free convective heat transfer over a flat plate
5. Performance analysis of a Propeller.
6. Determination of heat of combustion of Aviation fuel.
7. Performance analysis of Free jet.
8. Performance analysis of Wall jet.
9. Performance testing of Gas turbine engine.
10. Performance testing and Pressure distribution of Nozzles.

Total Hours: 45

LIST OF EQUIPMENTS

S. No.	Name of the equipment	Quantity Required
1	Piston engine	1 No.
2	Jet Engine / Engine model	1 No.
3	Forced Convection apparatus	1 No.
4	Free Convection apparatus	1 No.
5	Propeller performance Test Rig	1 No.
6	Digital Bomb Calorimeter	1 No.
7	Free and Wall jet test setup	1 No.
8	Computerized gas turbine engine Test Rig	1 No.
9	Nozzle Performance Test Rig	1 No.
10	Nozzle Pressure Distribution Test Rig	1 No.

U13AEP503	**DESIGN AND SIMULATION LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1**

LIST OF EXPERIMENTS

1. Analysis of bar element.
2. Analysis of truss members.
3. Analysis of beam element.
4. Analysis of composite beam.
5. Coupled degree of freedom.
6. Analysis of one dimensional temperature distribution.
7. Thermal stress distribution in bar element.
8. Buckling of columns.
9. Axisymmetric problems.
10. Heat transfer Analysis of 2-D component.
11. Harmonic Analysis of a beam.
12. Nonlinear analysis of a beam.
13. Coupled structural/thermal analysis of a beam.
14. Application of springs and joints.
15. Introduction to 3D element (Torsion problem on a shaft).

Total Hours: 45

U13GHP501	HUMAN EXCELLENCE – SOCIAL VALUES	L	T	P	C
		1	0	1	1

Course Objectives

- To produce responsible citizens to family and society.
- To uplift society by pure politics and need education.
- To realize the value of unity, service.
- To immunize the body.
- To get Divine peace through inward travel.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Adopt and practice social values as his/her regular duties.

CO2: Take over the social responsibilities.

CO3: Give solutions and to manage the challenging social issues.

CO4: Voluntarily participate and organize social welfare programmes.

CO5: Explore his/her ideology of techno social issues and provide the best solution.

Course Content

ORIGIN OF SOCIETY **5 Hours**

Evolution of universe: Creation theory, Big bang theory, Evolution theory, Permanence theory – Mithya, Maya – Evolution of living being – Evolution of Man – Formation of society and social values.

Practical: Group Discussion on Evolution of Man and formation of society, Panel discussion on Social values – Pancha Bhoodha Navagraha Meditation.

SELF AND SOCIETY **2 Hours**

Duty to self, family, society and world – Realization of Duties and Responsibilities of individuals in the society (Five fold cultures) – impact of social media on present day youth and correction measures.

Practical: Case study – interaction with different professionals.

EDUCATION AND SOCIETY **3 Hours**

Education: Ancient and Modern Models.

Practical: Making Short film on impact of education in social transformation.

DISPARITY AMONG HUMAN BEINGS **3 Hours**

Wealth’s for humans, Factors leading to disparity in human beings and Remedies.

Practical: Debate on disparity and social values.

CONTRIBUTION OF SELF TO SOCIAL WELFARE **3 Hours**

Participation in Social welfare – Related programmes – Recognized association – Activities for social awareness – Programme by Government and NGOs – Benefits of social service – Balancing the family and social life.

Practical: In campus, off campus projects.

GENERAL PRACTICAL **14 Hours**

Ashtanga Yoga: Pathanjali maharishi and Yoga – Involvement – Rules of Asanas – Suryanamaskara (12 Steps) – Meditation.

Standing: Pada Hastasana, Ardha Cakrasana, Trikonasana, Virukchsana (Eka Padaasana).

Sitting : Padmasana, Vakrasana, Ustrasana, Paschimatanasana.

Prone : Uthanapathasana, Sarvangasana, Halasana, Cakrasana.

Supine : Salabhasana, Bhujangasana, Dhanurasana, Navukasana.

Theory: 16 Hours **Practical: 14 Hours** **Total Hours: 30**

REFERENCES

1. Steven Weinberg, 'The First Three Minutes: A Modern View of the Origin of the Universe', Basic Books, 1993.
2. Vethathiri Maharishi, 'Vethathirian Principles of Life', The World Community Service Centre, Vethathiri Publications, 2003.
3. Vethathiri Maharishi, 'Karma Yoga: The Holistic Unity', The World Community Service Centre, Vethathiri Publications, 1994.
4. Vethathiri Maharishi, 'Prosperity of India', The World Community Service Centre, Vethathiri Publications, 1983.
5. Swami Vivekananda, 'The Cultural Heritage of India', First Edition, The Ramakrishna Mission Institute of Culture, 1937.
6. Vivekananda Kendra Prakashan Trust, "YOGA", Vivekanandha Kendra Prakashan Trust, Chennai, 1977.

SEMESTER VI

U13AET601	DIGITAL ELECTRONICS AND MICROPROCESSOR	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the working of digital and linear circuits.
- To study the architecture and instruction sets of 8085 microprocessor.
- To learn assembly language programming with 8085 microprocessor.
- To study the architecture of various peripheral interfacing devices for interfacing with 8085 microprocessor.
- To learn the basic concepts of serial and parallel data communication.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Design complex digital circuits.

CO2: Develop assembly language programs using 8085 for various applications.

CO3: Calculate the execution time of 8085 instructions for a computer.

CO4: Interface and control various peripherals with 8085 microprocessor.

CO5: Detect errors in digital data communication.

Course Content

DIGITAL AND LINEAR CIRCUITS 9 Hours

Need for Digital and Linear Circuits in Aircraft Systems – Elements of Digital Integrated Circuits (ICs): Adder, Subtractor, Multiplexer and Demultiplexer, Encoder and Decoder, Flip flops, Registers and Counters – Linear ICs: Operational Amplifier, Analog-to-Digital (A/D) Converter – Types of A/D converter, Successive Approximation and Dual Slope A/D converters – Digital-to-Analog (D/A) Converter: Weighted Resistor and Inverted R-2R Ladder D/A converters.

8085 MICROPROCESSOR 9 Hours

8085 Architecture – Instruction format – Instruction set – Data Transfer Operation – Arithmetic operation – Logical Operation – Branch operation – Addressing modes and Examples – Machine Cycles – Timing diagram.

8085 PROGRAMMING AND INTERFACING 9 Hours

Assembly language programming – Counters and Time Delays – Stack and Subroutines – Interrupts – Assembly language programs for various applications – Memory Interfacing – Interfacing I/O devices.

PERIPHERAL INTERFACING DEVICES **9 Hours**

Programmable Peripheral Interface 8255A – Programmable Interval Timer 8253 – Programmable Keyboard/Display Controller 8279 – Programmable Interrupt Controller 8259A.

DATA COMMUNICATION AND MICROPROCESSOR APPLICATIONS **9 Hours**

Serial communication – Parallel communication – Synchronous and Asynchronous Data Transfer – Software-Controlled Asynchronous Serial Input/output – Universal Synchronous and Asynchronous Receiver and Transmitter (USART) 8251A – Direct Memory Access (DMA) Data Transfer – DMA Controller 8237 – Applications of 8085 Microprocessor: Stepper Motor Controller, Temperature Controller.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Anil K. Maini, ‘Digital Electronics: Principles, Devices and Applications’, John Wiley and Sons Ltd, 2007.
2. Ramesh S. Gaonkar, ‘Microprocessor Architecture, Programming and Applications with the 8085’, Sixth Edition, Penram International Publishers, 2013.
3. Donald P. Leach and Albert P. Malvino, ‘Digital Principles and Applications’, Tata McGraw Hill, 1994.
4. Mike Tooley, ‘Aircraft Digital Electronic and Computer Systems – Principles, Operation and Maintenance’, First Edition, Butterworth-Heinemann, 2007.

U13AET602 VIRATIONS AND AEROELASTICITY

	L	T	P	C
U13AET602 VIBRATIONS AND AEROELASTICITY	3	0	0	3

Course Objectives

- To provide the knowledge about the dynamic behavior of different aircraft components and the interaction among the aerodynamic, elastic and inertia forces.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Relate the concept and types of vibration.

CO2: Calculate the vibration of the structure under various dynamic loading conditions.

CO3: Analyze the structure for its damping property and resonance condition.

CO4: Implement a structural model into a mathematical model.

CO5: Identify the effects of vibrations on aircraft structures and the change in aerodynamic property of the structures.

Course Content

SINGLE DEGREE OF FREEDOM SYSTEMS – FREE VIBRATION 10 Hours

Terminologies – Simple harmonic motion – Newton's Law – D' Alembert's principle – Energy Methods – Free vibrations – Damped vibrations.

SINGLE DEGREE OF FREEDOM SYSTEMS – FORCED VIBRATION 10 Hours

Forced Vibrations – With and without damping – Support excitation – Vibration measuring instruments.

MULTI DEGREES OF FREEDOM SYSTEM 7 Hours

Two degrees of freedom systems – Static and Dynamic couplings – Vibration absorber – Principal co-ordinates – Principal modes and orthogonal condition – Eigen value problems – Hamilton's principle – Lagrangian equation and application.

CONTINUOUS SYSTEMS 8 Hours

Vibration of elastic bodies – Vibration of strings – Longitudinal, Lateral and Torsional vibrations – approximate methods – Rayleigh and Holzer Methods to find natural frequencies.

ELEMENTS OF AEROELASTICITY 10 Hours

Concepts – Coupling – Aero elastic instabilities and their prevention – Basic ideas on wing divergence – loss and reversal of aileron control – Flutter and its prevention.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Singiresu S. Rao, ‘Mechanical Vibrations’, Fifth Edition, Prentice Hall, 2011.
2. V. P. Singh, ‘Mechanical Vibrations’, Fourth Edition, Dhanpat Rai and Co., 2014.
3. Leonard Meirovitch, ‘Fundamentals of Vibrations’, Tata McGraw Hill, 2001.
4. Tse. F.S., Morse, I.F., and Hunkle, R.T., ‘Mechanical Vibrations’, Prentice Hall, New York, 1984.
5. Scandlan R.H. and Rosenbaum R., ‘Introduction to the Study of Aircraft Vibration and Flutter’, John Wiley and Sons, New York, 1982.
6. Bisplinghoff R.L., Ashley H and Hogman R.L., ‘Aero elasticity’, Addition Wesley Publication, New York, 1983.
7. Fung Y.C., ‘An Introduction to the Theory of Aero elasticity’, John Wiley and Sons, New York, 1995.

U13AET603	AIRCRAFT STABILITY AND CONTROL	L	T	P	C
		3	0	0	3

Course Objectives

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

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Calculate aircraft trim and static stability characteristics.

CO2: Perform preliminary design computations to meet static stability and trim requirements.

CO3: Identify the lateral and longitudinal modes and relate the important physical influences of aircraft properties on these modes.

CO4: Determine the stability of the aircraft from the linearized equations of motion.

CO5: Design the control surfaces according to the stability requirements.

Course Content

GENERAL **7 Hours**

Degrees of freedom of a system – Static and dynamic stability – Need for stability in an airplane – purpose of controls – Inherently and marginally stable airplanes.

STATIC LONGITUDINAL STABILITY **14 Hours**

Stick fixed: Basic equations of equilibrium, Stability criterion, Wing and tail moments, Effect of fuselage and nacelles, Effect of center of gravity (c.g.) location, Power effects, Stabilizer setting and c.g. location, Elevator effects, stick fixed neutral point.

Stick free: Hinge moment coefficients, Stick free neutral point symmetric maneuvers, stick force gradients and stick force per g. Aerodynamic balancing of control surfaces.

STATIC LATERAL STABILITY **7 Hours**

Dihedral effect – coupling between rolling moment and yawing moment – Adverse yaw – Aileron power – Aileron reversal.

STATIC DIRECTIONAL STABILITY **7 Hours**

Weathercock effect, rudder requirements – One engine inoperative conditions, rudder lock.

DYNAMIC STABILITY **10 Hours**

Dynamic Longitudinal Stability – Equation of motion – Stability derivatives, Routh's discriminant, solving the stability quadratic – Phugoid motion, factors affecting the period and damping – Dynamic Lateral and Directional Stability – Dutch roll and spiral instability, Autorotation and spin, Two control airplane.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Nelson, R.C., ‘Flight Stability and Automatics Control’, Second Edition, McGraw Hill, 1997.
2. C. D. Perkins and R. E. Hage, ‘Airplane Performance, Stability and Control’, John Wiley and Sons, 1949.
3. Eitkin, B., and Reid, L.D., ‘Dynamics of Flight Stability and Control’, Third Edition, Wiley, New York, 1996.
4. Babister, A.W., ‘Aircraft Stability and Response’, Pergamon Press, 1980.
5. McCormick, B.W., ‘Aerodynamics, Aeronautics and Flight Mechanics’, John Wiley, 1995.
6. L. J. Clancy, ‘Aerodynamics’, Pitman, 1986.
7. Houghton, E. L., and Caruthers, N. B., ‘Aerodynamics for Engineering Students’, Edward Arnold Publishers, 1988.

U13AET604 COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	1	0	4

Course Objectives

- To introduce Governing Equations of viscous fluid flows and turbulence modeling.
- To introduce numerical modeling and its role in the field of fluid flow.
- To enable the students to understand the various discretization methods, solution procedures.
- To create confidence to solve complex problems in the field of fluid flow by using high speed computers.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Develop a working knowledge of the subject fundamentals.

CO2: Create situation to think holistically and systemically for developing problem solving skills.

CO3: Analyze and solve aerospace engineering problems numerically with high degree of accuracy.

CO4: Develop advanced skills in MATLAB and programming languages such as C/C++ & Fortran.

CO5: Develop skills to conceive, design, implement, and operate aerospace systems and subsystems in an enterprise and societal context using CFD tools.

Course Content

FUNDAMENTAL CONCEPTS **7 Hours**

Introduction – Basic Equations of Fluid Dynamics – Mathematical properties of Fluid Dynamics Equations – Elliptic, Parabolic and Hyperbolic equations – Well posed problems.

DISCRETIZATION, TRANSFORMATION AND GRIDS **10 Hours**

Discretization of Partial Differential Equations using Finite Difference Method – Transformations and grids – General Transformation of the Equations, Metrics and Jacobians, Coordinate Stretching, Boundary-Fitted Coordinate Systems, Adaptive Grids – Explicit Finite Difference Methods of subsonic, supersonic and viscous flows – The Lax-Wendroff Method, MacCormack's Method – Some basic numerical examples of the specific methods.

PANEL METHODS **7 Hours**

Incompressible Inviscid flows: Source, vortex and doublet panel, methods – Lifting flows over arbitrary bodies Introduction – Source panel method – Pressure distribution calculation over circular cylinder – Vortex panel method – Lifting flow calculation over aerofoil.

BOUNDARY LAYER EQUATIONS – STABILITY PROPERTIES 11 Hours

Boundary layer Equations and methods of solution – Implicit time dependent methods for inviscid and viscous compressible flows – Concept of numerical dissipation – Stability properties of explicit and implicit methods, like weak, absolute stable characteristics – Conservative upwind discretization for hyperbolic systems – Further advantages of upwind differencing, some example schemes like Leapfrog scheme.

FEM AND FINITE VOLUME TECHNIQUES IN CFD 10 Hours

Finite Element Techniques in Computational Fluid Dynamics – Finite Volume Techniques – Cell Centered and Cell Vertex Formulation – Lax-Wendoroff Time Stepping – Runge-Kutta Time Stepping – Accuracy – Flux splitting schemes, pressure correction solvers – SIMPLE, PESO – Introduction to turbulence modeling.

Theory: 45 Hours Tutorial: 15 Hours Total Hours: 60

REFERENCES

1. T. J. Chung, 'Computational Fluid Dynamics', Second Edition, Cambridge University Press, 2014.
2. Suhas V. Patankar, 'Numerical Heat Transfer and Fluid Flow', CRC Press, 1980.
3. John D Anderson Jr., 'Computational Fluid Dynamics – The Basics with Applications', McGraw-Hill Education, New York, 1995.
4. Fletcher, C.A.J., 'Computational Techniques for Fluid Dynamics', Vol. 1 and Vol. 2, Second Edition, Springer-Verlag, Berlin, 2013.
5. Charles Hirsch, 'Numerical Computation of Internal and External Flows', Vols. 1 and 2, Second Edition, John Wiley and Sons, New York, 2007.
6. John F. Wendt (Editor), 'Computational Fluid Dynamics: An Introduction', Third Edition, Springer-Verlag, Berlin, 2008.
7. Joel H. Ferziger and Milovan Peric, 'Computational Methods for Fluid Dynamics', Third Edition, Springer, 2002.
8. Pieter Wesseling, 'Principles of Computational Fluid Dynamics', Springer, 2001.
9. Klaus A. Hoffmann and Steve T. Chiang, 'Computational Fluid Dynamics', Vol. 1, Fourth Edition, Engineering Education System, 2000.
10. Klaus A. Hoffmann and Steve T. Chiang, 'Computational Fluid Dynamics for Engineers', Vol. 2, Engineering Education System, 1993.

U13AET605	ROCKET PROPULSION	L	T	P	C
		3	1	0	4

Course Objectives

- To study in detail about fundamentals of chemical rockets, rocket propulsion and advanced propulsion techniques.
- To provide students with an overview of various rocket technologies and applications.
- To provide students with a sound fundamental in gas dynamics, thermochemistry, heat transfer, and vehicle dynamics as related to rocket motor/vehicle analysis.
- To provide students with a sound fundamental in analysing/designing various rocket propulsion systems such as liquid propellant rocket motors, solid propellant rocket motors, multi-stage launch vehicles, arc jets, solid core nuclear thermal rocket motors, and ion thrusters.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Analyze the fluid flow in a rocket nozzle.

CO2: Perform preliminary heat transfer calculations in a rocket nozzle.

CO3: Design various rocket motor systems to satisfy a wide range of applications.

CO4: Perform analysis on solid-core nuclear thermal rockets, arc jets, and ion thrusters.

CO5: Analyze a rocket engine system to determine its specific impulse and performance.

Course Content

DEFINITIONS AND FUNDAMENTALS **10 Hours**

Operating principle of chemical rockets – Definitions: Rocket thrust, Exhaust velocity, Specific Impulse, Vehicle acceleration, Effective exhaust velocity, Characteristic velocity, Mass ratio, Propellant mass fraction, Burning time, Total impulse – Thrust coefficient, Isentropic flow throw nozzles, Rocket nozzle classifications – Under and over expanded nozzles, Optimum expansion – Numerical Problems.

IGNITION SYSTEMS IN ROCKETS **7 Hours**

Types of solid propellant rocket igniters – Pyrotechnic igniters and pyrogen igniters – Igniter Design Considerations: Igniter mass and chamber volume – Ignition Chain: Ignition delay, mode of heat transfer, flame spreading – Deflagration and Detonation – Hypergolic ignition – Ignition systems in liquid rockets.

