B. TECH. AEROSPACE ENGINEERING

Total Contact Hours = 29 Total Marks = 900 Total Credits = 27

SEMESTER 3rd		Contact Hrs			Marks			Credits
Subject Code	Subject Name	L	T	P	Int.	Ext.	Total	
BMAT0-F91	Mathematics-III	3	1	0	40	60	100	4
BAEE2-301	Fluid Mechanics	3	1	0	40	60	100	4
BAEE2-302	Engineering Thermodynamics	3	1	0	40	60	100	4
BAEE2-303	Strength of Materials	3	1	0	40	60	100	4
BAEE2-304	Machine Design	1	0	4	40	60	100	3
BAEE2-305	Introduction to Aerospace	3	1	0	40	60	100	4
BAEE2-306	Fluid Mechanics Lab.	0	0	2	60	40	100	1
BAEE2-307	Strength of Materials Lab.	0	0	2	60	40	100	1
BAEE2-308	Workshop Training	0	0	0	60	40	100	2
Total	Total 6 Theory & 2 Lab. Courses	16	5	8	440	460	900	27

Total Contact Hours = 29 Total Marks = 800 Total Credits = 25

SEMESTER 4th		Contact Hrs			Marks			Credits
Subject Code	Subject Name	L	T	P	Int.	Ext.	Total	
BMAT0-F92	Numerical Analysis	3	1	0	40	60	100	4
BAEE2-409	Aerodynamics-I	3	1	0	40	60	100	4
BAEE2-410	Aircraft Structure-I	1	0	4	40	60	100	3
BAEE2-411	Aircraft Propulsion-I	1	0	4	40	60	100	3
BAEE2-412	Aircraft System & Instrumentation	3	0	0	40	60	100	3
BAEE2-413	Theory of Machine	3	1	0	40	60	100	4
BAEE2-414	Aircraft Structure Lab.	0	0	4	60	40	100	2
BAEE2-415	Aircraft System Lab.	0	0	4	60	40	100	2
Total	Total 6 Theory & 2 Lab. Courses	14	3	12	360	440	800	25

Total Contact Hours = 27 **Total Marks = 800** **Total Credits = 26**

SEMESTER 5th		Contact Hrs			Marks			Credits
Subject Code	Subject Name	L	T	P	Int.	Ext.	Total	
BAEE2-516	Aircraft Structure-II	3	1	0	40	60	100	4
BAEE2-517	Aircraft Propulsion-II	3	1	0	40	60	100	4
BAEE2-518	Aerodynamics-II	3	1	0	40	60	100	4
BAEE2-519	Control Engineering	3	0	0	40	60	100	3
BAEE2-520	Flight Dynamics-I	3	1	0	40	60	100	4
BAEE2-521	Aircraft Propulsion Lab.	0	0	4	60	40	100	2
BAEE2-522	Aerodynamics Lab.	0	0	4	60	40	100	2
BAEE2-523	Training-II	0	0	0	60	40	100	3
Total	**Total 5 Theory & 2 Lab. Courses**	**15**	**4**	**8**	**380**	**420**	**800**	**26**

Total Contact Hours = 23 **Total Marks = 700** **Total Credits = 21**

SEMESTER 6th		Contact Hrs			Marks			Credits
Subject Code	Subject Name	L	T	P	Int.	Ext.	Total	
BAEE2-624	Experimental Stress Analysis	3	1	0	40	60	100	4
BAEE2-625	Computational Fluid Dynamics	3	1	0	40	60	100	4
BAEE2-626	Flight Dynamics-II	3	1	0	40	60	100	4
BAEE2-627	Avionics	3	1	0	40	60	100	4
Departmental Elective-I (Select any one)		3	0	0	40	60	100	3
BAEE2-656	Theory of Elasticity							
BAEE2-657	Helicopter Engineering							
BAEE2-658	Aero Elasticity							
BAEE2-628	CAD/CAM Lab.	0	0	2	60	40	100	1
BAEE2-629	Aircraft Design Lab.	0	0	2	60	40	100	1
Total	**Total 6 Theory & 2 Lab. Courses**	**15**	**4**	**4**	**320**	**380**	**700**	**21**