SOLID PROPELLANT ROCKETS **10 Hours**

Selection criteria of solid propellants – Important hardware components of solid rockets –

Propellant grain design considerations – Burn rate – Internal ballistics – Pressure-time curve – Starting transient – erosive burning – Rocket performance considerations – Staging of rockets – Thrust vector control – Thrust termination techniques – Numerical problems.

LIQUID PROPELLANT ROCKETS **10 Hours**

Liquid propellant rocket engine fundamentals – Liquid propellants – Propellant feed systems – Selection of liquid propellants – Valves and pipe lines – Thrust chambers – Injectors, combustion chamber and nozzle – Combustion Instability – Secondary injection thrust vector control in liquid rockets – Cooling in liquid rockets – Numerical Problems – Introduction to hybrid rockets – Relative advantages of liquid rockets over solid rockets – Types of Rocket tests – Rocket exhaust plumes.

ADVANCED PROPULSION TECHNIQUES **8 Hours**

Cryogenic rockets – Satellite thrusters – Electric rockets – Ion propulsion techniques – Nuclear rockets – Types, Solar sail, Anti-matter propulsion – Preliminary Concepts in nozzle less propulsion – Interplanetary missions.

Theory: 45 Hours **Tutorial: 15 Hours** **Total Hours: 60**

REFERENCES

1. George P. Sutton and Oscar Biblarz, ‘Rocket Propulsion Elements’, Eighth Edition, John Wiley and Sons Inc., New York, 2010.
2. Kou. K. K and Summerfield. M., “Fundamental Aspects of Solid Propellant Rockets”, Progress in Astronautics and Aeronautics, AIAA, Vol. 90, 1982.
3. Norazila Othman, Subramaniam Krishnan, and Wan Khairuddin Wan Ali, ‘Design and Development of Hydrogen Peroxide Monopropellant Thruster: Basic Theory and Performance Calculations’, Lambert Academic Publishers, 2011.
4. Barrere. M, ‘Rocket Propulsion’, Elsevier Publishing Company, New York, 1960.
5. Hill, P.G. and Peterson, C.R., ‘Mechanics and Thermodynamics of Propulsion’, Second Edition, Pearson Education, 1999.
6. Gordon Oates, ‘Aero Thermodynamics of Gas Turbine and Rocket Propulsion’, AIAA Education Series, New York, 1989.
7. J. W. Cornelisse, H. F. R. Schoyer, and K. F. Wakker, ‘Rocket Propulsion and Spaceflight Dynamics’, Pitman, London, 1979.

U13AEP601	AIRCRAFT DESIGN PROJECT PHASE-I	L	T	P	C
		0	0	3	1

LIST OF EXPERIMENTS

1. Comparative configuration study of different types of airplanes.
2. Comparative study on specification and performance details of aircraft.
3. Preparation of comparative data sheets.
4. Work sheet layout procedures.
5. Comparative graphs preparation and selection of main parameters for the design.
6. Preliminary weight estimations, selection of main parameters.
7. Power plant selection, Aerofoil selection, Wing tail and control surfaces.
8. Preparation of layouts of balance diagram and three view drawings.
9. Drag estimation.
10. Detailed performance calculations and stability estimates.

Total Hours: 45

U13AEP602 AIRCRAFT SYSTEMS LABORATORY

L	T	P	C
0	0	3	1

LIST OF EXPERIMENTS

1. Safety precautions, procedures and documentation while working on aircraft.
2. Aircraft jacking up procedure.
3. Aircraft Refueling/Defueling procedure.
4. Removal and Reinstallation of main wings.
5. Removal and Reinstallation of Undercarriage.
6. Removal and Reinstallation of engine.
7. Disassembly and assembly of sub components from engine.
8. Engine ground running procedure.
9. Familiarization with Electrical circuit diagram and circuit tracing.
10. Troubleshooting on various systems of aircraft.

Total Hours: 45

LIST OF EQUIPMENTS

1. Fuel, Water finding paste or capsule.
2. Rotary pump.
3. Container and Clean glass jar.
4. Fuselage support stand.
5. Wing support stand.
6. Engine removal sling.
7. Engine hoist and stand.
8. Engine removal and fitment tools.

U13AEP603	COMPUTATIONAL FLUID DYNAMICS LABORATORY	L	T	P	C
		0	0	3	1

Course Objectives

- Students get expertise in the advanced commercial CFD codes to do internal and external flow simulation.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Simulate and analyze fluid flow using commercial codes like ANSYS fluent, CFX, CFD++, etc.

CO2: Model various geometries using meshing code.

CO3: Mesh various geometries using commercial meshing codes like ICEMCFD, GAMBIT, etc.

CO4: Describe various Turbulence models available in CFD.

CO5: Interpret different boundary conditions for specific problems.

LIST OF EXPERIMENTS

1. Introduction to modeling and meshing using pre-processor.
2. Introduction to solver and postprocessor analysis using computational code.
3. Exercises on Grid independence study and convergence test using simple cases like pipe flow, diffuser flows, flow over cylinder, airfoils etc.
4. Exercises on internal flow simulation of subsonic, sonic and supersonic flows.
5. Exercises on external flow simulation of subsonic, sonic and supersonic flows.
6. Simulation of Internal cold flow with mass addition (simple cases).
7. Simulation of internal hot flow with mass addition (simple cases).
8. Simulation of steady reactive internal flow with mass addition (simple cases on moving boundary problem).
9. Simulation transient unsteady flow with mass addition (simple cases).
10. Simulation of flow over a backward facing step.
11. Simulation of flow over an unsymmetrical aerofoil.
12. Internal flow simulation of a solid rocket motor with Convergent-Divergent nozzle.

Total Hours: 45

U13AEP604	MINI PROJECT	L	T	P	C
		0	0	3	1

Course Objectives

- To provide opportunity for the students to implement their skills acquired in the previous semesters to practical problems.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the knowledge of Mathematics, Science, and fundamentals of Aerodynamics, Structures, and Propulsion to identify and formulate the engineering problems in aerospace applications.

CO2: Create aircraft system component models using CATIA, AutoCAD, etc.

CO3: Conduct experiments by considering the constraints such as economics, environment, health and safety.

CO4: Simulate, analyze and interpret data using software tools such as MATLAB, ANSYS fluent, CFX, CFD++, ICEM CFD, GAMBIT, etc.

CO5: Develop a project planning strategy and work as an individual or as a member on project teams and communicate the results effectively by compiling project reports and presentations.

GUIDELINES

1. Selection of a topic or project title in consultation with project guide.
2. Develop a project planning strategy.
3. If it is an industry-sponsored project, a concurrent letter from industry is required.
4. A maximum of 4 students per group will do the project.
5. The project may be done in one of the labs under the supervision of a guide or in the selected industry.
6. At the end of the project, a report will be written and a technical presentation along with demonstration will be made by the students.
7. The report, project demonstration and technical presentation will be evaluated at the end of the semester.

U13GHP601	HUMAN EXCELLENCE – NATIONAL VALUES	L	T	P	C
		1	0	1	1

Course Objectives

- To produce responsible citizens.
- To uphold our culture and spiritual life.
- To realize the value of unity, service.
- To immunize the body.
- To get Divine peace through inward travel.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Act as a good and responsible citizen.

CO2: Conserve and protect eco cycle.

CO3: Voluntarily work with global welfare organization and provide solution for global peace.

CO4: Invent his/her technical design by considering humanity and nature.

Course Content

RIGHTS AND RESPONSIBLE CITIZENSHIP **5 Hours**

Citizenship – Its significance – Enlightened citizenship – what are the rights to citizenship – Emerging India – Its glory today – Global perspective.

GREATNESS OF INDIAN CULTURE **5 Hours**

Outsiders view about India – about yoga – culture – joint family – morality – service – food – behaviour – attitude – work.

Indian culture and its greatness – dress coding – festivals – food is medicine – games – traditional medicines.

INDIA AND PEACE **5 Hours**

India and Peace – who are the person to participate world peace – India and Spirituality – Great spiritual leaders – Shankarar – Ramanujar – Mathvar – Buddha – Mahaveerar – Vallalar – Ramakrishna paramahamsar – Mathaamirthananthamaayi – Ramanar – Aravindhar – Annai.

INDIA'S MESSAGE TO THE WORLD **5 Hours**

India's message to the world – Thiruvalluvar – Thirukural – Manivasagar – Tiruvasagam – Aravindhar – B.K.S Iyengar – yoga asanas – Sir C.V.Raman, Physics – Ramanujam, Maths – Rabinthranath Tagore, Literature – A.P.J Abdulkalam.

GLOBAL PEACE **3 Hours**

It's role in global peace – Vethathiri maharishi – World peace – Thiruvalluvar – Vallalar – Service and sacrifice – Unity in diversity – Case studies – live examples – National values – Identification and practice.

MEDITATION AND YOGASANAS **7 Hours**

Nine Centre Meditations – Introduction – practice – benefits – Yogasanas-II.

Total Hours: 30

REFERENCES

1. Drunvalo Melchizedek, 'The Ancient Secret of the Flower of Life', Vol. 1, First Edition, Light Technology Publishing, 1999.
2. Dr. M. B. Gurusamy, 'Globalisation – Gandhian Approach', Kumarappa Research Institution, 2001.
3. Vethathiri Maharishi, 'Karma Yoga: The Holistic Unity', The World Community Service Centre, Vethathiri Publications, 1994.
4. Vethathiri Maharishi, 'World Peace', The World Community Service Centre, Vethathiri Publications, 1957.
5. Vethathiri Maharishi, 'Atomic Poison', The World Community Service Centre, Vethathiri Publications, 1983.
6. Vethathiri Maharishi, 'The World Order of Holistic Unity', The World Community Service Centre, Vethathiri Publications, 2003.
7. Swami Vivekananda, 'What Religion Is', Forty First Edition, The Ramakrishna Mission Institute of Culture, 2009.

ELECTIVE I FOR VI SEMESTER

U13GST003	PRINCIPLES OF MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives

- To study the importance and functions of management in an organization.
- To study the importance of planning and also the different types of plan.
- To understand the different types of organization structure in management.
- To understand the basis and importance of directing and controlling in management.
- To understand to the importance of corporate governance and social responsibilities.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand the concepts of management, administration and the evolution of management thoughts.

CO2: Understand and apply the planning concepts.

CO3: Analyze the different organizational structures and understand the staffing process.

CO4: Analyze the various motivational and leadership theories and understand the communication and controlling processes.

CO5: Understand the various international approaches to management.

Course Content

MANAGEMENT CONTEXT **9 Hours**

Management – Definition – Importance – Functions – Skills required for managers – Roles and functions of managers – Science and Art of Management – Management and Administration – Evolution of Classical, Behavioral and Contemporary management thoughts.

PLANNING **9 Hours**

Nature and Purpose – Steps involved in Planning – Forms of Planning – Types of plans – Plans at Individual, Department and Organization level - Managing by Objectives – Forecasting – Purpose – Steps and techniques. Decision-making – Steps in decision making.

ORGANISING **9 Hours**

Nature and Purpose of Organizing – Types of Business Organization – Formal and informal organization – Organization Chart – Structure and Process – Strategies of Departmentation – Line and Staff authority – Benefits and Limitations – Centralization vs De-Centralization and

Delegation of Authority – Staffing – Manpower Planning – Recruitment – Selection – Placement – Induction.

DIRECTING AND CONTROLLING **9 Hours**

Nature and Purpose – Manager vs. Leader – Motivation – Theories and Techniques of Motivation – Leadership – Styles and theories of Leadership – Communication – Process – Types – Barriers – Improving effectiveness in Communication – Controlling – Nature – Significance – Tools and Techniques.

CONTEMPORARY ISSUES IN MANAGEMENT **9 Hours**

Corporate Governance Social responsibilities – Ethics in business – Recent issues – American approach to Management – Japanese approach to Management – Chinese approach to Management – Indian approach to Management.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Tripathy PC and Reddy PN, 'Principles of Management', Fourth Edition, Tata McGraw-Hill, 2008.
2. Dinkar Pagare, 'Principles of Management', Sultan Chand and Sons, 2000.
3. Kanagasapapathi. P, 'Indian Models of Economy, Business and Management', Prentice Hall of India, New Delhi, 2008.
4. G.K.Vijayaraghavan and M.Sivakumar, 'Principles of Management', Fifth Edition Lakshmi Publications, 2009.
5. Harold Koontz and Heinz Weihrich, 'Essentials of Management – An International perspective', Eighth Edition, Tata McGraw-Hill, 2009.
6. Charles W.L. Hill and Steven L McShane, 'Principles of Management', Tata McGraw-Hill, 2009.

U13AEE601	AIRCRAFT MAINTENANCE, REPAIR AND OVERHAUL	L	T	P	C
		3	0	0	3

Course Objectives

- To study the maintenance and repair of welding, plastic and composite components.
- To study the basic concepts of the maintenance and repair of airframe systems and the procedures followed for overhaul of airframe systems.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Identify and maintain the equipments used in welding shop.

CO2: Apply the Inspection and Maintenance procedures for sheet metal, plastics and composite components.

CO3: Apply the Inspection and Maintenance procedures for various aircraft systems.

CO4: Identify the levels of maintenance including overhaul and extent of intervention and critical operations.

CO5: Apply methods of storage and handling of materials in shop floor.

Course Content

WELDING IN AIRCRAFT STRUCTURAL COMPONENTS **4 Hours**

Equipments used in welding shop and their maintenance – Ensuring quality welds – Welding jigs and fixtures – Soldering and brazing.

SHEET METAL REPAIR AND MAINTENANCE **5 Hours**

Inspection of damage – Classification – Repair or replacement – Sheet metal inspection – Nondestructive Testing – Riveted repair design, Damage investigation – reverse technology.

PLASTICS AND COMPOSITES IN AIRCRAFT ` **9 Hours**

Review of types of plastics used in airplanes – Maintenance and repair of plastic components – Repair of cracks, holes etc., and various repair schemes – Scopes – Inspection and Repair of composite components – Special precautions – Autoclaves.

AIRCRAFT JACKING, ASSEMBLY AND RIGGING **9 Hours**

Airplane jacking and weighing and Center of Gravity location – Balancing of control surfaces – Inspection and maintenance – Helicopter flight controls – Tracking and balancing of main rotor.

REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM 9 Hours

Inspection and maintenance of landing gear systems – Inspection and maintenance of air-conditioning and pressurization system, water and waste system – Installation and maintenance of Instruments – Handling – Testing – Inspection.

INSPECTION AND MAINTENANCE OF AUXILARY SYSTEMS 9 Hours

Inspection and maintenance of auxiliary systems – Fire protection systems – Ice protection system – Rain removal system – Position and warning system – Auxiliary Power Units (APUs) SAFETY PRACTICES: Hazardous materials storage and handling – Aircraft furnishing practices – Equipments – Troubleshooting – Theory and practices.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Kroes, Watkins and Delp, 'Aircraft Maintenance and Repair', McGraw-Hill, New York, 1992.
2. Larry Reithmeir, 'Aircraft Repair Manual', Palamar Books, Marquette, 1992.
3. Brimm D.J. and Bogges H.E., 'Aircraft Maintenance', Pitman Publishing corp., New York, 1940.
4. A&P MECHANICS, 'Aircraft Hand Book', FAA Himalayan Book House, New Delhi, 1996.
5. A&P MECHANICS, 'General Hand Book', FAA Himalayan Book House, New Delhi, 1996.

U13AEE602	WIND TUNNEL TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives

- The students are exposed to various types and techniques of aerodynamic data generation on aerospace vehicle configurations in the aerospace industry.
- They are also exposed to design considerations and calibration of various types of wind tunnels.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Design low speed / high speed wind tunnel.

CO2: Measure the flow properties in the wind tunnel.

CO3: Make the model as per the wind tunnel requirement and also do wind tunnel calibration.

CO4: Use various instruments for measuring the flow properties.

CO5: Use non-intrusive instruments to predict the flow diagnostics.

Course Content

PRINCIPLES OF MODEL TESTING **6 Hours**

Scaling law – Buckingham'π' Theorem – Non-Dimensional Numbers – Scale Effect – Types of Similarities – Lift and drag coefficients estimation – Reynolds number correction.

WIND TUNNELS **8 Hours**

Classification – Special problems of Testing in Subsonic, Transonic, Supersonic and Hypersonic speed regions – Layouts – sizing and design parameters.

CALIBRATION OF WIND TUNNELS **11 Hours**

Test section speed – Horizontal buoyancy – Flow angularities – Turbulence measurements – Associated instrumentation – Calibration of supersonic tunnels.

WIND TUNNEL MEASUREMENTS **5 Hours**

Pressure and velocity measurements – Force measurements – Three component and six component balances – Internal balances.

FLOW VISUALIZATION **7 Hours**

Smoke and Tuft grid techniques – Dye injection special techniques – Optical methods of flow visualization – Introduction to Particle image velocimetry, Particle tracking velocimetry – Laser Doppler velocimetry and Hot-wire anemometry.

HIGH SPEED WIND TUNNELS **8 Hours**

Blow down, in draft and induction tunnel layouts and their design features – Transonic, supersonic and hypersonic tunnels and their peculiarities – Helium and gun tunnels, Shock tubes, Cryogenic wind tunnels – Introduction to digital wind tunnel.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Rae, W.H. and Pope, A., 'Low Speed Wind Tunnel Testing', Third Edition, Wiley-Interscience, 1999.
2. Pope, A., and Goin, L., 'High Speed Wind Tunnel Testing', John Wiley Publication, 1985.
3. Justin D. Pereira, 'Wind Tunnels: Aerodynamics, Models and Experiments', Nova Science Publishers, 2011.
4. Susan B. Chaplin, 'Wind Tunnels: Design/Construction, Types and Usage Limitations, Nova Science Publishers, 2013.

U13AEE603	**THEORY OF ELASTICITY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

- To introduce the basic tasks of theory of elasticity and methods of solving the problems.
- To apply the methods of theory of elasticity in technical calculations on the basis of illustrative examples.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Identify stress-strain relation in 3D, principal stress and principal strain.

CO2: Be proficient with basic concepts in continuum mechanics of solids, including of strain, internal force, stress and equilibrium in solids.

CO3: Analyze a structure using Elasticity concepts.

CO4: Use analytical techniques to predict deformation, internal force and failure of simple solids and structural components.

CO5: Solve aerospace-relevant problems in plane strain and plane stress in Cartesian and polar coordinates.

Course Content

ASSUMPTIONS IN ELASTICITY **4 Hours**

Definitions – Notations and sign conventions for stress and strain – Equations of equilibrium.

BASIC EQUATIONS OF ELASTICITY **15 Hours**

Strain-displacement relations – Stress-strain relations – Lame's constant – cubical dilation – Compressibility of material – Bulk modulus – Shear modulus – Compatibility equations for stresses and strains – Principal stresses and principal strains – Mohr's circle – Saint Venant's principle.

PLANE STRESS AND PLANE STRAIN PROBLEMS **8 Hours**

Airy's stress function – Bi-harmonic equations – Polynomial solutions – Simple two-dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams.

POLAR COORDINATES **10 Hours**

Equations of equilibrium – Strain displacement relations – Stress-strain relations – Airy's stress function – Axisymmetric problems – Kirsch-Michell's and Boussinasque problems.

TORSION **8 Hours**

Navier's theory – St. Venant's theory – Prandtl's theory on torsion – Semi-inverse method and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Timoshenko, S. P., and Goodier, J. N., 'Theory of Elasticity', Third Edition, McGraw-Hill Ltd., Tokyo, 1970.
2. Enrico Volterra and J.H. Caines, 'Advanced Strength of Materials', Prentice Hall New Jersey, 1991.
3. Wang, C.T., 'Applied Elasticity', McGraw-Hill Co., New York, 1993.
4. Sokolnikoff, I.S., 'Mathematical Theory of Elasticity', McGraw-Hill, New York, 1978.

U13AEE604	INTRODUCTION TO CRYOGENIC ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives

- To provide the knowledge about the history and applications of cryogenic engineering, properties of cryogenic liquids and solids, refrigeration technologies, air liquefaction process, industrial gas separation and purification system, low power cryocoolers, adiabatic and vacuum technologies, cryogenic liquid storage and transportation, as well as cryogenic measurements.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply classical thermodynamics principles to various cryogenics systems.

CO2: Calculate the rate of heat transfer for various cryogenic systems.

CO3: Design typical cryogenic insulation system for space propulsion.

CO4: Analyze the performance parameters of cryogenic rockets.

CO5: Apply general safety principles to various cryogenics systems.

Course Content

BASIC PRINCIPLES **8 Hours**

Introduction to Cryogenics and superconductivity – Applications of Cryogenics – Common Cryogens and their properties – Cryogenic rockets – Thermodynamic analysis of low-temperature systems – Basic principles of low temperature heat transfer, Cryogenic liquefaction process.

CRYOGENIC HEAT TRANSFER **12 Hours**

Basic modes of heat transfer: conduction, convection and radiation in cryogenic systems in steady and unsteady conditions – Temperature dependent thermal conductivity, Boiling and two phase flow, Pool and film boiling of cryogenic fluids – Thermal contact resistance: Unique problems of heat transfer in cryogenic applications.

Thermo-physical properties of cryogenic systems: PVT behavior of a pure substance – Mechanical properties of materials used in cryogenic systems – Transport properties of solids – thermal properties, emissivity, absorptivity and reflectivity, electrical properties and superconductivity – Prediction of thermodynamic properties, ultra-low temperature refrigerators, cryocoolers.

CRYO INSULATION AND DEVICES **10 Hours**

Storage vessel, thermal shields and insulation, effect of size and shape of storage vessel on heat in-leak, vapour shielding, vacuum insulation, evacuated porous insulation, solid foams, multilayer insulation, composite insulation, critical radius of insulation – micro-sphere insulation, typical insulation systems for space propulsion, aerogel beds, light density Mylar, comparison of insulations.

Cryogenic Instrumentation: strain, displacement and position, pressure, flow, liquid level, density and temperature for cryogenic applications.

Cryogenic Equipments: Introduction of Compressors, pumps, expansion engines, valves, and heat exchangers for cryogenic applications.

PERFORMANCE ANALYSIS OF CRYOGENIC ROCKETS **8 Hours**

Design concepts of cryogenic rockets, selection of propellants and its challenges, boil-off rate, thrust and velocity gain, specific impulse, propellant feed system, tank pressurization and vent system, two-phase flow and heat transfer in reduced gravity, process design parameters, launch-window.

SAFETY WITH CRYOGENIC SYSTEMS **7 Hours**

Introduction – physiological hazards, explosions and flammability, excessive pressure gas, suitability of materials and construction techniques, safety considerations for liquid hydrogen and liquid oxygen – General safety principles.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Thomas M. Flynn, ‘Cryogenic Engineering’, Second Edition, CRC Press, Taylor and Francis Inc., 2004.
2. Barron, R., ‘Cryogenic Systems’ Second Edition, Oxford Science Publications, Oxford University Press, New York, 1985.
3. Barron, R.F, ‘Cryogenic Heat Transfer’, Philadelphia, PA: Taylor and Francis Publishers, 1999.
4. Augustynowicz, S.D. and Fesmire, J.E., “Cryogenic Insulation System for Soft Vacuum”, Advances on Cryogenic Engineering, Vol. 45, Kluwer Academic / Plenum Publishers, pp. 1691-1698, 2000.
5. Mamata Mukhopadhyay, ‘Fundamentals of Cryogenic Engineering’, Prentice Hall India Pvt Ltd., New Delhi, 2010.

U13AEE605	**MODERN FLIGHT CONTROL THEORY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

- To understand the state space model of a dynamic system.
- To know the basics of nonlinear control.
- To study LQR and robust controllers for UAVs.
- To study adaptive controllers and its application to UAVs.
- To learn fuzzy logic and neural network based control methods.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Estimate the states of a dynamic system.

CO2: Design LQR controller for an aircraft/UAV dynamics using MATLAB.

CO3: Design a robust PID controller for an aircraft/UAV dynamics using MATLAB.

CO4: Design model reference adaptive controller for an aircraft/UAV dynamics using MATLAB.

CO5: Tune the parameters of intelligent controllers for aircraft stability.

Course Content

MODERN CONTROL CONCEPTS **12 Hours**

The Concept of State – State Space Formulation – State Space Model of Linear Systems – State Transition Matrix – Eigen Values and Eigen Vectors – Canonical Forms – Controllability and Observability – State Variable Feedback Control by Pole Placement: Direct Comparison, Controllable Canonical form, Ackermann's formula – State Observers: Full-order and Reduced-order Observers – Linearization of Nonlinear Systems with Aircraft model – Perturbation Theory.

OPTIMAL FLIGHT CONTROL **9 Hours**

Types of Optimal Control Problem – Selection of Performance Index – Linear Quadratic Regulator (LQR) – LQR Controller for Unmanned Aerial Vehicles (UAVs) – Kalman filter State Estimation.

ROBUST FLIGHT CONTROL **9 Hours**

Robust Control – System Uncertainty – Internal Model Control – Multivariable H_2 and H_∞ Controls for Aircraft dynamics – Robust Stability and Performance – Robust PID Controller for UAVs.

ADAPTIVE FLIGHT CONTROL **6 Hours**

General Adaptive Flight Control System – MIT Rule – Model Reference Adaptive Flight Control – Self-tuning regulators – Adaptive Controller for UAVs.

INTELLIGENT FLIGHT CONTROL **9 Hours**

Intelligent Flight Control System (IFCS) Structure – Fuzzy Logic based Flight Control – Neural Networks (NN) aided Flight Control – Aircraft Landing Control using Fuzzy Logic and NN – Direct and Indirect Adaptive Flight Controls using NN – Fault tolerant Flight Control System – Introduction to Genetic Algorithms for Flight Control applications.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Roland S. Burns, 'Advanced Control Engineering', Butterworth-Heinemann Publishers, 2001.
2. Marcel Oosterom, "Soft Computing Methods in Flight Control System Design", ISBN 90-8559-060-4, 2005.
3. Kashyapa Narenathreyas, "Fuzzy Logic Control for Aircraft Longitudinal Motion", Master Thesis, Department of Control Engineering, Czech Technical University, January 2013.
4. Chingiz Hajiyev and Sıtkı Yenal Vural, "LQR Controller with Kalman Estimator Applied to UAV Longitudinal Dynamics", Scientific Research Journal, February 2013.
5. Kemin Zhou, John C. Doyle and Keith Glover, 'Robust and Optimal Control', Prentice Hall, 1995.
6. Salah I. Al Swailem, "Application of Robust Control in Unmanned Vehicle Flight Control System Design", PhD Thesis, Cranfield University, March 2004.
7. Zachary Thompson Dydek, "Adaptive Control of Unmanned Aerial Systems", PhD Thesis, Massachusetts Institute of Technology, September 2010.

U13AEE606	INTRODUCTION TO UNMANNED AERIAL VEHICLES AND MICRO AERIAL VEHICLES	L	T	P	C
		3	0	0	3

Course Objectives

- To study the working, design and analysis of various Unmanned/Micro Aerial Vehicle systems.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Prepare preliminary design requirements for an unmanned aerial vehicle.

CO2: Select the suitable components for making unmanned aerial vehicle.

CO3: Perform system testing for unmanned aerial vehicles.

CO4: Integrate various systems of unmanned aerial vehicle.

CO5: Design micro aerial vehicle systems by considering practical limitations.

Course Content

INTRODUCTION TO UNMANNED AIRCRAFT SYSTEMS (UAS) 9 Hours

History, UAS and its applications, Types of UAV, The Systemic Basis of UAS, System Composition, Scope and Limitations, Existing UAV systems, UAS future.

DESIGN OF UAV SYSTEMS 12 Hours

Introduction to Design and Selection of the System, Aerodynamics and Airframe Configurations, Characteristics of Aircraft Types, Payload Types, Launch and Recovery.

DEVELOPMENT OF UAV SYSTEMS 8 Hours

System Development, Certification, Establishing Reliability, System Ground Testing, System In-flight Testing.

DEPLOYMENT OF UAV SYSTEMS 9 Hours

Introduction, Network-Centric Operations (NCO), Teaming with Manned and Other Unmanned Systems, Naval Roles, Army Roles, Air Force Roles, Civilian, Paramilitary and Commercial Roles.

INTRODUCTION TO MICRO AERIAL VEHICLE (MAV) 7 Hours

Evolution of MAV, Bio-inspiration, Design of MAV, Practical implementation and limitations, Future trends and applications.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Thomas Gleason and Paul Fahlstrom, ‘Introduction to UAV Systems’, Fourth Edition, John Wiley and Sons Ltd., 2012.
2. Reg Austin, ‘Unmanned Aircraft Systems: UAVs Design, Development, and Deployment’, First Edition, John Wiley and Sons Ltd., 2010.
3. K. Nonami, F. Kendoul, S. Suzuki, W. Wang, and D. Nakazawa, ‘Autonomous Flying Robots: Unmanned Aerial Vehicles and Micro Aerial Vehicles’, Springer Science, 2010.
4. Tal Shima and Steven J. Rasmussen, ‘UAV Cooperative Decision and Control: Challenges and Practical Approaches’, Society for Industrial and Applied Mathematics, Philadelphia, 2008.

U13GST008	PROFESSIONAL ETHICS	L	T	P	C
		3	0	0	3

Course Objectives

- To create an awareness on Engineering Ethics and its use in one's profession.
- To instill moral values, social values and loyalty.
- To provide an insight into ones professional rights and a view of professional ethics in the global context.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand the ethical theories and concepts.

CO2: Understanding an engineer's work in the context of its impact on society.

CO3: Understand and analyze the concepts of safety and risk.

CO4: Understand the professional responsibilities and rights of Engineers.

CO5: Understand the concepts of ethics in the global context.

Course Content

ENGINEERING ETHICS AND THEORIES **9 Hours**

Definition, Moral issues, Types of inquiry, Morality and issues of morality, Kohlberg and Gilligan's theories, consensus and controversy, Professional and professionalism, moral reasoning and ethical theories, virtues, professional responsibility, integrity, self-respect, duty ethics, ethical rights, self-interest, egos, moral obligations.

SOCIAL ETHICS AND ENGINEERING AS SOCIAL EXPERIMENTATION **9 Hours**

Engineering as social experimentation, codes of ethics, Legal aspects of social ethics, the challenger case study, Engineers duty to society and environment.

SAFETY **9 Hours**

Safety and risk – assessment of safety and risk – risk benefit analysis and reducing risk – the Three Mile Island and Chernobyl case studies – Bhopal gas tragedy.

RESPONSIBILITIES AND RIGHTS OF ENGINEERS **9 Hours**

Collegiality and loyalty – respect for authority – collective bargaining – confidentiality – conflicts of interest – occupational crime – professional rights – employee rights – Intellectual Property Rights (IPR) – discrimination.

GLOBAL ISSUES AND ENGINEERS AS MANAGERS, CONSULTANTS AND LEADERS 9 Hours

Multinational Corporations – Environmental ethics – computer ethics – weapons development – engineers as managers – consulting engineers – engineers as expert witnesses and advisors – moral leadership – Engineers as trend setters for global values.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Mike Martin and Roland Schinzinger, ‘Ethics in Engineering’, McGraw-Hill, New York, 2005.
2. John R. Boatright, ‘Ethics and the Conduct of Business’, Pearson Education, New Delhi. 2003.
3. Bhaskar S., ‘Professional Ethics and Human Values’, Anuradha Agencies, Chennai, 2005.
4. Charles D. Fleddermann, ‘Engineering Ethics’, Pearson Education / Prentice Hall, New Jersey, 2004.
5. Charles E. Harris, Michael S. Protchard and Michael J Rabins, ‘Engineering Ethics – Concepts and Cases’, Wadsworth Thompson Learning, United States, 2000.

SEMESTER VII

U13AET701	COMPOSITE MATERIALS AND STRUCTURES	L	T	P	C
		3	0	0	3

Course Objectives

- To develop an understanding of the linear elastic analysis of composite materials. This understanding will include concepts such as anisotropic material behaviour and the analysis of laminated plates.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Identify the properties of fiber and matrix materials used in commercial composite materials.

CO2: Analyze the structural properties of composite materials.

CO3: Implement composite structures in aerospace design based on knowledge acquired in composites analysis.

CO4: Apply the conventional failure theories to composite materials.

CO5: Select the most appropriate manufacturing process for fabricating composite components based on its requirement.

Course Content

STRESS-STRAIN RELATION **6 Hours**

Introduction – Advantages and application of composite materials, reinforcements and matrices – Generalised Hooke's Law – Elastic constants for anisotropic, orthotropic and isotropic materials.

METHODS OF ANALYSIS **12 Hours**

Micromechanics – Mechanics of materials approach, Elasticity approach to determine material properties – Macro mechanics – Stress-strain relations with respect to natural axis and arbitrary axis – Experimental characterization of lamina.

LAMINATED PLATES **10 Hours**

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

SANDWICH CONSTRUCTIONS **10 Hours**

Basic design concepts of sandwich construction – Materials used for sandwich construction – Failure modes of sandwich panels – Flexural rigidity of Sandwich beams and plates.

FABRICATION PROCESS **7 Hours**

Various open and closed mould processes – Manufacture of fibres – Types of resins and properties and applications – Netting analysis.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Autar K. Kaw, 'Mechanics of Composite Materials', Second Edition, First Indian Reprint, CRC Press, 2009.
2. Jones, R.M., 'Mechanics of Composite Materials', McGraw-Hill, Kogakusha Ltd., Tokyo, 1999.
3. Lalit Gupta, 'Advanced Composite Materials', Revised Edition, Fourth Reprint, Himalayan Books, 2007.
4. Alan Baker, Stuart Dutton, and Donald Kelly, 'Composite Materials for Aircraft Structures', Second Edition, AIAA, 2004.
5. Agarwal, B.D., and Broutman, L.J., 'Analysis and Performance of Fibre composites', Third Edition, Wiley India Pvt. Ltd., 2012.

U13AET702	AVIONICS	L	T	P	C
		3	0	0	3

Course Objectives

- To know about the functioning of avionics systems in civil and military aircrafts.
- To know the architectures for integrating avionics systems.
- To know about the modern technology in cockpit display systems.
- To know the basic concepts in aircraft communication and navigation.
- To learn the fundamentals of Radar systems.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Prepare preliminary design requirements for avionics systems.

CO2: Integrate avionics systems using data buses.

CO3: Analyze the performance of various cockpit display technologies.

CO4: Formulate navigation algorithms for Aerospace vehicles.

CO5: Design autopilot for small aircrafts using MATLAB.

Course Content

INTRODUCTION TO AVIONICS **4 Hours**

Need for Avionics in civil, military aircrafts and space systems – Typical Avionics Systems – Avionics Systems Integration – Avionics System Requirements – Avionics System Environment.

DIGITAL AVIONICS ARCHITECTURE **12 Hours**

Digital System Concepts – Digital Computers – Avionics System Architectures: First Generation to Fourth Generation – Avionic Data Buses: MIL-STD-1553B – ARINC 429 – ARINC 629 – Avionics Full-Duplex Switched Ethernet.

COCKPIT DISPLAYS AND CONTROL **6 Hours**

Display Technologies: CRT, LED, LCD, EL and Plasma panel – Civil Cockpit and Military Cockpit displays: MFD, HUD, HMD and Virtual Cockpit, HDD, Synthetic Vision Display, Moving Map Color Display, Intelligent Display System, Virtual Retinal Display – Data Entry and Control: Touch Screen, Direct Voice Input (DVI) and Speech Recognition, HOTAS, VTAS.

COMMUNICATION AND NAVIGATION SYSTEMS **13 Hours**

Communication Systems: Radio Frequency Spectrum, HF, VHF, UHF, SATCOM, ATC Transponder and Interrogator, TCAS, GPWS, and ADS-B – Navigation Systems:

Classification, VOR/DME, LORAN, RNAV, Doppler and Inertial Navigation, Satellite Navigation, Hybrid Navigation – Approach and Landing aids: ILS, GLS and MLS.

FLIGHT CONTROL SYSTEMS (FCS) 6 Hours

Flight controls: Primary and Secondary controls, Mechanical, Hydro mechanical, Fly-by-Wire, Fly-by-Light FCS – Autopilot Systems: Lateral and Longitudinal autopilots – Autopilot Design Examples.

RADAR AND ELECTRONIC WARFARE 4 Hours

Radar: Basics and Principles, Radar Altimeter, Weather Radar, Doppler radar – Electronic Warfare: ECM, ECCM and ESM Techniques.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. R. P. G. Collinson, ‘Introduction to Avionics Systems’, Third Edition, Springer Science, London, 2011.
2. Cary R. Spitzer (Ed.), Uma Ferrell (Ed.) and Thomas Ferrell (Ed.), ‘Digital Avionics Handbook’, Third Edition, CRC Press, 2014.
3. Cary R. Spitzer, ‘Digital Avionics Systems: Principles and Practice’, Second Edition, The Blackburn Press, 2001.
4. Ian Moir, Allan Seabridge and Malcolm Jukes, ‘Civil Avionics Systems’, Second Edition, Wiley, 2013.
5. Mike Tooly and David Wyatt, ‘Aircraft Communications and Navigation Systems: Principles, Maintenance and Operation’, Butterworth-Heinemann’s Series, 2007.
6. John H. Blakelock, ‘Automatic Control of Aircraft and Missiles’, Second Edition, Wiley-Inter Science Publications, 1991.
7. Mohinder Singh, ‘Electronic Warfare’, Popular Science and Technology Series, 1988.