Total Contact Hours = 15 **Total Marks = 500** **Total Credits = 19**

SEMESTER 7th		Contact Hrs			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
BAEE2-730	Mechanics of Composite Materials	3	1	0	40	60	100	4
BAEE2-731	Aerospace Quality Assurance	3	1	0	40	60	100	4
BAEE2-732	Finite Element Methods	3	1	0	40	60	100	4
Departmental Elective-II (Select any one)		3	0	0	40	60	100	3
BAEE2-759	Space Mechanics							
BAEE2-760	Guidance & Navigation							
BAEE2-761	Applied Gas Dynamics							
BAEE2-733	Training	0	0	0	60	40	100	4
Total	**Total 4 Theory & Courses**	**12**	**3**	**0**	**220**	**280**	**500**	**19**

Total Contact Hours = 6 **Total Marks = 300** **Total Credits = 12**

SEMESTER 8th		Contact Hrs			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
Open Elective-II		3	0	0	40	60	100	3
Departmental Elective-III (Select any one)		3	0	0	40	60	100	3
BAEE2-862	Experimental Aerodynamics							
BAEE2-863	Rockets & Missiles							
BAEE2-864	Aero Engine Maintenance & Repair							
BAEE2-834	Project	0	0	0	60	40	100	6
Total	**Total 2 Theory & Courses**	**6**	**0**	**0**	**320**	**380**	**300**	**12**

Total Credits: 25 + 25 + 27 + 25 + 26 + 21 + 19 + 12 = 180

ENGINEERING MATHEMATICS-III

Subject Code: BMAT0-F91 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

UNIT-I (13 Hrs.)

Fourier Series: Periodic function, Fourier Seies, Dirichlet's conditions, Fourier series for even and odd functions, Change of interval, Half range Fourier series, Other forms of Fourier series.

Fourier Transforms: Dirichlet's conditions, Fourier integral formula (without proof), Fourier transform, Inverse Theorem for Fourier transform, Fourier sine and cosine transforms and their inversion formulae. Properties of Fourier transform, Convolution theorem of Fourier transforms, Parseval's identity.

UNIT-II (10 Hrs.)

Laplace Transforms: Laplace transforms of various standard functions (Exponential, Algebraic, Sine, Cosine), Properties of Laplace transforms, inverse Laplace transforms, transform of derivatives and integrals, Laplace transform of unit step function, impulse function,

Application of Laplace Transforms: Solution of ordinary linear differential equations with constant coefficients, and simultaneous differential equations.

UNIT-III (12 Hrs.)

Partial Differential Equations: Formation of partial differential equations, Linear partial differential equations, homogeneous partial differential equations with constant coefficients. Classification of partial differential equation.

Applications of PDEs: Wave equation and Heat conduction equation in one dimension. Two dimensional Laplace equation in Cartesian Coordinates, solution by the method of separation of variables.

UNIT-IV (10 Hrs.)

Functions of Complex Variable: Limits, continuity and derivative of the function of complex variable, Analytic function, Cauchy-Riemann equations, conjugate functions, harmonic

functions; Conformal Mapping: Definition, standard transformations, translation, rotation, inversion, bilinear. Complex Integration: Line integrals in the complex plane, Cauchy's theorem, Cauchy's integral formula and derivatives of analytic function. Taylor's and Laurent's expansions (without proofs), singular points, poles, residue, Integration of function of complex variables using the method of residues(Integration Of type

$\int_0^{2\pi} F(Cos\theta, Sin\theta)d\theta, \quad \int_{-\infty}^{\infty} \frac{f(x)}{F(X)} dx)$

Recommended Books:

1. E. Kreyszing, 'Advanced Engineering Mathematics', 8th Edn., John Wiley, New Delhi.
2. B.S. Grewal, 'Higher Engineering Mathematics', Khanna Publishers, New Delhi.
3. Ian N. Sneedon, 'Elements of Partial Differential Equations', McGraw- Hill, Singapore, **1957**.
4. Peter. V. O'Nil, 'Advanced Engineering Mathematics', Wadsworth Publishing Company.
5. H.C. Taneja, 'Engineering Mathematics', Volume-I & II, I.K. Publisher.