U13AET703	SPACE MECHANICS AND MISSILE TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives

- To study the various coordinate systems for space applications.
- To know the planetary laws and orbital elements.
- To study the motion of artificial satellites, interplanetary space probes and ballistic missiles using two-body problem.
- To learn the various methods of satellite orbit transfer.
- To study the dynamics of rockets and cruise missiles.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Estimate the trajectory/orbit of a space vehicle or a satellite in a suitable coordinate system.

CO2: Calculate the delta-v required for transferring a spacecraft from one orbit to another.

CO3: Perform orbit perturbation analysis for satellite orbits.

CO4: Design a trajectory and estimate the amount of propellant required for interplanetary and lunar missions.

CO5: Analyze the performance of ballistic missiles and cruise missiles.

Course Content

INTRODUCTION TO SPACE MECHANICS **6 Hours**

The Solar System – Earth's atmosphere and its properties – The Celestial Sphere – The Ecliptic – Right Ascension – Declination – Equinoxes and Solstices – Sidereal Time – Solar Time – Coordinate Systems for Space applications – Kepler's Laws – Orbital Elements.

TWO-BODY MOTION AND ORBITAL MANEUVERS **12 Hours**

Two-body Problem – Orbit equation – Space vehicle trajectories: Basic aspects, Circular orbits, Elliptical orbits, Parabolic Orbits, Hyperbolic Orbits – Kepler's Equation and Time of Flight – Orbital Maneuvers: In-plane orbit changes, Hohmann Transfer, Bielliptical Transfer, Out-of-plane orbit changes, Propulsion for maneuvers – Orbit Perturbations – Special and General Perturbations Methods – Example Problems.

INTERPLANETARY AND LUNAR TRAJECTORIES **9 Hours**

Patched Conic Approximation – Sphere of Influence – Simplified example – Realistic Interplanetary mission – Locating the planets – Design of departure and arrival trajectories –

Gravity-Assist maneuvers – Design of Lunar Trajectory – Departure and arrival lunar trajectories – Example Problems.

BALLISTIC MISSILE TRAJECTORIES 9 Hours

General Ballistic Missile Problem – Geometry of Ballistic Missile Trajectory – Free-flight Range – Flight-path Angle – Maximum Range Trajectory – Time of Free-Flight – Re-entry conditions – Effect of Launching Errors – Influence Coefficients – Effect of Earth Rotation – Example Problems.

SPACE ENVIRONMENT AND MISSILE TECHNOLOGY 9 Hours

Space Environment – Peculiarities – Effect of Space Environment on Spacecraft materials and orbit – Classification of Missiles – Airframe Components of Missile – Missile Aerodynamic Forces – Body Upwash and Downwash in Missiles – Description of Vertical, Inclined and Gravity Turn Trajectories – Determination of Burnout range and Altitude – Simple Approximations to Burnout Velocity – Vehicle Optimization – Separation Dynamics and Techniques.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Charles D. Brown, ‘Elements of Spacecraft Design’, First Edition, AIAA Education Series, 2002.
2. Roger R. Bate, Donald D. Mueller, and Jerry E. White, ‘Fundamentals of Astrodynamics’, Dover Publications Inc., New York, 1971.
3. Vladimir A. Chobotov, ‘Orbital Mechanics’, Third Edition, AIAA Education Series, 2002.
4. Howard D. Curtis, ‘Orbital Mechanics for Engineering Students’, Third Edition (Revised), Butterworth-Heinemann, 2013.
5. David A. Vallado and James Wertz (Ed.), ‘Fundamentals of Astrodynamics and Applications’, Fourth Edition, Microcosm Press, 2013.
6. Martin J. L. Turner, ‘Rocket and Spacecraft Propulsion: Principles, Practice and New Developments’, Third Edition, Springer, 2009.
7. George P. Sutton and Oscar Biblarz, ‘Rocket Propulsion Elements’, Eighth Edition, John Wiley and Sons Inc., New York, 2010.
8. J.W. Cornelisse, H.F.R Schoyer, and K.F. Wakker, ‘Rocket Propulsion and Spaceflight Dynamics’, Pitman Publishing Limited, London, 1979.

U13AET704 FLIGHT VEHICLE DESIGN

L	T	P	C
3	0	0	3

Course Objectives

- To familiarize students with the important issues and methodologies of aircraft design.
- To illustrate the process of aircraft synthesis as an outcome of the integration of the disciplines of aerodynamics, performance, stability and control, propulsion, structures and aero elasticity.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Conduct trade-off between the conflicting demands of different disciplines by performing a detailed preliminary design of a complete aircraft.

CO2: Select the wing planform based on the mission requirements.

CO3: Design the control surfaces based on the stability requirements.

CO4: Estimate weight, wing loading and other performance parameters related to conceptual design of a complete aircraft.

CO5: Select the appropriate power plant for the aircraft and Identify design features of aerospace structures, and calculate load factors.

Course Content

CONCEPTUAL AIRCRAFT DESIGN **7 Hours**

Design process, flow chart, survey of various types of airplanes, over-view of design process – Airplane configuration description – Take-off weight – Preliminary Estimate – Spread sheet approach.

PRELIMINARY AERODYNAMIC DESIGN **8 Hours**

Selection of wing loading – Initial Airplane layout – Three view drawings – Arrangement of surfaces, mass, moment and inertia properties and balance diagram – Wing loading effect on take-off, landing, climb, acceleration, range, combat, flight ceiling, and glide rate – Spread sheets.

DESIGN OF WING, FUSELAGE AND TAIL **9 Hours**

Main plane: Airfoil cross-section shape, taper ratio selection, sweep angle selection, wing drag estimation – Spread sheet for wing design.

Fuselage: Volume consideration, quantitative shapes, air inlets, wing attachments – Aerodynamic considerations and drag estimation – Spread sheets.

Tail arrangements: Horizontal and vertical tail sizing – Tail planform shapes – Airfoil selection type – Tail placement – Spread sheets for tail design.

DESIGN OF PROPULSION SYSTEM **5 Hours**

Propulsion selection, thrust to weight ratio, number of engines, engine rating, turbo-jet engine sizing – Installed thrust corrections, spread sheets – Propeller propulsive systems – Propeller design for cruise, static thrust – Turboprop propulsion – Piston and turbo-prop sizing – Propeller spread sheets.

PERFORMANCE ESTIMATION **8 Hours**

Take-off phases, minimum take-off specification, climb gradients – Balanced field length – Landing approach – Free roll and braking – Spread sheet for take-off and landing distance – Enhance lift considerations – passive lift enhancement, trailing edge flap configuration, lift and drag determination – Active lift enhancement, Drag polar, Power to climb.

Static Stability: Control surface sizing – Effect of static margin on performance, Lateral and directional static stability – Contribution of airframe components – Aileron sizing, Rudder area sizing.

STRUCTURAL DESIGN **8 Hours**

Estimation of loads on complete aircraft components – Structural design of fuselage, wings and undercarriages, controls, connections and joints – Materials for modern aircraft – Methods of analysis, testing and fabrication.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Thomas C Corke, ‘Design of Aircraft’, Pearson Education, 2003.
2. John P Fielding, ‘Introduction to Aircraft Design’, Cambridge University Press, 1999.
3. Darrol Stinton D., ‘The Design of the Aeroplane’, Second Edition, Black Well Science, 2001.
4. Daniel P. Raymer, ‘Aircraft Design: A Conceptual approach’, Fifth Edition, AIAA Education Series, 2012.

U13AEP701	PROJECT WORK – PHASE-I	L	T	P	C
		0	0	6	0

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the knowledge of Mathematics, Science, and fundamentals of Aerodynamics, Structures, Propulsion and Avionics to identify, formulate and analyze complex engineering problems in aerospace applications.

CO2: Develop a project planning strategy.

CO3: Create aircraft system component models using CATIA, AutoCAD, etc.

CO4: Conduct experiments, analyze and interpret data by applying appropriate techniques, utilizing available resources and software tools.

CO5: Work as an individual or as a member on project teams and communicate the results effectively by compiling project reports and presentations.

GUIDELINES

1. Selection of a topic or project title in consultation with project guide.
2. Develop a project planning strategy.
3. If it is an industry-sponsored project, a concurrent letter from industry is required.
4. A maximum of 4 students per group will do the project.
5. The project may be done in one of the labs under the supervision of a guide or in the selected industry.

U13AEP702	AIRCRAFT DESIGN PROJECT PHASE-II	L	T	P	C
		0	0	3	1

LIST OF EXPERIMENTS

1. V-n diagram for the design study.
2. Gust and maneuverability envelopes.
3. Critical loading performance and final V-n graph calculation.
4. Structural design study – Theoretical approach.
5. Load estimation of wings.
6. Load estimation of fuselage.
7. Balancing and maneuvering loads on tail plane, Aileron and Rudder loads.
8. Detailed structural layouts.
9. Design of some components of wings, fuselage.
10. Preparation of a detailed design report with CAD drawings.

Total Hours: 45

U13AEP703	AVIONICS LABORATORY	L	T	P	C
		0	0	3	1

Course Objectives

- To study the logic gates and basic digital circuits.
- To verify the working of simple digital circuits.
- To execute and verify assembly language programs for various applications with 8085 microprocessor.
- To understand the data communications in MIL-STD-1553B data bus.
- To understand the data communications in ARINC 429 data bus.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Design and analyze complex digital circuits.

CO2: Develop and execute assembly language programs using 8085 for any applications.

CO3: Interface and control stepper motors using 8085 microprocessor.

CO4: Integrate avionic systems using MIL-STD-1553B data bus.

CO5: Integrate avionic systems using ARINC 429 data bus.

LIST OF EXPERIMENTS

DIGITAL ELECTRONICS **12 Hours**

1. Design and Implementation of 4-bit adder and subtractor circuit using IC 7483 and IC 7486.
2. Implementation of Multiplexer and Demultiplexer circuits.
3. Implementation of Encoder and Decoder circuits.
4. Design and Implementation of 4-bit shift register with D-flip flops using IC 7474.

MICROPROCESSOR PROGRAMMING **18 Hours**

5. Program to add two 8-bit and two 16-bit numbers (Hexadecimal and decimal).
6. Program to subtract two 8-bit and two 16-bit numbers.
7. Program to find a largest number from a series of numbers.
8. Program to arrange an array of data in ascending and descending order.
9. Program to transfer a block of data.
10. Program to interface and control a stepper motor.

INTEGRATED AVIONICS (DATA BUSES) **15 Hours**

11. Message transfer from Bus Controller (BC) to a Remote Terminal (RT) and RT to BC with MIL-STD-1553B data bus.

12. Message transfer from one RT to another RT and BC to all RTs with MIL-STD-1553B data bus.
13. Message transfer from one RT to all other RTs with MIL-STD-1553B data bus.
14. Normal message transfer and Broadcast message transfer with Mode Code examples in MIL-STD-1553B data bus.
15. Message transfer in BCD and BNR formats and File transfer with ARINC 429 data bus.

Total Hours: 45

LIST OF EQUIPMENTS

1. Digital Logic Trainer / Bread board Kit.
2. 8085 Microprocessor Kit.
3. MIL-STD-1553B Interface Cards (Including Data bus and Accessories).
4. ARINC 429 Interface Cards (Including Data bus and Accessories).
5. Bus couplers.

U13AEP704	**AIRFRAME AND AERO ENGINE MAINTENANCE LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1**

LIST OF EXPERIMENTS

AIRFRAME MAINTENANCE

1. Welded patch repair by TIG, MIG and Riveting.
2. Removal and fitment of wings.
3. Removal and fitment of Empennage.
4. Removal and fitment of undercarriage.
5. Brake unit Removal and fitment.

AERO ENGINE MAINTENANCE

6. Stripping of a piston engine and reassembly.
7. Piston Engine - cleaning, visual inspection, and NDT checks.
8. Piston Engine Components - dimensional checks.
9. Propeller Pitch Setting and balancing.
10. Jet Engine – Identification of components and defects.
11. Piston and Jet Engine starting procedure.

Total Hours: 45

LIST OF EQUIPEMENTS

1. Stand for empennage.
2. Piston Engine.
3. Jet Engine.
4. Standard tools for dismantling and assembly.
5. Non-destructive Testing equipment.

U13GHP701	HUMAN EXCELLENCE – GLOBAL VALUES	L	T	P	C
		1	0	1	1

Course Objectives

- To realize global brotherhood and protect global.
- To know the youths participation in politics.
- To know importance of retain of our culture and Maintain.
- To know impact of global terrorism.
- To know the current economic status among the youths.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Behave as responsible human beings respecting the global values.

CO2: Acquire knowledge on the complex patterns involved in maintaining world's peace and ecological balance.

CO3: Demonstrate skills required for the emergency of mono-culture at the global level.

CO4: To learn about Man is the cause and Man is the solution.

Course Content

GLOBAL BROTHERHOOD AND PROTECT GLOBE **5 Hours**

Global values – Understanding and identification – Its importance – Racial discrimination and solution.

MAN IS THE CAUSE AND MAN IS THE SOLUTION **5 Hours**

Ecological imbalance – global warming – rain fall – status – acid rain – plastic usage – control – Political upheavals – nowadays political status – basic rights to citizen – corruption – youths participate in politics – M.K.Stalin – Kanimozhi – Rahul Gandhi.

GREATNESS OF CULTURE **5 Hours**

Social inequality and solution – live case discussions and debate – black money – poverty people – Cultural degradation – live case discussions and debate – difference between Indian culture and western culture – Impact of western culture in India – How to retain our culture and solution.

EMERGENCE OF MONOCULTURE **4 Hours**

Emergence of monoculture – solution – Global terrorism – Its cause and effect – solution.

MARGINALIZATION OF GLOBAL ECONOMIC **4 Hours**

Economic marginalization and solution – its impact in the globe – globalization in market – its effect in local market – merits – demerits of globalization – Man is the cause and man is the solution.

MEDITATION AND YOGASANAS **7 Hours**

Nithyananda Meditation and Divine Meditation – Introduction – practice – benefits – Yogasanas–III.

Total Hours: 30

REFERENCES

1. Vethathiri Maharishi, 'World Peace', The World Community Service Centre, Vethathiri Publications, 1957.
2. 'Prosperous India' by Swami Vivekananda.
3. Vethathiri Maharishi, 'Samuka Chikkalkalukkana Aaivuth Theervukal', Vethathiri Publications.
4. Vethathiri Maharishi, 'World Community Life', Vethathiri Publications.

ELECTIVE II FOR VII SEMESTER

U13GST004	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

Course Objectives

- To apply knowledge of OR techniques to domain specific industrial situations to optimize the quality of decisions.
- To conduct investigations by the use of OR techniques.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply linear programming model and assignment model to domain specific situations.

CO2: Analyze the various methods under transportation model and apply the model for testing the closeness of their results to optimal results.

CO3: Apply the concepts of PERT and CPM for decision making and optimally managing projects.

CO4: Analyze the various replacement and sequencing models and apply them for arriving at optimal decisions.

CO5: Analyze the inventory and queuing theories and apply them in domain specific situations.

Course Content

LINEAR MODEL **9 Hours**

The phases of OR study – formation of an L.P model – graphical solution – simplex algorithm – artificial variables technique (Big M method, two phase method) – duality in simplex.

TRANSPORTATION AND ASSIGNMENT MODELS **9 Hours**

Transportation model: Initial solution by North West corner method – least cost method – VAM – Optimality test – MODI method and stepping stone method.

Assignment model: Formulation – balanced and unbalanced assignment problems.

PROJECT MANAGEMENT BY PERT AND CPM **9 Hours**

Basic terminologies – Constructing a project network – Scheduling computations – PERT – CPM – Resource smoothening, Resource leveling, PERT cost.

REPLACEMENT AND SEQUENCING MODELS **9 Hours**

Replacement models: Replacement policies – Replacement of items that deteriorate with time (value of money not changing with time) – Replacement of items that deteriorate with time (Value of money changing with time) – Replacement of items that fail suddenly (individual and group replacement policies).

Sequencing models: n job on 2 machines – n jobs on 3 machines – n jobs on m machines, Traveling salesman problem.

INVENTORY AND QUEUING THEORY **9 Hours**

Variables in inventory problems, EOQ, deterministic inventory models, order quantity with price break, techniques in inventory management.

Queuing system and its structure – Kendall's notation – Common queuing models - M/M/1: FCFS/∞/∞ - M/M/1: FCFS/n/∞ - M/M/C: FCFS/∞/∞ - M/M/1: FCFS/n/m.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Hamdy A. Taha, 'Operations Research: An Introduction', Eighth Edition, Pearson Education India, 1982.
2. Hira and Gupta, 'Introduction to Operations Research', S.Chand and Co., 2002.
3. Hira and Gupta, 'Problems in Operations Research', S.Chand and Co., 2008.
4. Wagner, 'Operations Research', Prentice Hall of India, 2000.
5. S.Bhaskar, 'Operations Research', Second Edition, Anuradha Agencies, 2004.

U13GST005	ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives

- To acquire knowledge of economics to facilitate the process of economic decision making.
- To acquire knowledge on basic financial management aspects.
- To develop the skills to analyze financial statements.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Evaluate the economic theories, cost concepts and pricing policies.

CO2: Understand the market structures and integration concepts.

CO3: Understand the measures of national income, the functions of banks and concepts of globalization.

CO4: Apply the concepts of financial management for project appraisal.

CO5: Understand accounting systems and analyze financial statements using ratio analysis.

Course Content

ECONOMICS, COST AND PRICING CONCEPTS 9 Hours

Economic theories – Demand analysis – Determinants of demand – Demand forecasting – Supply – Actual cost and opportunity cost – Incremental cost and sunk cost – Fixed and variable cost – Marginal costing – Total cost – Elements of cost – Cost curves – Breakeven point and breakeven chart – Limitations of break even chart – Interpretation of break even chart – Contribution – P/V-ratio, profit-volume ratio or relationship – Price fixation – Pricing policies – Pricing methods.

CONCEPTS ON FIRMS AND MANUFACTURING PRACTICES 9 Hours

Firm – Industry – Market – Market structure – Diversification – Vertical integration – Merger – Horizontal integration.

NATIONAL INCOME, MONEY AND BANKING, ECONOMIC ENVIRONMENT 9 Hours

National income concepts – GNP – NNP – Methods of measuring national income – Inflation – Deflation – Kinds of money – Value of money – Functions of bank – Types of bank – Economic liberalization – Privatization – Globalization.

CONCEPTS OF FINANCIAL MANAGEMENT **9 Hours**

Financial management – Scope – Objectives – Time value of money – Methods of appraising project profitability – Sources of finance – Working capital and management of working capital.

ACCOUNTING SYSTEM, STATEMENT AND FINANCIAL ANALYSIS **9 Hours**

Accounting system – Systems of book-keeping – Journal – Ledger – Trail balance – Financial statements – Ratio analysis – Types of ratios – Significance – Limitations.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Prasanna Chandra, 'Financial Management Theory and Practice', Eighth Edition, Tata McGraw-Hill, 2011.
2. J. Fred Weston, Scott Besley, and Eugene F. Brigham, 'Essentials of Managerial Finance', Dryden Press, 1996.
3. Pandey, I. M., 'Financial Management', Eleventh Edition, Vikas Publishing House Pvt. Ltd., 2014.
4. James C. Van Horne and John Martin Wachowicz, 'Fundamentals of Financial Management', Thirteenth Edition, Prentice Hall, 2008.
5. James C. Van Horne, 'Financial Management and Policy', Twelfth Edition, Prentice Hall, 2002.
6. M. Y. Khan and P. K. Jain, 'Management Accounting: Text, Problems and Cases', Tata McGraw-Hill Education, 2006.
7. P. Saravanavel, 'Management Accounting – Principles and Practice', Sultan Chand and Sons, 1997.

U13AEE701	PRINCIPLES OF COMBUSTION	L	T	P	C
		3	0	0	3

Course Objectives

- To provide students with an understanding of the basic principles associated with combustion processes, how these concepts relate to experimental observations and how they can be used for theoretical and/or numerical modelling.
- To understand the basics of combustion kinetics and mechanisms.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the basic principles of combustion thermodynamics concepts into various engineering systems.

CO2: Compute adiabatic flame temperatures of multi-component gas mixtures with dissociation of the products.

CO3: Formulate the reaction mechanism by applying chemical kinetic principle.

CO4: Measure the flame speed and flame structure by using classical laminar flame theories.

CO5: Evaluate the combustion characteristics for Solid propellant.

Course Content

INTRODUCTION **10 Hours**

General Objectives of Combustion Modeling, Classification of Combustion Problems. General Structure of a Theoretical Model, Governing Equations for Combustion Modeling (Conservation and Transport Equations), Some Common Assumptions made in Combustion Models.

REVIEW OF CHEMICAL THERMODYNAMICS: Criteria for Thermodynamics equilibrium, Conservation of Atomic Species, Mole and Mass Fractions, Equivalence Ratio, Thermochemical Laws, Relationship between Bond Energies and Heats of Formation, Heats of Reaction for Constant-Pressure and Constant-Volume Combustion, Energy Balance Considerations for Flame Temperature Calculations, Equilibrium Constants, The Clausius Clapeyron Equation for Phase Equilibrium.

CHEMICAL KINETICS AND REACTION MECHANISMS **8 Hours**

Rates of Reactions and Their Functional Dependence, Total Collision Frequency, Equation of Arrhenius, Rates of Reaction, Methods for Measurement of Gas-Phase Reaction Rates, One-Step Chemical Reactions of Various Orders, Chain Reactions, Surface Reactions, Reaction

Flow Analysis, Gas-Phase Reaction Mechanisms of Aliphatic Hydrocarbon and Oxygen System, Formation Mechanism of Nitrogen Oxides, Formation and Control of CO and Particulates.

MULTICOMPONENT REACTING SYSTEMS 8 Hours

Conservation Equations for Multicomponent Reacting Systems: Definitions of Concentrations, Velocities, and Mass Fluxes, Fick's Law of Diffusion, Theory of Ordinary Diffusion in Gases at Low Density, Continuity Equation and Species Mass Conservation Equations, Conservation of Momentum, Momentum Equation Derivation By Infinitesimal Control Volume Approach, Navier-Stokes Equations, Conservation of Energy, Physical Derivation of the Multicomponent Diffusion Equation, Solution of a Multicomponent-Species System, Shvab-Zel'dovich Formulation, Dimensionless Ratios of Transport Coefficients, Boundary Conditions at an Interface.

PHYSICS OF FLAMES 12 Hours

Detonation and Deflagration Waves of Premixed Gases. Qualitative Differences between Detonation and Deflagration, Brief description about the Hugonoit Curve, Determination of Chapman-Jouguet Detonation-Wave Velocity, Detonation-Wave Structure, The Mechanism of Deflagration-to-Detonation Transition (DDT) in Gaseous Mixtures, Spontaneous Detonation Initiation, Functional Form of Distribution of Ignition Delay.

Premixed Laminar Flames: Flame Speed Measurement Methods, Diagnostic Method for Flame Structure Measurements. Classical Laminar Flame Theories. Effect of Chemical and Physical Variables on Flame Speed. Flame Quenching, Flammability Limits of Premixed Laminar Flames, Spalding's Theory of Flammability Limits and Flame Quenching.

Gaseous Diffusion Flames and Combustion of a Single Liquid Fuel Droplet: Burke and Schumann's Theory of Laminar Diffusion Flames, Laminar Jet with Chemical Reactions, Numerical Solution of Two Dimensional Axisymmetric Laminar Diffusion Flames, Evaporation of a Single Fuel Droplet, Droplet Combustion in Quiescent Environments.

COMBUSTION CHARACTERISTICS OF PROPELLANTS 7 Hours

Basic understanding on Solid Propellants and Their Combustion Characteristics, Thermal Decomposition and Combustion of Nitramines, Burning Behavior of Homogeneous Solid Propellants, Chemically Reacting Boundary-Layer Flows, Ignition and Combustion of Single Energetic Solid Particles, Combustion of Solid Particles in Multiphase Flows. Basic understanding on the burning characteristics of liquid and cryogenic propellants. Applications of Turbulent and Multi-Phase Combustion.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Kenneth Kuan-yun Kuo, ‘Principles of Combustion’, Second Edition, ISBN: 978-0-471- 04689-9, January 2005.
2. Kenneth Kuan-yun Kuo and Ragini Acharya, ‘Fundamentals of Turbulent and Multi-Phase Combustion’, ISBN: 978-0-470-22622-3, March 2012.
3. Kenneth Kuan-yun Kuo and Ragini Acharya, ‘Applications of Turbulent and Multi-Phase Combustion’, ISBN: 978-1-118-12756-8, April 2012.
4. Harrje, D.T., and Reardon F.H., “Liquid Propellant Rocket Combustion Instability”, NASA SP-194, NASA Washington, 1972.
5. Yang,V., and Anderson, W., “Liquid Rocket Engine Combustion Instability”, Progress in Astronautics and Aeronautics”, Vol.169, AIAA Inc., Washington, 1995.

U13AEE702	INDUSTRIAL AND EXPERIMENTAL AERODYNAMICS	L	T	P	C
		3	0	0	3

Course Objectives

- To know the basics of winds, atmosphere and its causes.
- To acquire knowledge about application of wind energy collectors and non-aeronautical uses of aerodynamics.
- To know the fundamentals of wind tunnel model measurements.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Identify the Atmospheric boundary layer and applications of wind energy collectors.

CO2: Analyze the aerodynamics of road vehicles, buildings and problems of flow induced vibrations.

CO3: Use measurement techniques involved in Aerodynamic testing.

CO4: Analyze the model measurements, Lift and drag measurements through various techniques and testing of different models.

CO5: Apply the Wind tunnel boundary corrections and Scale effects.

Course Content

ATMOSPHERE **7 Hours**

Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows.

WIND ENERGY COLLECTORS **6 Hours**

Horizontal axis and vertical axis machines – Power coefficient – Betz coefficient by momentum theory.

VEHICLE AND BUILDING AERODYNAMICS **9 Hours**

Power requirements and drag coefficients of Automobiles, Aerodynamics of Ground Vehicles and Hovercraft**.**

Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, building codes, building ventilation and Architectural aerodynamics.

FLOW INDUCED VIBRATIONS **6 Hours**

Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, galloping and stall flutter.

MODEL MEASUREMENTS **9 Hours**

Mounting of models, rigidity – Measurement of interference – Lift and drag measurements through various techniques – Testing procedures. Testing: 3-D wings, controls, complete model, power effects, aero elasticity, dynamic stability – Testing with ground plane, testing wind mill generator – Testing engines, Jettison tests – Data reduction, Data correction.

WIND TUNNEL BOUNDARY CORRECTIONS AND SCALE EFFECTS **8 Hours**

Effects of lateral boundaries, Method of images, Wall corrections, Effects of Buoyancy, Solid Blocking, Wake Blocking – General downwash correction – Lift interference correction – Corrections for reflection plane models – Scale effects on aerodynamic characteristics and stability derivatives.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Jewel B. Barlow, William H RAE, Jr. and Alan Pope, ‘Low speed Wind Tunnel Testing’, John Wiley and Sons, 1999.
2. M. Sovran (Ed.), ‘Aerodynamics and Drag Mechanisms of Bluff bodies and Road Vehicles’, Plenum Press, New York, 1978.
3. P. Sachs, ‘Winds Forces in Engineering’, Pergamon Press, 1978.
4. N. G. Calvent, ‘Wind Power Principles’, Charles Griffin and Co., London, 1979.

U13AEE703	**GUIDANCE, NAVIGATION AND CONTROL**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

- To know the basic concepts of guidance, navigation, and control (GNC) of aerospace vehicles.
- To study the performance of tracking Radars.
- To study various navigation methods for flight vehicles.
- To study the guidance algorithms for aerospace vehicles.
- To learn the control algorithms for UAVs and missiles.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Select suitable coordinate system for aerospace vehicle guidance and navigation.

CO2: Analyze the performance of tracking Radars.

CO3: Formulate integrated navigation algorithms for UAVs and Missiles.

CO4: Formulate guidance laws for aerospace vehicles.

CO5: Design and analyze autopilot control systems for guided missiles and UAVs.

Course Content

INTRODUCTION **8 Hours**

Basics of Guidance, Navigation and Control (GNC) of Aerospace vehicles – Guidance Law – Guidance Process – Missile Guidance Concept – Missile Seeker – Missile-Target relative motion and Line-of-Sight (LOS) – Coordinate Systems and Transformation – Input-Output Transfer Function.

RADAR TARGET TRACKING **9 Hours**

Radar Basics – Moving Target Indication (MTI) Radar – Limitation of MTI Radar performance – Airborne MTI (AMTI) Radar – Pulse Doppler Radar – Tracking Radar: Tracking Servo mechanism, Sequential Lobing, Conical Scan, Mono-pulse Tracking: Amplitude comparison and Phase comparison tracking.

NAVIGATION SYSTEMS FOR GUIDANCE **10 Hours**

Gyros and Stabilized platforms – Principles of Inertial Sensors – Inertial Navigation System (INS): Stabilized platform and Strapdown mechanisms – Global Positioning System (GPS) – Vision-based Navigation – Waypoint Navigation – Integrated INS/GPS and Kalman Filter.

GUIDANCE SYSTEMS AND ALGORITHMS **9 Hours**

Beam Rider Guidance – Homing Guidance – Inertial Guidance – Ranging Navigation Guidance – Laser based Guidance – Imaging Infrared Guidance – Proportional Navigation (PN) Guidance – Augmented PN Guidance – Command Guidance – Waypoint Guidance.

CONTROL SYSTEMS **9 Hours**

Integrated Guidance and Control – Control of Aerodynamic Missiles – Missile Autopilot – Autopilot for UAVs – Vanguard Control System – Director Fire Control System – Tracking Control laws.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Rafael Yanushevsky, 'Modern Missile Guidance', CRC Press, 2007.
2. George M. Siouris, 'Missile Guidance and Control Systems', Springer-Verlag Inc., 2004.
3. Merrilh I. Skolnik, 'Introduction to Radar Systems', Third Edition, Tata McGraw-Hill, 2002.
4. Mohinder S. Grewal, Lawrence R. Weill and Angus P. Andrews, 'Global Positioning Systems, Inertial Navigation, and Integration', Second Edition, John Wiley and Sons, 2007.
5. Rafael Yanushevsky, 'Guidance of Unmanned Aerial Vehicles', CRC Press, 2011.
6. John H. Blakelock, 'Automatic Control of Aircraft and Missiles', Second Edition, Wiley-Inter Science Publication, 1991.
7. Ching-Fang Lin, 'Modern Navigation, Guidance, and Control Processing', Prentice Hall Series, 1991.

U13AEE704	FATIGUE AND FRACTURE	L	T	P	C
		3	0	0	3

Course Objectives

- To provide an introduction to the principles and methods of fracture and fatigue design with application to metals.
- To familiarize the student with the techniques for solving fatigue problems and develop expertise in the area of enhancing fatigue life of engineering components.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Explain the need and importance of fatigue analysis.

CO2: Analyze the fatigue life a component based on its S-N data.

CO3: Define the physical phases in a fatigue life of a component.

CO4: Recognize the mechanics of the propagation of cracks during fracture in a material.

CO5: Distinguish the fatigue based design philosophies and classify the materials based on their fatigue life.

Course Content

FATIGUE OF STRUCTURES **7 Hours**

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

STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR **10 Hours**

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.

PHYSICAL ASPECTS OF FATIGUE **10 Hours**

Phases in fatigue life – Crack initiation – Crack growth – Final Fracture – Dislocations – fatigue fracture surfaces.

FRACTURE MECHANICS **10 Hours**

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.

FATIGUE DESIGN AND TESTINIG **8 Hours**

Safe life and Fail – safe design philosophies – Environmental fatigue: corrosion fatigue, fretting fatigue, low temperature and high temperature fatigue – Importance of Fracture Mechanics in aerospace structures.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. R. W. Hertzberg, 'Deformation and Fracture Mechanics of Engineering Materials', John Wiley and Sons, 1996.
2. C. R. Brooks and A. Choudhury, 'Failure Analysis of Engineering Materials', McGraw-Hill, 2002.
3. Barrois W and Ripely, E.L., 'Fatigue of Aircraft Structure', Pergamon Press, 1983.
4. Sin, C.G., 'Mechanics of Fracture', Vol. I, Sijthoff and W. Noordhoff International Publishing Co., Netherlands, 1989.

U13AEE705	AIR TRAFFIC CONTROL AND AERODROME DESIGN	L	T	P	C
		3	0	0	3

Course Objectives

- To study the procedure of the formation of aerodrome and its design and air traffic control.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Describe the procedure of formation of aerodrome and its design.

CO2: Describe the functions of Air Traffic Control and their responsibilities.

CO3: Describe the functions of Radar in Air Traffic Control.

CO4: Interpret Aerodrome data.

CO5: Identify and describe the importance of visual aids in airports.

Course Content

BASIC CONCEPTS 9 Hours

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

AIR TRAFFIC SERVICES 9 Hours

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

FLIGHT INFORMATION ALERTING SERVICES, COORDINATION, EMERGENCY PROCEDURES AND RULES OF THE AIR 10 Hours

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

AERODROME DATA, PHYSICAL CHARACTERISTICS AND OBSTACLE RESTRICTION 9 Hours

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

VISUAL AIDS FOR NAVIGATION, VISUAL AIDS FOR DENOTING OBSTACLES EMERGENCY AND OTHER SERVICES 8 Hours

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

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

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

SEMESTER VIII

ELECTIVES III, IV and V FOR VIII SEMESTER

U13GST002	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives

- To acquire knowledge on TQM concepts.
- To acquire knowledge on quality systems.
- To develop skills to use TQM tools for domain specific applications.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand quality concepts and philosophies of TQM.

CO2: Apply TQM principles and concepts of continuous improvement.

CO3: Apply and analyze the quality tools, management tools and statistical fundamentals to improve quality.

CO4: Understand the TQM tools as a means to improve quality.

CO5: Remember and understand the quality systems and procedures adopted.

Course Content

INTRODUCTION **9 Hours**

Definition of Quality, Dimensions of Quality, Quality costs, Top Management Commitment, Quality Council, Quality Statements, Barriers to Total Quality Management (TQM) Implementation, Contributions of Deming, Juran and Crosby, Team Balancing

TQM PRINCIPLES **9 Hours**

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Continuous Process Improvement, 5S, Kaizen, Just-In-Time and TPS

STATISTICAL PROCESS CONTROL **9 Hours**

The seven tools of quality, New seven Management tools, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Concept of six sigma.

TQM TOOLS **9 Hours**

Quality Policy Deployment (QPD), Quality Function Deployment (QFD), Benchmarking, Taguchi Quality Loss Function, Total Productive Maintenance (TPM), FMEA.

QUALITY SYSTEMS **9 Hours**

Need for ISO 9000 and Other Quality Systems, ISO 9001:2008 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, ISO 14001:2004

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Dale H. Besterfield, Hemant Urdhwareshe, Mary Besterfield-Sacre, Carol Besterfield-Michna, Rashmi Urdhwareshe, and Glen H. Besterfield, 'Total Quality Management', Third Edition, Pearson Education, 2011.
2. James Robert Evans and William M. Lindsay, 'The Management and Control of Quality', South-Western (Thomson Learning), 2008.
3. Armand V. Feigenbaum, 'Total Quality Control', Fourth Edition, McGraw Hill, 2004.
4. John S. Oakland, 'Total Quality Management: Text with Cases', Butterworth-Heinemann, 2003.
5. Narayana V. and Sreenivasan, N.S., 'Quality Management – Concepts and Tasks', New Age International, 1996.
6. Zeiri, 'Total Quality Management for Engineers', Woodhead Publishers, 1991.

U13GST006 PRODUCT DESIGN AND DEVELOPMENT

L	T	P	C
3	0	0	3

Course Objectives

- To acquire knowledge on the various stages of a product development process.
- To develop skills for using the various tools and techniques for developing products.
- To acquire knowledge on project management techniques.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand the process to plan and develop products.

CO2: Understand the process of collecting information and developing product specifications.

CO3: Understand the concept generation, selection and testing processes.

CO4: Understand the concepts of product architecture, industrial design and design for manufacture.

CO5: Understand the basics of prototyping, economic analysis and project planning and execution processes.

Course Content

INTRODUCTION – DEVELOPMENT PROCESSES AND ORGANIZATIONS – PRODUCT PLANNING 9 Hours

Characteristics of successful product development to Design and develop products, duration and cost of product development, the challenges of product development.

A generic development process, concept development: the front-end process, adapting the generic product development process, the AMF development process, product development organizations, the AMF organization.

The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

IDENTIFYING CUSTOMER NEEDS – PRODUCT SPECIFICATIONS 9 Hours

Gathering raw data from customers, interpreting raw data in terms of customer needs, organizing the needs into a hierarchy, establishing the relative importance of the needs and reflecting on the results and the process.

Specifications, establish specifications, establishing target specifications setting the final specifications.

CONCEPT GENERATION – CONCEPT SELECTION – CONCEPT TESTING
9 Hours

Activity of concept generation, clarify the problem, search externally, search internally, explore systematically, reflect on the results and the process.

Overview of methodology, concept screening, concept scoring, caveats.

Purpose of concept test, choosing a survey population and a survey format, communicate the concept, measuring customer response, interpreting the result, reflecting on the results and the process.

PRODUCT ARCHITECTURE – INDUSTRIAL DESIGN – DESIGN FOR MANUFACTURING **9 Hours**

Meaning of product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues.

Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, is assessing the quality of industrial design.

Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

PROTOTYPING – PRODUCT DEVELOPMENT ECONOMICS – MANAGING PROJECTS **9 Hours**

Prototyping basics, principles of prototyping, technologies, planning for prototypes.