FLUID MECHANICS

Subject Code: BAEE2-301 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Unit-I

1. **Introduction:** Fluid and continuum, Physical properties of fluids, Rheology of fluids
2. **Kinematics of Fluid flow:** Types of fluid flows: Continuum & free molecular flows. Steady and unsteady, uniform and non-uniform, laminar and turbulent flows, rotational and irrotational flows, compressible and incompressible flows, subsonic, sonic and supersonic flows, sub-critical, critical and supercritical flows, one, two and three dimensional flows, streamlines, continuity equation for 3D and 1D flows, circulation, stream function and velocity potential, source, sink, doublet and half-body

Unit-II

3. **Fluid Statistics:** Pressure-density-height relationship, manometers, pressure transducers, pressure on plane and curved surfaces, centre of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to linear acceleration and uniform rotation about an axis
4. **Dynamics of Fluid Flow:** Euler's Equation of motion along a streamline and its integration, Bernoulli's equation and its applications- Pitot tube, orifice meter, venturi meter and bend meter, Hot-wire anemometer and LDA, notches and weirs, momentum equation and its application to pipe bends

Unit-III

5. **Dimensional Analysis and Hydraulic Similitude:** Dimensional analysis, Buckingham's Pi theorem, important dimensionless numbers and their significance, geometric, kinematics and dynamic similarity, model studies
6. **Laminar and Turbulent Flow:** Equation of motion for laminar flow through pipes, Stokes' law, transition from laminar to turbulent flow, turbulent flow, types of turbulent flow, isotropic, homogenous turbulence, scale and intensity of turbulence, measurement of turbulence, eddy viscosity, mixing length concept and velocity distribution in turbulent flow over smooth and rough surfaces, resistance to flow, minor losses, pipe in series and parallel, power transmission through a pipe, siphon, water hammer, three reservoir problems and networks

Unit-IV

7. **Boundary Layer Analysis:** Boundary layer thickness, boundary layer over a flat plate, laminar boundary layer, application of momentum equation, turbulent boundary layer, laminar sublayer, separation and its control, Drag and lift, drag on a sphere, a two dimensional cylinder, and an aerofoil, Magnus effect.

Recommended Books:

1. S. Narasimhan, 'First Course in Fluid Mechanics', University Press.
2. S.K. Som & G. Biswas, 'Introduction of Fluid Mechanics & Fluid Machines', 2nd Edn., TMH, **2000**.
3. M.M. Das, 'Fluid Mechanics & Turbomachines', Oxford University Press.
4. S.K. Agarwal, 'Fluid Mechanics & Machinery', TMH.
5. Hunter Rouse, 'Elementary Mechanics of Fluids', John Wiley & Sons. Omc., **1946.**
6. I.H. Shames, 'Mechanics of Fluids', McGraw Hill, Int. Student, Education, **1988**.
7. Jagdish Lal, 'Fluid Mechanics'.

ENGINEERING THERMODYNAMICS

Subject Code: BAEE2-302 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Unit-I

BASIC THERMODYNAMICS:
Systems, Zeroth Law, First Law - Heat and work transfer in flow, second law, Clausius statement - concept of entropy change in non-flow processes.

AIR CYCLES:
Otto, Diesel, Dual combustion and Brayton combustion cycles – Air standard efficiency - Mean effective pressure – Actual and theoretical PV diagrams of two stroke and four stroke IC Engines.

Unit-II

THERMODYNAMICS OF ONE DIMENSIONAL FLUID FLOW:
Application of continuity, momentum and energy equations- Rankine cycle – Isentropic flow of ideal gases through nozzles - Simple jet propulsion system - Thrust rocket motor – Specific impulse.

Unit-III

REFRIGERATION AND AIR CONDITIONING:
Principles of refrigeration, Air conditioning - Heat pumps - Vapour compression – Vapour absorption types - Coefficient of performance, Properties of refrigerants.

Unit-IV

AIR COMPRESSORS:
Classification and working principle of compressors (Descriptive Treatment). Isothermal and Isentropic efficiency of air compressors.

RECOMMENDED BOOKS

1. E. Rathakrishnan, 'Fundamentals of Engineering Thermodynamics', Prentice – Hall, India, **2000.**
2. P.K. Nag, 'Engineering Thermodynamics', 7th Edn., Tata McGraw-Hills Co., Ltd., **1993.**
3. Yunus A. Cengal, 'Thermodynamics an Engineering Approach', 3rd Edn., Tata McGraw-Hill Co., Ltd., **2002**.

REFERENCES

1. A. Mayhew and B. Rogers, 'Engineering Thermodynamics', Longman Green & Co. Ltd., London, E.L.B.S. Edition, **1990**.
2. G.J. Van Wylen and R.E. Sonntag, 'Fundamentals of Classical Thermodynamics', S.I. Version, 2nd Edn., **1986**.
3. D.H. Bacon, 'Engineering Thermodynamics', Butterworth & Co., London, **1989**.
4. M.A. Saad, 'Thermodynamics for Engineers', Prentice-Hall of India Pvt. Ltd., **1989**.
5. Reynolds, 'Thermodynamics', Int. Student Edn., McGraw-Hill Book Co., Ltd., **1990.**

STRENGTH OF MATERIALS

Subject Code: BAEE2-303 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Unit-I

Compound Stress and Strains: Introduction, state of plane stress, Principal stress and strain, Mohr's stress circle.

3-D Stress, Theory of Failure, Castinglion's Theorem, Impact Load: Three dimensional state of stress & strain, equilibrium equations. Generalized Hook's Law. Theories of Failure. Castigliano's Theorem. Impact load & stresses.

Unit-II

Stresses, Deflection in Beams, Torsion: Review of pure Bending**.** Direct and shear stresses in beams due to transverse and axial loads, composite beams. Equation of elastic curve, cantilever and simply supported beams, Macaulay's method, area moment method, fixed and continuous beams. Review of Torsion, combined bending & torsion of solid & hollow shafts.
Helical and Leaf Springs: deflection of springs by energy method, helical springs under axial load and under axial twist (respectively for circular and square cross sections) axial load and twisting moment acting simultaneously both for open and closed coiled springs, laminated springs.

Unit-III

Columns and Struts: Combined bending and direct stress, middle third and middle quarter rules. Struts with different end conditions. Euler's theory and experimental results, Ranking Gardon Formulae, Examples of columns in mechanical equipment and machines.
Thin & Thick cylinders & spheres: Hoop and axial stresses and strain. Volumetric strain. 2 Radial, axial and circumferential stresses in thick cylinders subjected to internal or external pressures, Compound cylinders. Stresses in rotating shaft and cylinders. Stresses due to interference fits.

Unit-IV

Curved Beams: Bending of beams with large initial curvature, position of neutral axis for rectangular, trapezoidal and circular cross sections, stress in crane hooks, stress in circular rings subjected to tension or compression.
Unsymmetrical Bending: Properties of beam cross-section, slope of neutral axis, stress and deflection in unsymmetrical bending, determination of shear center and flexural axis (for symmetry about both axis and about one axis) for I-section and channel section.

Recommended Books:

1. Pytel, 'Mechanics of Materials'.
2. Ryder, 'Strength of Materials'.
3. Timoshenko and & Yσungs, 'Strength of Materials'.
4. Bear Jhonson, 'Mechanics of Materials'.
5. C.L. Dym and I.H. Shames, 'Solid Mechanics', **1990**.
6. Nash William, 'Strength of Materials', TMH, **1998.**

MACHINE DESIGN

Subject Code: BAEE2-304 **L T P C**
1 0 4 3

Unit-I

Introduction: Definition, Design requirements of machine elements, Design procedure, Standards in design, Selection of preferred sizes, Indian Standards designation of carbon & alloy steels, Selection of materials for static and fatigue loads.
Design against Static Load: Modes of failure, Factor of safety, Principal Stresses, Stresses due to bending and torsion, Theory of failure.

Unit-II

Design against Fluctuating Loads: Cyclic stresses, Fatigue and endurance limit, Stress concentration factor, Stress concentration factor for various machine parts, Notch sensitivity, Design for finite and infinite life, Soderberg, Goodman & Gerber criteria.

Riveted Joints: Riveting methods, materials, Types of rivet heads, Types of riveted joints, Caulking and Fullering, Failure of riveted joint, Efficiency of riveted joint, Design of boiler joints, Eccentric loaded riveted joint.

Unit-III

Shafts: Cause of failure in shafts, Materials for shaft, Stresses in shafts, Design of shafts subjected to twisting moment, bending moment and combined twisting and bending moments, Shafts subjected to fatigue loads, Design for rigidity

Keys and Couplings: Types of keys, splines, Selection of square & flat keys, Strength of sunk key, Couplings- Design of rigid and flexible couplings

Unit-IV

Mechanical Springs: Types, Material for helical springs, End connections for compression and tension helical springs, Stresses and deflection of helical springs of circular wire, Design of helical springs subjected to static and fatigue loading

Power Screws: Forms of threads, multiple threads, Efficiency of square threads, Trapezoidal threads, Stresses in screws, Design of screw jack

Note: Design data book is allowed in the examination

Recommended Books

1. Joseph E. Shigely, 'Mechanical Engineering Design', McGraw Hill Publications.
2. Alex Valance and VI Doughtie, 'Design of Machine Memebers', McGraw Hill Co.
3. M.F. Spott, 'Machine Design', Prentice Hall India.
4. Maleev and Hartman, 'Machine Design', **CBS**.
5. Black & Adams, 'Machine Design', McGraw Hill.
6. Sharma and Agrawal, 'Machine Design', S.K. Kataria & Sons.
7. V.B. Bhandari, 'Design of Machine Elements', Tata McGraw Hill Co.