Elements of economic analysis, base case financial mode, Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis.

Understanding and representing task, baseline project planning, accelerating projects, project execution, postmortem project evaluation.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Karl. T. Ulrich, Steven D. Eppinger, ‘Product Design and Development’, Fifth Edition, Irwin/McGraw-Hill, 2011.
2. A. K. Chitale and R. C. Gupta, ‘Product Design and Manufacturing’, Fifth Edition, Prentice Hall India Pvt. Ltd., 2011.
3. Tim Jones, ‘New Product Development: An Introduction to a Multifunctional Process’, Butterworth-Heinemann, 1997.
4. Geoffrey Boothroyd, Peter Dewhurst, and Winston A. Knight, ‘Product Design for Manufacture and Assembly’, Third Edition, CRC Press, 2010.

U13AEE801	AVIATION, QUALITY ASSURANCE, SAFETY RULES AND REGULATIONS, CERTIFICATION STANDARDS, LICENSING	L	T	P	C
		3	0	0	3

Course Objectives

- To introduce the students about civil aircraft safety rules and regulations which are being followed by Directorate General of Civil Aviation and FAA.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand the various aviation standards in quality assurance, safety rules and regulations.

CO2: Understand the certification standards and licensing standards.

CO3: Understand various aeronautical organization standards and regulations.

CO4: Understand Aviation laws and regulations related to each type of organization.

CO5: Analyze flight testing certification standards.

Course Content

C.A.R. SERIES 'A' – PROCEDURE FOR CIVIL AIR WORTHINESS REQUIREMENTS AND RESPONSIBILITY OPERATORS Vis-à-vis AIR WORTHINESS DIRECTORATE **6 Hours**

Introduction to FAA – IATA regulations and its relevance to CAR – Responsibilities of operators / owners – Procedure of CAR issue, amendments etc., Objectives and targets of airworthiness directorate – Airworthiness regulations and safety oversight of engineering activities of operators.

C.A.R. SERIES 'B' **3 Hours**

Issue Approval of Cockpit check list – MEL, CDL: Deficiency list (MEL and CDL) – Preparation and use of cockpit checklist and emergency list.

C.A.R. SERIES 'C' – DEFECT RECORDING, MONITORING, INVESTIGATION AND REPORTING **3 Hours**

Defect recording, reporting, investigation, rectification and analysis; Flight report; Reporting and rectification of defects observed on aircraft; Analytical study of in-flight readings and recordings; Maintenance control by reliability Method.

C.A.R. SERIES 'D' – AIRCRAFT MAINTENANCE PROGRAMMES 4 Hours

Reliability Programmes (Engines) – Aircraft maintenance programme and their approval – On condition maintenance of reciprocating engines – TBO – Revision programme – Maintenance of fuel and oil uplift and consumption records – Light aircraft engines – Fixing routine maintenance periods and component TBOs – Initial and revisions.

C.A.R. SERIES 'E' – APPROVAL OF ORGANISATIONS 3 Hours

Approval of organizations in categories A, B, C, D, E, F, and G – Requirements of infrastructure at stations other than parent base.

C.A.R. SERIES 'F' – AIR WORTHINESS AND CONTINUED AIR WORTHINESS 6 Hours

Procedure relating to registration of aircraft; Procedure for issue / revalidation of Type Certificate of aircraft and its engines / propeller; Issue / revalidation of Certificate of Airworthiness; Requirements for renewal of Certificate of Airworthiness.

C.A.R. SERIES 'L' and 'M' 8 Hours

Issue of AME Licence, its classification and experience requirements, Mandatory Modifications / Inspections.

C.A.R. SERIES 'X' AND QUALITY ASSURANCE 12 Hours

Registration Markings of aircraft; Weight and balance control of an aircraft; Provision of first aid kits and Physician's kit in an aircraft; Use furnishing materials in an aircraft; Concessions; Aircraft log books; Document to be carried on board on Indian registered aircraft; Procedure for issue of tax permit; Procedure for issue of type approval of aircraft components and equipment including instruments; Aviation Safety (AVS) Quality Management System (QMS).

Theory: 45 Hours Tutorial: 0 Hours Total Hours: 45

REFERENCES

1. 'Civil Aviation Requirements with Latest Amendment (Section 2 Airworthiness)', Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi, 2000.
2. FAA, Quality regulation document - VS 1300.2C
3. 'Aircraft Manual (India)' – Latest Edition, The English Book Store, 17-1, Connaught Circus, New Delhi.
4. Wg Cdr D P Sabharwal (Retd.), 'Q and A – Objective and subjective for CAR-Section-2'.

U13AEE802 EXPERIMENTAL STRESS ANALYSIS

L	T	P	C
3	0	0	3

Course Objectives

- To understand the relation between the mechanics theory and experimental stress analysis.
- To bring consciousness on experimental method of finding the response of the structure to different types of load.
- To establish the fundamental concepts and newly experimental techniques.
- To be able to use the experimental techniques on the practical problems.
- To understand about various methods of Nondestructive testing.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Determine the structural properties (stress, strain) using various experimental techniques.

CO2: Formulate and solve general three dimensional problems of stress-strain analysis especially fundamental problems of elasticity.

CO3: Analyze the strain gauge data under various loading condition by using gauge rosette method.

CO4: Apply experimental techniques of stress analysis using photoelasticity and strain gauges.

CO5: Experimentally evaluate the location and size of defect in solid and composite materials by using various Non-destructive Testing methods.

Course Content

MEASUREMENTS **4 Hours**

Principles of measurements – Accuracy – Sensitivity and range of measurements.

EXTENSOMETERS **9 Hours**

Mechanical – Optical – Acoustical – Electrical extensometers and their uses – Advantages and disadvantages.

STRAIN GAUGES **12 Hours**

Strain Measurements: Introduction – Properties of Strain gauge Systems – Types of Strain gauges.

Electrical Resistance Strain Gauge: Introduction – Strain Sensitivity in Alloys – Strain gauge Adhesives – Gauge sensitivity and gauge factor.

Strain Gauge Circuit: Potentiometer and its Application – Wheatstone bridge – Bridge Sensitivity – Null Balance Bridges.

Analysis of Strain Gauge Data: Two gauge rosette – Rectangular rosette – Delta Rosette, Stress Gage – Plane Shear gage.

PHOTOELASTICITY **10 Hours**

Optics related to photo elasticity – Ordinary light – Monochromatic light – Polarized light – Natural and artificial Birefringence – Stress optic law in two dimensions at normal incidence – Material fringe value interms of stress function – Polariscope – Plane polariscope – Circular polariscope – Effect of stressed model in plane polariscope – Effect of stressed model in circular polariscope.

NON DESTRUCTIVE TESTING (NDT) **10 Hours**

Fundamentals of NDT – Radiography – Ultrasonic testing – Magnetic Particle Inspection – Dye Penetrant Technique – Eddy Current Testing – Acoustic Emission Technique – Fundamentals of brittle coating methods – Introduction to Moire Fringe technique – Holography – Thermography – Fibre optic sensors.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Dr. Sadhu Singh, 'Experimental Stress Analysis', Khanna Publications, 2009.
2. Dally, J.W., and Riley, W.F., 'Experimental Stress Analysis', College House Enterprises, New York, 2005.
3. Srinath, L.S., Raghava, M.R., Lingaiah,K., Garagesha,G. Pant B. and Ramachandra,K., 'Experimental Stress Analysis', Tata McGraw-Hill, New Delhi, 1984.
4. J. Srinivas, 'Stress Analysis and Experimental Techniques: An Introduction', Alpha Science International Ltd, 2011.

U13AEE803	HYPERSONIC AND HIGH TEMPERATURE GAS DYNAMICS	L	T	P	C
		3	0	0	3

Course Objectives

- To introduce the basic fundamentals of hypersonic flow with an emphasis on high-temperature gas dynamics for producing new generation of engineers/scientists for meeting the future needs of the aerospace industries.
- To provide the students with the concept that certain physical flow phenomena become progressively more important in hypersonic flows than supersonic flows.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the basic concepts of hypersonic aerodynamics to hypersonic Internal/External flow fields.

CO2: Establish the properties of inviscid hypersonic flows using surface inclination and approximate methods.

CO3: Establish the boundary layer equations for hypersonic flow.

CO4: Analyze the properties of hypersonic shockwaves and boundary layer interactions in hypersonic flow.

CO5: Apply High-temperature gas dynamics to hypersonic Internal/External flow fields.

Course Content

INTRODUCTION TO HYPERSONIC FLOW **9 Hours**

Brief description of hypersonic flight – Definition of hypersonic flow – Review of aerodynamics – Newtonian theory, Lift and Drag of wings at hypersonic speeds, Thin shock layers, Entropy layer, Viscous interaction, High-temperature flows, Low density flow.

INVISCID HYPERSONIC FLOW **9 Hours**

Basic hypersonic shock relations – hypersonic similarity parameters – hypersonic expansion – wave relations – hypersonic equivalence principle and blast wave theory – hypersonic blunt-body problem.

VISCOUS HYPERSONIC FLOW **9 Hours**

Governing equations for Viscous flow – Navier-Stokes equations – Similarity parameters and boundary conditions – boundary layer equations for hypersonic flow – Hypersonic aerodynamic heating, Hypersonic viscous interaction, CFD solutions of hypersonic viscous flows.

HIGH-TEMPERATURE GAS DYNAMICS **9 Hours**

Importance of high-temperature flows, nature of high-temperature flows, Chemical effects in Air – Elements of Kinetic Theory – review of statistical thermodynamics – Collision frequency and mean free path – Velocity and speed distribution functions – Mean velocities – Definition of transport phenomena – Transport coefficient – mechanism of diffusion – Energy transport by thermal conduction and diffusion – Total thermal conductivity – Viscous high temperature flows.

APPLICATION TO INTERNAL / EXTERNAL HYPERSONIC AERODYNAMICS **9 Hours**

Experimental methods for hypersonic flows: Impulse facilities, hypersonic wind tunnels, shock tunnels, gun tunnels, free piston shock tunnels, expansion tubes – Application to Internal/External Hypersonic Aerodynamics: High L/D Hypersonic configurations – Waveriders, Aerodynamic heating, and Hypersonic Cruiser.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. John D. Anderson, Jr, 'Hypersonic and High Temperature Gas Dynamics', Second Edition, AIAA Education Series, 2006.
2. John D. Anderson., 'Modern Compressible Flow', Third Edition, Tata McGraw-Hill, New Delhi, 2012.
3. John D Anderson, Jr., 'Fundamentals of Aerodynamics', Chapter 14, Fourth Edition, Tata McGraw-Hill Publishing Company Ltd., 2007.
4. Vinh,N.X, A.Busemann, and R.D Culp, 'Hypersonic and Planetary Entry Flight Mechanics', University of Michigan Press, Ann Arbor, 1980.
5. Hayes, W.D, and R.F Probstein, 'Hypersonic Flow Theory', Second Edition, Academic Press, New York, 1966.

U13AEE804	GPS, INERTIAL NAVIGATION SYSTEM AND ADVANCED NAVIGATION TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives

- To learn the basics of coordinate systems and its transformation.
- To study the principles of inertial sensors.
- To understand the in-depth knowledge in inertial navigation.
- To study the principles of satellite navigation.
- To study the various hybrid navigation methods with Kalman filter.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Perform coordinate transformation required for aerospace vehicle navigation.

CO2: Analyze the performance of inertial sensors.

CO3: Formulate inertial navigation and hybrid navigation algorithms for aerospace vehicles.

CO4: Track and analyze GPS satellite signals.

CO5: Apply Kalman filter algorithm for various applications.

Course Content

NAVIGATION BASICS **6 Hours**

Principles of Navigation – Position Fixing and Dead Reckoning – Geometry of the Earth – Coordinate Systems (Frames): ECI, ECEF, Body, NED, ENU, WGS-84 systems – Coordinate Transformations: DCM, Euler Angles, Rotation Matrix, Body to NED, ECEF to NED, ECEF to WGS – Navigation Equations.

INERTIAL SENSORS AND UNITS **12 Hours**

Gyroscope Properties – Conventional gyroscopes: Rate-integrating gyroscope, Dynamically Tuned gyroscope – Rate Gyroscopes – Vibratory Coriolis Gyroscopes – MEMS gyroscopes: Tuning fork gyroscope – Quartz and Silicon sensors – Optical gyroscopes: Sagnac effect, Ring Laser gyroscope and Fiber Optic gyroscope – Accelerometers: Specific force measurement, Torque balance pendulous accelerometer, Resonant MEMS accelerometer – Inertial Sensor Errors – Inertial Measurement Unit (IMU) – AHRS.

INERTIAL NAVIGATION SYSTEM (INS) **9 Hours**

Principles of Inertial Navigation – INS Mechanization: Gimballed Platform and Strapdown arrangements– Inertial Navigation Attitude Algorithms: DCM, Euler and Quaternion methods

– Inertial Navigation Equations – INS Error Corrections – INS Initialization and Alignment Techniques.

GLOBAL POSITIONING SYSTEM (GPS) 9 Hours

GPS Satellites – GPS Principles of Operation – Pseudorange – GPS Segments – GPS Signal Structure – Acquisition and Tracking – GPS Time – Position and Velocity Calculations – GPS Receiver Architecture – GPS Data Errors – Dilution of Precision – Differential GPS – WAAS.

ADVANCED NAVIGATION TECHNIQUES 9 Hours

Radar Navigation – Terrain Referenced Navigation – Vision based Navigation – Bio-inspired Navigation – Integrated/Hybrid Navigation: Kalman Filter Equations, Doppler aided Inertial Navigation, GPS aided Inertial Navigation and its Techniques, Vision aided Inertial Navigation, Terrain aided Inertial Navigation, Assisted GPS with Mobile Networks.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Esmat Bekir, ‘Introduction to Modern Navigation Systems’, World Scientific Publishing Co. Pte. Ltd, 2007.
2. Paul D. Groves, ‘Principles of GNSS, Inertial, and Multisensor Integrated Navigation Systems’, Artech House Inc., 2008.
3. Mohinder S. Grewal, Lawrence R. Weill and Angus P. Andrews, ‘Global Positioning Systems, Inertial Navigation, and Integration’, Second Edition, John Wiley and Sons Inc., 2007.
4. David H. Titterton and John L. Weston, ‘Strapdown Inertial Navigation Technology’, Second Edition, Institution of Electrical Engineers, 2004.
5. Robert M. Rogers, ‘Applied Mathematics in Integrated Navigation Systems’, Second Edition, AIAA Publications, 2003.
6. R. P. G. Collinson, ‘Introduction to Avionics Systems’, Chapters 5 and 6, Third Edition, Springer Science, London, 2011.
7. ‘Basic Guide to Advanced Navigation’, Second Edition, Handbook of NATO Research Technology Organization, 2010.

U13AEE805	AIRCRAFT STRUCTURAL ANALYSIS	L	T	P	C
		3	0	0	3

Course Objectives

- To provide an overview of the issues those need to be addressed in the structural design of an airframe.
- To highlight the role played by different disciplines within the context of structural design.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the basic equations of stress, strain, equilibrium and boundary conditions for structures with different dimensions.

CO2: Apply the 3D stress-strain relation for solving engineering problems.

CO3: Analyze the given structure for its stability and geometric strength using strain energy method and matrix method.

CO4: Analyze the thin structures for their bending strength.

CO5: Design and analyze an aircraft component for its bending, shear and torsional resistance.

Course Content

BASIC ELASTICITY **9 Hours**

Stress – Notation for forces and stresses – Equations of equilibrium – Plane stress – Boundary conditions – Determination of stresses on inclined planes – Principal Stresses – Strain – Compatibility equations – Plane strain – Determination of strains on inclined planes – Principal strains – Stress-strain relationships.

ENERGY METHODS **10 Hours**

Strain energy and complementary energy – Principle of the stationary value of the total complementary energy – Application to deflection problems – Virtual work Method – Applications of the principle of virtual work.

MATRIX METHODS **9 Hours**

Stiffness matrix for an elastic spring – Matrix analysis of pin-jointed frameworks – Stiffness matrix for a uniform beam.

ANALYSIS OF THIN PLATE **8 Hours**

Pure bending of thin plates – Plates subjected to bending and twisting – Plates subjected to a distributed transverse load – Combined bending and in-plane loading of a thin rectangular plate.

ANALYSIS OF AIRCRAFT COMPONENTS **9 Hours**

Analysis of Wing spars and box beams – Tapered wing spar – Open and closed section beams – Beams having variable stringer areas – Analysis of Fuselages – Bending – Shear – Torsion.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Megson, T.H.G., 'An Introduction to Aircraft Structural Analysis', Second Edition Butterworth-Heinemann, 2013.
2. Chajes, A., 'Principles of Structural Stability Theory', Prentice Hall, 1987.
3. Auchert, T.R., 'Energy Principles in Structural Mechanics', McGraw Hill, 1989.
4. Howard D.Curtis, 'Fundamentals of Aircraft Structural Analysis', Irwin Publications, 1997.
5. Megson, T.H.G., 'Aircraft Structures for Engineering Students', Fifth Edition (Rev.), Butterworth-Heinemann, 2012.

U13AEE806	**SUPPLY CHAIN MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

- To impart Knowledge and equip the Future Managers to take Decisions in the Area of Supply Chain Management with Focus on Strategic Sourcing, Supply Chain Networking Management, Planning demand-supply and Inventory Management along with current trends in Supply Chain Management.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the basic equations of stress, strain, equilibrium and boundary conditions for structures with different dimensions.

CO2: Apply the 3D stress-strain relation for solving engineering problems.

CO3: Analyze the given structure for its stability and geometric strength using strain energy method and matrix method.

CO4: Analyze the thin structures for their bending strength.

CO5: Design and analyze an aircraft component for its bending, shear and torsional resistance.

Course Content

INTRODUCTION TO SUPPLY CHAIN MANAGEMENT **9 Hours**

Supply Chain – Fundamentals, Importance, Decision Phases, Process View – Supplier-Manufacturer-Customer chain – Drivers of Supply Chain Performance – Structuring Supply Chain Drivers – Overview of Supply Chain Models and Modeling Systems.

STRATEGIC SOURCING **8 Hours**

In-sourcing and Out-sourcing – Types of Purchasing Strategies – Supplier Evaluation, Selection and Measurement – Supplier Quality Management – Creating a world class supply base – World Wide Sourcing.

SUPPLY CHAIN NETWORK **10 Hours**

Distribution Network Design – Role, Factors Influencing, Options, Value Addition – Models for Facility Location and Capacity Location – Impact of uncertainty on Network Design – Network Design decisions using Decision trees – Distribution Center Location Models – Supply Chain Network optimization models.

PLANNING DEMAND INVENTORY AND SUPPLY **9 Hours**

Overview of Demand forecasting in the supply chain – Aggregate planning in the supply chain – Managing Predictable Variability – Managing supply chain cycle inventory – Uncertainty in the supply chain – Safety Inventory – Determination of Optimal level of product availability – Coordination in the Supply Chain.

CURRENT TRENDS **9 Hours**

eBusiness and eSourcing – Framework and Role of Supply Chain in e-business and b2b practices – Supply Chain IT Framework – Internal Supply chain management – Fundamentals of transaction management – Supplier relationship management – Information Systems development – Packages in Supply Chain – eSRM, eLRM, eSCM, SCOR Model.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Sunil Chopra and Peter Meindi, ‘Supply Chain Management-Strategy Planning and Operation’, Pearson Education, 2004.
2. Monczka et al., ‘Purchasing and Supply Chain Management’, Second Edition, Thomson Learning, 2002.
3. Altekar Rahul V, ‘Supply Chain Management – Concept and Cases’, Prentice Hall India, 2005.
4. Shapiro Jeremy F, ‘Modeling the Supply Chain’, Second Edition, Thomson Learning, 2002.
5. Ballou Ronald H, ‘Business Logistics and Supply Chain Management’, Pearson Education, 2004.

U13AEE807	AIRCRAFT PRODUCTION TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives

- To introduce the basic concepts of manufacturing via shaping, forming, machining and assembly.
- To develop a knowledge of appropriate parameters to be used for various machining operations.
- To make students aware of the necessity to manage manufacturing processes and systems for the best use of material and human resources with particular emphasis on product safety and environmental considerations.
- To introduce students to traditional and non-traditional manufacturing processes with particular emphasis on forming and machining processes.
- To introduce students to the scientific principles underlying material behavior during forming and machining processes so as to enable them to undertake calculations of forces, work piece and tool stresses and material removal rates.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Recommend appropriate part manufacturing processes when provided a set of functional requirements and product development constraints.

CO2: Recommend cost-effective material options based upon net part shape, expected loading, operating environment, cost constraints, and life expectancy.

CO3: Fabricate basic parts and assemblies using powered and non-powered machine shop equipment in conjunction with mechanical documentation.

CO4: Ascertain product and process quality levels through the use of precision measurement tools and statistical quality control charts.

CO5: Mitigate production problems using risk management and root cause analysis tools.

Course Content

CASTING **9 Hours**

Casting types, procedure to make sand mould, types of core making, moulding tools, machine moulding, special moulding processes – CO_2 moulding, shell moulding, investment moulding, permanent mould casting, pressure die casting, centrifugal casting, continuous casting, casting defects.

WELDING **9 Hours**

Classification of welding processes, Principles of Oxyacetylene gas welding, A.C. metal arc welding, resistance welding, submerged arc welding, tungsten inert gas welding, metal inert gas welding, plasma arc welding, thermic welding, electron beam welding, laser beam welding, defects in welding, soldering and brazing.

MACHINING **9 Hours**

General principles (with schematic diagrams only) of working and commonly performed operations in the following machines: Lathe, Shaper, Planer, Horizontal milling machine, Universal drilling machine, cylindrical grinding machine, Capstan and Turret lathe; Basics of CNC machines, General principles and applications of the following processes: Abrasive jet machining, Ultrasonic machining, Electric discharge machining, Electro chemical machining, Plasma arc machining, Electron beam machining and Laser beam machining.

FORMING AND SHAPING OF PLASTICS **9 Hours**

Types of plastics – characteristics of the forming and shaping processes – Moulding of Thermoplastics – working principles and typical applications of Injection moulding – Plunger and screw machines – Blow moulding – Rotational moulding – Film moulding – Extrusion typical industrial applications – Thermoforming – processing of thermosets – working principles and typical applications – compression moulding – Transfer moulding – Bonding of thermoplastics – Fusion and solvent methods – Induction and Ultrasonic methods.

METAL FORMING AND POWDER METALLURGY **9 Hours**

Principles and applications of the following processes: Forging, Rolling, Extrusion, Wire drawing and Spinning, Powder metallurgy, Principal steps involved, advantages, disadvantages and limitations of powder metallurgy.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. S.K Hajra Choudhury, ‘Elements of Workshop Technology’, Vol. I and II, Media Promoters and Publishers Pvt., Ltd., Mumbai, 2001.
2. R. K. Jain and S. C. Gupta, ‘Production Technology’, Sixteenth Edition, Khanna Publishers, 2001.
3. H. M. T. Bangalore, ‘Production Technology – Hand Book’, Tata McGraw-Hill Education, 2001.

4. Roy A. Linberg, ‘Process and Materials of Manufacturing Technology, Prentice Hall India, 2000.
5. M. Adithan and A. B. Gupta, ‘Manufacturing Technology’, New Age International, 2007.
6. Serope Kalpajian and Steven R. Schimid, ‘Manufacturing Engineering and Technology’, Pearson Education, Inc., 2002.

U13AEE808 HELICOPTER AERODYNAMICS

L	T	P	C
3	0	0	3

Course Objectives

- To present the basic ideas of evolution, performance and associated stability problems of helicopter.
- To familiarize the elements of helicopter aerodynamics, V/STOL Aircrafts and ground effect machines.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Familiarize on major helicopter components, characteristics and configurations.

CO2: Apply Momentum and simple blade element theories to helicopter's rotor blades.

CO3: Analyze the power requirements in forward flight and associated stability problems of helicopter.

CO4: Analyze the performance of VTOL and STOL aircrafts.

CO5: Apply the ground effect concept to ground effect machines.

Course Content

ELMENTS OF HELICOPTER AERODYNAMICS **10 Hours**

Configurations based on torque reaction – Jet rotors and compound helicopters – Methods of control – Collective and cyclic pitch changes – Lead-Lag and flapping hinges.

IDEAL ROTOR THEORY **12 Hours**

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

POWER ESTIMATES **8 Hours**

Induced, profile and parasite power requirements in forward flight – Performance curves with effects of altitude – Preliminary ideas on helicopter stability.

LIFT, PROPULSION AND CONTROL OF V/STOL AIRCRAFT **8 Hours**

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.

GROUND EFFECT MACHINES **7 Hours**

Types – Hover height, lift augmentation and power calculations for plenum chamber and peripheral jet machine – Drag of hovercraft on land and water – Applications of hovercraft.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Gessow A and Myers G.C., 'Aerodynamics of the Helicopter', Continuum International Publishing Group Ltd., 1997.
2. Gupta. L, 'Helicopter Engineering', Himalayan Books, 1996.
3. Simon Newman, 'The Foundations of Helicopter Flight', Halsted Press, 1994.
4. John M. Seddon and Simon Newman, 'Basic Helicopter Aerodynamics', Third Edition, AIAA Education Series, 2011.
5. J. Gordon Leishman, 'Principles of Helicopter Aerodynamics', Second Edition, Cambridge University Press, 2006.
6. Philip Terpstra, 'V/STOL Aircraft Design', Third Edition, Spirit Publications, 2005.
7. Barnes W. McCormick, 'Aerodynamics of V/STOL Flight', Academic Press Inc., 1967.
8. Barnes W. McCormick, 'Aerodynamics, Aeronautics and Flight Mechanics', Second Edition, Wiley India Pvt. Ltd., 2009.
9. Liang Yun and Alan Bliault, 'Theory and Design of Air Cushion Craft', First Edition, Butterworth-Heinemann, 2000.
10. Richard E. Kuhn, Richard J. Margason and Peter Curtis, 'Jet Induced Effects: The Aerodynamics of Jet and Fan Powered V/STOL Aircraft in Hover and Transition', First Edition, AIAA, 2006.

U13AEE809	VISCOUS FLOW THEORY	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the continuum mechanical derivation of the Navier-Stokes equations and the appropriate boundary conditions.
- To understand the boundary layer theory.
- To apply the equations to various fluid problems giving a mathematical description of the flow, and to solve the industrial problems.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the basic laws of fluids to the incompressible and compressible flow fields.

CO2: Calculate the properties of laminar and turbulent boundary layers.

CO3: Establish the laminar, thermal and turbulent boundary layer equations.

CO4: Calculate the change in boundary layer behavior due to shock interactions

CO5: Predict various turbulent characteristics on different geometries.

Course Content

INTRODUCTION **10 Hours**

Real and ideal fluids, Boundary layer concept, Boundary layer on an airfoil, Boundary layer separation, Derivation of the Equations of Motion: Review of Cartesian tensor notation. Review of thermodynamics – Heat transfer – Derivation of the full compressible viscous Newtonian equations – conservation of mass, momentum, energy – Vorticity and entropy equations – Kelvin's theorem – Introduction to Non-Newtonian fluids.

LAMINAR INCOMPRESSIBLE VISCOUS FLOW **10 Hours**

Exact solutions: stagnation point flow, Jeffrey-Hamel flow, Stokes problems – Low Reynolds number flow – Introduction to perturbation theory – Boundary layer theory – Effects of pressure gradient and curvature – Boundary layer integral equations – Thwaites method – Laminar separation, separation bubbles.

LAMINAR COMPRESSIBLE VISCOUS FLOW **8 Hours**

Exact solutions: compressible Couette flow, flow through a shock wave – Compressible boundary layers – Introduction to shock-boundary layer interaction and hypersonic effects: dissociation, heating, and non-equilibrium thermodynamics.

TRANSITION TO TURBULENCE **7 Hours**

Linear transition theory – Introduction to nonlinear theory and numerical methods – Introduction to experimental results in bounded and free shear flows, both incompressible and compressible – Effects of roughness, turbulence, vibration, noise, curvature, etc – Transition-separation interactions in boundary layers.

TURBULENT FLOW **10 Hours**

Introduction to Turbulent Flow: Reynolds averaged equations of motion – Introduction to statistics and correlations – Kolmogorov scale – 5/3 law for inertial range self-similarity – Law of the wall in the turbulent boundary layer – Introduction to experimental results for various fundamental turbulent flows – bluff bodies, internal flows, free shear flows – Introduction to far field self-similarity theories – Introduction to compressible-boundary layer flow.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Frank M. White, 'Viscous Fluid Flow', Third Edition, Tata McGraw Hill Pvt Ltd., New Delhi, 2011.
2. H.Schlichting and K.Gersten, 'Boundary Layer Theory', Eighth Edition, Springer, 2001.
3. Richard Courant and Kurt Otto Friedrichs, 'Supersonic Flow and Shock Waves', Springer Science and Business Media, 1976.
4. Lagerstrom, P.A., 'Laminar Flow Theory', Princeton University Press, 1996.
5. John David Anderson, 'Hypersonic and High Temperature Gas Dynamics', American Institute of Aeronautics and Astronautics, 2006.
6. Carl M. Bender and Steven A. Orszag, 'Advanced Mathematical Methods for Scientists and Engineers I: Asymptotic Methods and Perturbation Theory', Springer-Verlag, New York, 2010.
7. Rutherford Aris, 'Vectors, Tensors and the Basic Equations of Fluid Mechanics', Dover Publications, 2012.

U13AEE810	**INTRODUCTION TO MULTIDISCIPLINARY SYSTEM DESIGN OPTIMIZATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

- To present the tools and methodologies for performing system optimization in a multidisciplinary design context. Focus will be equally strong on all three aspects of the problem: (i) the multidisciplinary character of engineering systems, (ii) design of these complex systems, and (iii) tools for optimization.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Formulate the problem setup for engineering design.

CO2: Do engineering design optimization using different optimization methods.

CO3: Do topology optimization with design application for efficient product output.

CO4: Analyze between the experiment and simulation results for better optimization.

CO5: Do optimized design using modern methods.

Course Content

PROBLEM FORMULATION AND SETUP **13 Hours**

System characterization: Identification of objectives, design variables, constraints, subsystems System-level coupling and interactions – Examples of MSDO in practice.

Visualization techniques in design optimization – Subsystem model development – Model partitioning and decomposition, interface control – Collaborative Optimization, Bi-Level Formulations – Subsystem model selection: fidelity versus expense – Model and simulation development and validation.

OPTIMIZATION AND SEARCH METHODS **9 Hours**

Optimization and exploration techniques: Review of linear and nonlinear programming – Heuristic techniques: genetic algorithms simulated annealing, Tabu search – Design Space Exploration: Design of Experiments (DOE) – Full factorial search, parameter study, Taguchi/orthogonal arrays, latin hypercubes.

PROGRAMMING METHODS **8 Hours**

Mixed integer programming (application to hub spoke / network problems) – Sensitivity and post-optimality analysis – Jacobian matrix, Hessian, finite differences – Adjoint methods and Lagrange multipliers.

MULTI-OBJECTIVE AND STOCHASTIC CHALLENGES **8 Hours**

Multiobjective optimization – Weighted sum optimization – Weak and strong dominance – Pareto front computation – Goal programming and isoperformance – Physical Programming – Multiattribute Utility Theory – Introduction to robust design – Monte-Carlo Sampling – Design under uncertainty – Reliability analysis, Taguchi methods – Module 4: Implementation Issues and Real World Applications – System assessment and extensions.

OPTIMIZATION IN REAL ENGINEERING APPLICATION **7 Hours**

Definition of Optimality – Design for value, including lifecycle costing – Optimizing product families and platforms – Implementation issues – Model reduction – Approximation techniques – response surfaces – kriging – neural networks – Concurrent design.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Arora, J. S., 'Introduction to Optimum Design', McGraw-Hill, 1989.
2. Deb, K., 'Optimization for Engineering Design – Algorithms and Examples', Prentice Hall India, 1995.
3. Singiresu S. Rao, 'Engineering Optimization: Theory and Practice', Fourth Edition, John Wiley and Sons, Inc., 2009.
4. MIT Course ware: Engineering Systems Division – Multidisciplinary System Design Optimization (Course no. ESD 77).

U13AEE811	EXPERIMENTAL METHODS IN FLUID MECHANICS	L	T	P	C
		3	0	0	3

Course Objectives

- To enable students to understand various experimental procedures available in fluid mechanics with application to aircraft industry / research.
- To further it gives them the idea about error calibration, data acquisition and wind tunnel measurements.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Analyze the basic principles in fluid measurements.

CO2: Measure data using wind tunnel balances.

CO3: Analyze the basic principles of flow visualization techniques.

CO4: Do various measurements of pressure, velocity and temperature parameters.

CO5: Use data acquisition system for experiments.

Course Content

BASIC MEASUREMENTS IN FLUID MECHANICS **8 Hours**

Objective of experimental studies – Fluid mechanics measurements – Properties of fluids – Measuring instruments – Performance terms associated with measurement systems – Direct measurements – Analogue methods – Flow visualization – Components of measuring systems – Importance of model studies – Experiments on Taylor-Proudman theorem and Ekman layer – Measurements in boundary layers.

WIND TUNNEL MEASEUREMENTS **7 Hours**

Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels – Power losses in a wind tunnel – Instrumentation and calibration of wind tunnels – Turbulence – Wind tunnel balance – Principle and application and uses – Balance calibration.

FLOW VISUALIZATION AND ANALOGUE METHODS **10 Hours**

Visualization techniques – Smoke tunnel – Hele-Shaw apparatus – Interferometer – Fringe-Displacement method – Shadowgraph – Schlieren system – Background Oriented Schliren (BOS) System – Hydraulic analogy – Hydraulic jumps – Electrolytic tank.

PRESSURE, VELOCITY AND TEMPERATURE MEASUREMENTS **10 Hours**

Pitot-Static tube characteristics – Velocity measurements – Hot-wire anemometry – Constant current and Constant temperature – Hot-Wire anemometer – Hot-film anemometry – Laser

Doppler Velocimetry (LDV) – Particle Image Velocimetry (PIV) – Pressure Sensitive Paints – Pressure measurement techniques – Pressure transducers – Temperature measurements.

DATA ACQUISITION SYSTEMS AND UNCERTAINTY ANALYSIS 10 Hours

Data acquisition and processing – Signal conditioning – Estimation of measurement errors – Uncertainty calculation – Uses of uncertainty analysis – Introduction to design and analysis of experiments.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Rathakrishnan, E., 'Instrumentation, Measurements, and Experiments in Fluids', CRC Press, 2007.
2. Robert B Northrop, 'Introduction to Instrumentation and Measurements', Second Edition, CRC Press, 2006.
3. Cameron Tropea, Alexander Yarin, and John F. Foss (Ed.), 'Springer Handbook of Experimental Fluid Mechanics', Springer-Verlag, 2007.
4. Richard J. Goldstein (Ed.), 'Fluid Mechanics Measurements', Second Edition, Taylor and Francis, 1996.

U13AEE812	HIGH ENERGETIC FUELS AND PROPELLANTS	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the various types of fuels and propellants used in gas turbine and space propulsion systems.
- To provide the students with more detailed discussions on the design and development of high energetic fuels and propellants for meeting the future needs of the aerospace industry.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Identify the various types of fuels and propellants used in gas turbine and space propulsion systems.

CO2: Perform the design calculations for solid propellant.

CO3: Evaluate the combustion characteristics for different types of grains in solid propellant.

CO4: Perform the design calculations for liquid and cryogenic propellants.

CO5: Analyze the combustion characteristics of liquid propellant.

Course Content

INTRODUCTION 7 Hours

Aviation Fuels: Types of jet engine fuels, Properties of fuels commonly used in gas turbine combustors, combustion temperature and fuel-air ratio, Flame propagation, flame speed on fuel air ratio, estimate of TSFC, supersonic combustion – Introduction to bio fuels, Green aviation.

SOLID PROPELLANTS 10 Hours

Classification – Double Base, Composite, Composite Modified Double Base, Fuel- rich and Metalized Propellants; Propellant formulations, Mechanical and Ballistic Properties; The Mechanism of Deflagration-to-Detonation Transition (DDT) in high-performance combustors, Factors influencing ignition delay, Binders, burning-rate modifiers, curing agents, energetic and binders plasticizers, additives, Viscoelastic properties of propellants. Ageing Characteristics, low-smoke propellants, igniter propellants, propellant processing and manufacture, Hazards: Inadvertent ignition.

COMBUSTION OF SOLID PROPELLANTS **10 Hours**

Physical and chemical process, ignition process, extinction or thrust termination, combustion instability, vortex-shedding instability, Ignition and flame spread characteristic: Influence of Solid Propellant Grains geometry on ignition and flame spread characteristics. Different types of grains: End Burning, Radial Burning and Non-cylindrical Burning Grains; Segmented Grains; Grain Clustering; Burning Surface Area Evaluation; Design Criteria; Combustion characteristics of radial burning Dual Thrust Motor Grains.

LIQUID PROPELLANTS **10 Hours**

Essential Characteristics of Liquid Propellants, Propellant properties: performance of propellants, Common physical hazards: corrosion, explosion hazards, fire hazards, accidental spills, health hazards, material compatibility, Desirable physical properties: low freezing point, high specific gravity, stability, heat transfer properties, pumping properties, temperature variations, ignition, combustion and flame properties, additive, Different types of Liquid Oxidizers: Characteristics of liquid oxygen, hydrogen peroxide, nitric acid, and nitrogen tetroxide, Different types of liquid fuels: characteristics of hydrocarbon fuels, liquid hydrogen, hydrazine, unsymmetrical dimethylhydrazine, and monomethylhydrazine, Different types of Liquid mono propellants, Gelled propellants, Gaseous propellants.

Cryogenic Propellants: Production, Storage and Handling; Thermo-physical Properties of Cryogenic Propellants; Phenomenon of Thermal Stratification; Methods of Elimination of Thermal Stratification, Safety and environmental concerns.

COMBUSTION OF LIQUID PROPELLANTS **8 Hours**

Physical and chemical processes in the combustion of liquid propellants: injection, atomization, vaporization, mixing and reaction, Rapid combustion zone, injection/atomization zone, stream tube combustion zone, analysis and simulation, combustion instability: chugging, buzzing or entropy waves, screeching or screaming, pogo instability, Rating techniques and control of instabilities.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. George P Sutton and Oscar Biblarz, 'Rocket Propulsion Elements', Seventh Edition, John Wiley and Sons, 2001.
2. Philip G. Hill and Carl R. Peterson, 'Mechanics and Thermodynamics of Propulsion', Addison-Wesley Publishing Company, New York, 1999.
3. Kenneth Kuan-yun Kuo, 'Fundamentals of Solid Propellant rockets', AIAA Education Series, 1980.

4. Kenneth Kuan-yun Kuo, ‘Principles of Combustion’, Second Edition, Wiley-Interscience, 2005.
5. Yang,V., and Anderson, W., “Liquid Rocket Engine Combustion Instability”, Progress in Astronautics and Aeronautics, Vol.169, AIAA Inc., Washington, 1995.
6. Harrje, D.T., and Reardon F.H., “Liquid Propellant Rocket Combustion Instability”, NASA SP-194, NASA Washington, 1972.
7. Gordon Oates, ‘Aero thermodynamics of Gas Turbine and Rocket Propulsion’, AIAA Education Series, New York, 1989.
8. F. A. Williams, M. Barrere, and N. C. Huang, ‘Fundamental Aspects of Solid Propellant Rocket’, 1978.

U13AEE813	AIRPORT MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives

- To increase the professional knowledge and capability of airport management personnel worldwide in order to improve the performance of airports in their core missions (safety, security, efficiency, quality, social / environmental responsibility, etc.).
- To encourage the adherence to uniform standards and awareness of best practices at the world's airports.
- To promote the recognition of professional excellence in airport management.
- To expand communication among airport executives globally to knowledge sharing among the world's airports.

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1: Specify the design requirements related to Airport Management operations.

CO2: Estimate the runway requirements for performance of aircraft during takeoff and landing.

CO3: Understand the functions and operation of the aircraft control, ground electronics airfield lighting, runway and taxi way markings.

CO4: Appreciate the importance of weather, safety and collision avoidance to ensure Aviation safety and security.

CO5: Familiarize with next generation Radar, communication, ATC network and compliance to environmental acts.

Course Content

AIRPORT ADMINISTRATION **8 Hours**

ICAO convention, Definitions, Aviation terminology – ICAO Annexes, Airport Act, Regulations and Rules – Airport classification, designations and codes – Maintenance, security, safety, passenger and freight handling, Airfield equipment, Infrastructure and maintenance – Lighting, markings, runway and taxi ways, parking, hangars and maintenance, FBO services, VIP handling surface movement control.

AIRLINES **6 Hours**

Ticketing – gate control – crew handling – departure schedules – Aviation information manuals flight planning – FIR, FICs.

AIRPORT TERMINAL AREA MANAGEMENT **9 Hours**

Passenger and cargo handling – baggage and security – customs and immigration – Arrival / departure and transmit lounge – utilities and services – FOREX – taxi – transfer.

AIR TRAFFIC MANAGEMENT AND WEATHER **9 Hours**

Airside, landside, communications, phonetics and phraseology, Radio/Radar communications and landing aids, approach, departures, landings and takeoffs – Met services, briefing, weather reporting deicing / snow clearance, run way water logging drawings, Airport IMC / VMC

AIRPORT ENVIRONMENT AND ECOLOGY **9 Hours**

Greenhouse effect, ODS, CO_2 and Nox emissions, impact on climatic change, ICAO recommendations and IPCC recommendations – Birds, menace, animals intrusion, noise, pollution and emissions, waste management.

AIRPORT EMERGENCY HANDLING **4 Hours**

Runway obstruction – Intrusion – Accidents, Fire, Crash Management – Airport safety management system.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Seth B. Young and Alexander T. Wells, ‘Airport Planning and Management’, Sixth Edition, McGraw-Hill Professional, 2011.
2. International Civil Aviation Organization (ICAO) Annexes.
    - www.icao.int/safety/ism/ICAO%20Annexes/Forms/AllItems.aspx
    - www.caa.govt.nz/ICAO/ICAO_Compliance.htm
    - www.icao.int/safety/airnavigation/NationalityMarks/annexes_booklet_en.pdf
3. International Air Transport Association (IATA) Publications and Manuals.
4. ‘Air Traffic Control Handbook’, Transportation Dept., Federal Aviation Administration, Air Traffic Operations Program.
    - www.faa.gov/documentLibrary/media/Order/ATC.pdf
    - www.faa.gov/regulations_policies/orders_notices/index.cfm/go/document.information/documentID/1023549
5. P. S. Senguttuvan, ‘Fundamentals of Air Transport Management’, First Edition, Excel Books, 2006.
6. Richard De Neufville and Amedeo R. Odoni, ‘Airport Systems: Planning, Design, and Management’, McGraw-Hill Publishing, 2003.

U13AEE814 SATELLITE COMMUNICATIONS

L	T	P	C
3	0	0	3

Course Objectives

- To learn the basics of satellite communication signals.
- To understand link budget equations to provide sufficient margin for performance.
- To learn the modulation techniques in satellite communication.
- To learn multiple access and error correction techniques in satellite communication.
- To study the application of satellite communications.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Determine the link margin for a satellite communication system.

CO2: Modulate a carrier signal or demodulate a modulated signal mathematically.

CO3: Apply the multiplexing techniques in communication systems.

CO4: Analyze the performance of various multiple access techniques.

CO5: Detect and correct errors in data communication.

Course Content

BASICS OF SATELLITE COMMUNICATION **6 Hours**

Satellite Communications Architecture – Communication links – Types of Communication Signals – Signal Propagation – Polarization – Effect of Troposphere and Ionosphere on satellite signals – Frequency Bands – Data rate and Bandwidth – Modulation – Interference – Communication Subsystems – Communications Payload – Orbital aspects of Satellite Communication.

SATELLITE LINK DESIGN **5 Hours**

Satellite Link Equation – Satellite Link Parameters – Uplink and Downlink Design – Frequency Considerations – Propagation Considerations – Noise Considerations – Interference related Problems – Antenna Gain-to-Noise Temperature (G/T) Ratio – Link Budget Analysis.

MODULATION TECHNIQUES **10 Hours**

Amplitude Modulation (AM) – Different forms of AM – Frequency Modulation (FM) – Frequency Spectrum – Generation and Detection of FM Signals – Pulse Amplitude Modulation – Pulse Width Modulation – Pulse Position Modulation – Pulse Code Modulation (PCM) – Differential PCM – Delta Modulation – Adaptive Delta Modulation – Digital

Modulation: Amplitude Shift Keying, Frequency Shift Keying, Phase Shift Keying (PSK), Types of PSK.

MULTIPLEXING AND MULTIPLE ACCESS TECHNIQUES **10 Hours**

Frequency Division Multiplexing – Time Division Multiplexing – Frequency Division Multiple Access – Time Division Multiple Access: Frame Structure, Burst Structure, Frame Acquisition and Synchronization – Code Division Multiple Access: Direct Sequence, Frequency Hopping, Time Hopping – Space Division Multiple Access – Frequency Re-use – Transponder Assignment Modes.

ERROR DETECTION AND CORRECTION CODING SCHEMES **7 Hours**

Channel Coding – Forward Error Correction Coding – Linear Block Codes – Cyclic Codes – BCH Codes – Convolutional Codes.

EARTH STATION AND SATELLITE APPLICATIONS **7 Hours**

Earth Station Components – Antenna Subsystem – RF Subsystem – Communication Subsystem – Network Interface Subsystem – Applications: Mobile Satellite Services – Satellite and Cable Television – DTH – DBS – Satellite Radio – Satellite Phones – INTELSAT – INMARSAT – INSAT – GPS Satellites.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. Anil K. Maini and Varsha Agrawal, ‘Satellite Technology Principles and Applications’, John Wiley and Sons, 2007.
2. Timothy Pratt and Charles W. Bostian, ‘Satellite Communications’, John Wiley and Sons, 2001.
3. Michael O. Kolawole, ‘Satellite Communication Engineering’, Marcel Dekker Inc., 2002.
4. Gerard Maral and Michel Bousquet, ‘Satellite Communications Systems: Systems, Techniques and Technology’, John Wiley and Sons, 2007.
5. Wilbur L. Pritchard, H.G. Suyderhoud and Robert A. Nelson, ‘Satellite Communication Systems Engineering’, Prentice Hall, 2006.
6. Nazzareno Diodato, ‘Satellite Communications’, Sciyo Publications, 2010.
7. Giovanni E. Corazza, ‘Digital Satellite Communications’, Springer Publications, 2007.

U13AEE815	JET PROPULSION POWER PLANTS	L	T	P	C
		3	0	0	3

Course Objectives

- To provide the students with more detailed discussion of the major components in jet propulsion power plants and its efficiency testing.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the basic thermodynamic principles to perform thermodynamic cycle analysis in ideal gas turbine engines.

CO2: Calculate the performance parameters for a real gas turbine engine.

CO3: Design and analyze the turbo machinery components in a gas turbine engine.

CO4: Perform the design calculation for inlet and nozzles.

CO5: Evaluate the performance parameters of air breathing engine by conducing engine test.

Course Content

INTRODUCTION **8 Hours**

Components of a jet engine and brief history of gas turbine propulsion for aerospace applications – Thermodynamics and Combustion Fundamentals: Laws of thermodynamics, mixtures of perfect gases, reacting flow analysis assuming complete combustion – Parametric cycle analysis of ideal engines: Ideal turbojet with after burner, ideal turbofan with optimum bypass ratio, ideal turbofan with optimum fan pressure ratio – Ideal turboshaft engine with regeneration – Component performance – Ideal ramjet, Thermodynamics of Brayton-cycle engines.

CYCLE ANALYSIS OF REAL GAS TURBINE ENGINES **7 Hours**

Uninstalled thrust of turbojet engine, summary of equations – turbojet engine, Design input, Steps of engine parametric cycle analysis – Thrust specific fuel consumption, Turbojet with after burner, Turbofan engine – separate exhausts and convergent nozzles, with afterburning-mixed flow exhaust stream, Turboprop engine, variable gas properties – Component efficiencies.

TURBOMACHINERY **10 Hours**

Turbomachinery fundamentals – Euler's turbomachinery equations, Axial-flow compressor analysis-two dimensional flow through blade rows, velocity diagrams, cascade airfoil and loss coefficient, diffusion factor, stage loading and flow coefficient, stage pressure ratio, blade Mach number, radial equilibrium equation, compressor performance, compressor starting problems, Centrifugal-flow compressor analysis – general equations, Axial flow turbine analysis-stage parameters, adiabatic efficiency, exit swirl angle, stage loading and flow coefficient, degree of reaction, stage temperature and pressure ratio, blade spacing, radial variations, velocity ratio, turbine cooling, turbine performance, Centrifugal-flow turbine analysis – general equations – Design problems.

DESIGN CONSIDERATIONS OF INLETS AND NOZZLES 10 Hours

Introductions to inlets and nozzles, Subsonic inlets – inlet total pressure ratio, inlet sizing – throat diameter, inlet flow distortion, inlet drag, Nacelle and interference drag, diffuser, Supersonic inlets – basics of one-dimensional inlet flow, normal shock wave, ideal one-dimensional internal compression inlet, Inlet types-internal compression inlet, external compression inlet, mixed compression inlet, Total pressure recovery, Mass flow characteristics, Inlet design and sizing, inlet performance, Exhaust nozzles – convergent nozzle, convergent-divergent nozzle, Nozzle functions – engine backpressure control, exhaust nozzle area ratio, thrust reversing and vectoring, nozzle coefficients – gross thrust coefficient, discharge coefficient, velocity coefficient, angularity coefficient, nozzle performance.

COMBUSTION SYSTEMS DESIGN AND ENGINE TESTING 10 Hours

Introduction to combustion systems: combustion process, ignition, combustion stability, length scaling, combustion system total pressure ratio, diffusers – dump diffuser design, Fuels, main burners, combustion efficiency, exit temperature profile, Main burner design parameters, afterburners, Flame stabilization, Total pressure loss.

ENGINE TESTING: Proof of Concepts: Design Evaluation tests – Structural Integrity – Environmental Ingestion Capability – Preliminary Flight Rating Test, Qualification Test, Acceptance Test – Reliability figure of merit – Durability and Life Assessment Tests, Reliability Tests – Open Air Test Bed, Ram Air Testing, Altitude Testing, Altitude test facility, Flying Test Bed, Ground Testing of Engine Installed in Aircraft, Flight testing – Jet thrust measurements in flight.

Theory: 45 Hours Tutorial: 0 Hours Total Hours: 45

REFERENCES

1. Jack D Mattingly, ‘Elements of Gas Turbine Propulsion’, McGraw Hill series in Aeronautical and Aerospace Engineering, New York, 2009.
2. Oates, G.C., ‘Aero Thermodynamics of Aircraft Engine Components’, AIAA Education Series, New York, 1985.

3. Hill, P.G. and Peterson, C.R., 'Mechanics and Thermodynamics of Propulsion', Addison-Wesley Longman INC, 1999.
4. Irwin E. Treager, 'Gas Turbine Engine Technology', Seventh Edition, Tata McGraw Hill Publishing Co. Ltd., 2003.
5. P.P Walsh and P. Peletcher, 'Gas Turbine Performance', Blackwell Science, 1998.
6. Michael J. Kores, and Thomas W. Wild, 'Aircraft Power Plant', Seventh Edition, Tata McGraw Hill Publishing Co. Ltd., 2002.
7. J P Holman, 'Experimental Methods for Engineers', Tata McGraw-Hill Publishing Co. Ltd, 2007.
8. Cohen, H., Rogers, G.F.C. and Saravanamuttoo, H.I.H., 'Gas Turbine Theory', Fourth Edition, Pearson Education, 1989.
9. MIL-5007 E, 'Military Specifications: Engine, Aircraft, Turbo Jet and Turbofan; General Specification for Advance Aero Engine testing', October 1973.

U13AEE816	NON-DESTRUCTIVE TESTING FOR AEROSPACE APPLICATIONS	L	T	P	C
		3	0	0	3

Course Objectives

- To enable the students to acquire knowledge in various methods of non-destructive testing (NDT) to evaluate the material integrity used in aerospace applications.
- To study the working principle with component level of each NDT methods.

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Evaluate the various methods of Non-destructive testing (NDT) to test the material integrity used in engineering application.

CO2: Use radiography NDT methods for aerospace applications.

CO3: Use ultrasonic NDT methods for aerospace applications.

CO4: Apply the different NDT processes in aerospace industry.

CO5: Use Thermal inspection, Optical holography NDT methods for aerospace applications.

Course Content

INTRODUCTION TO NDT **6 Hours**

Importance of NDT in quality assurance – Different types of nondestructive techniques to obtain information regarding size, location and orientation of damage or cracks – Visual inspection techniques and coin tapping technique for composite structures and adhesive bonds.

RADIOGRAPHIC INSPECTION **9 Hours**

X–ray radiography: Principles of X-ray radiography, equipment – Production of X-rays, Absorption, scattering, X-ray film processing – industrial radiographic practice, micro-radiography, Gamma ray radiography: Radioactivity, gamma ray sources, film radiography, application, examples – General radiographic procedures – Reading and Interpretation of Radiographs – Defects in welding.

ULTRASONICS **8 Hours**

Principle of wave propagation – Ultrasonic equipment – Variables affecting an ultrasound test – Pulse echo technique, pitch-catch technique, through transmission technique, A-scan, B-Scan, C-scan – Determination of elastic constants using Ultrasonic velocity.

LIQUID PENETRANT TEST **12 Hours**

Basic concept – Test equipment – Test Parameters and Procedure – Safety precautions.

MAGNETIC PARTICLE TEST: Methods of generating magnetic field – Demagnetization of materials – Magnetic particle test: Principles, Test Equipment and Procedure – Interpretation and evaluation.

EDDY CURRENT TEST: Principles of eddy current – Factors affecting eddy currents – Test system and test arrangement – Standardization and calibration – Application and effectiveness.

OTHER METHODS **10 Hours**

Thermal Inspection: Principles, equipment, inspection methods, applications – Optical Holography: Principles, applications, Holographic recording interferometer techniques of inspection – Acoustic Emission Inspection: Sources of acoustic emission in composites, peak amplitude, rise time during events, ring-down counts duration of events.

Theory: 45 Hours **Tutorial: 0 Hours** **Total Hours: 45**

REFERENCES

1. J Prasad and C G Krishnadas Nair, 'Non-Destructive Test and Evaluation of Materials', Tata McGraw-Hill Publishing Co. Ltd., 2008.
2. P. E. Mix, 'Introduction to Non-Destructive Testing', John Wiley and Sons, 2005.
3. Bray, Don E. and Don McBride, 'Nondestructive Testing Techniques', Chapter 11 (Ultrasonic Testing of Aerospace Materials), John Wiley and Sons, New York, 1992.
4. Baldev Raj, T. Jayakumar, and M. Thavasimuthu, 'Nondestructive Testing', Narosa Publishing House, 1997.
5. C. Hellier, 'Handbook of Nondestructive Evaluation', McGraw-Hill, 1994.

U13AEP801	**PROJECT WORK – PHASE-II**	**L**	**T**	**P**	**C**
		0	**0**	**18**	**6**

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the knowledge of Mathematics, Science, and fundamentals of Aerodynamics, Structures, Propulsion and Avionics to identify, formulate and analyze complex engineering problems in aerospace applications.

CO2: Design aircraft system components by considering the constraints such as economics, environment, health and safety, manufacturability.

CO3: Conduct experiments by applying appropriate techniques, utilizing available resources and understand the impact of project results in environmental and societal context.

CO4: Simulate, analyze and interpret data using software tools such as MATLAB, ANSYS fluent, CFX, CFD++, ICEM CFD, GAMBIT, etc.

CO5: Work as an individual or as a member on project teams and communicate the results effectively by compiling project reports and presentations.

GUIDELINES

1. Develop a project planning strategy.
2. If it is an industry-sponsored project, a concurrent letter from industry is required.
3. A maximum of 4 students per group will do the project.
4. The project may be done in one of the labs under the supervision of a guide or in the selected industry.
5. At the end of the project, a report will be written and a technical presentation along with demonstration will be made by the students.
6. The report, project demonstration and technical presentation will be evaluated by the internal and external examiners.