INTRODUCTION TO AEROSPACE

Subject Code: BAEE2-305 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Unit-I

1. HISTORICAL EVALUATION: History of Aviation, Early Development of Airplanes, Biplanes and Monoplanes, History of Spaceflight, Development of Space Vehicle, Classification of Duct Jet Propulsion, Rocket Propulsion, Advance Propulsion and Applications.

2. CONFIGURATIONS: Anatomy of flight vehicles, Components of an airplanes and their function, Configuration of space vehicle, Earth's atmosphere and gravitational field, Bluff bodies v/s Streamlined body, Airfoil, Lift generation, Significance of L/D ratio, Aerodynamic forces.

Unit-II

3. PROPULSION: Classification and Essential features of propulsion, Jet propulsion, General characteristics of rocket engines, Theory of propulsion, Elementary gas dynamics, Spacecrafts and Aircraft performance.

Unit-III

4. AEROSPACE STRUCTURES AND MATERIALS: General types of Construction and Structural Layout, Flight Envelope and V-N Diagrams, Monocoque, Semimonocoque, Corrugated, Sandwich Structure, Reinforced and Honeycomb Structures, Geodesic Construction, Aerospace Materials, Metallic and Non-Metallic Materials, Uses of Aluminium Alloy, Titanium, Stainless Steel, Composite and Ceramic Materials

Unit-IV

5. INSTRUMENTS AND NAVIGATION: Basic Instrumentation, Electronics (DC Electronics, AC Electronics, Semiconductors, Electro-Optics and Digital Electronics), Sensing Devices, Bridge Circuits, Optical Devices and Introduction to Computer Based Data Acquisition, Measurements in Aerodynamics, Flight Structures, Flight Control, Principles of Navigation, Celestial, Radio, and Inertial Navigation Schemes, Navigational and Guidance Requirements for Orbital, Planetary, and Atmospheric Entry Missions

RECOMMENDED BOOKS:

1. Shevel, 'Fundamentals of Flight', Prentice Hall, **1989**.
2. G.D. Merrill, 'Principle of Guided Missile Design', Van Nostrand Co., INC., **1977.**
3. J.D. Anderson, 'Introduction to Flight', McGraw-Hill, **2000**.
4. A.C. Kermode, 'Flight without Formulae', Pitman, **1970.**

FLUID MECHANICS LAB.

Subject Code: BAEE2-306 **L T P C**
0 0 2 1

1. To verify the momentum equation using the experimental set-up on diffusion of submerged air jet.
2. To determine the coefficient of discharge of an orifice of a given shape. Also to determine the coefficient of velocity and the coefficient of contraction of the orifice mouth piece.
3. To calibrate an orifice meter, venturimeter, and bend meter and study the variation of the co-efficient of discharge with the Reynolds number.
4. To study the transition from laminar to turbulent flow and to determine the lower critical Reynolds number.
5. To study the velocity distribution in a pipe and also to compute the discharge by integrating the velocity profile.
6. To study the variation of friction factor, 'f' for turbulent flow in commercial pipes.
7. To study the boundary layer

STRENGTH OF MATERIALS LAB.

Subject Code: BAEE2-307 **L T P C**
0 0 2 1

1. Strength testing of a given mild steel specimen on UTM with full details and s-e plot on the machine.
2. Other tests such as shear, bend tests on UTM.
3. Impact testing on impact testing machine like Charpy, Izod or both.
4. Hardness testing of given specimen using Rockwell and Vickers/Brinell testing machines.
5. Spring index testing on spring testing machine.
6. Fatigue testing on fatigue testing machine.
7. Creep testing on creep testing machine.
8. Deflection of beam experiment, comparison of actual measurement of deflection with dial gauge to the calculated one, and or evaluation of young's modulus of beam.
9. Torsion testing of a rod on torsion testing machine.
10. Study of non-destructive testing methods like magnetic flaw detector, ultrasonic flaw detector, eddy current testing machine, dye penetrant tests.

NUMERICAL ANALYSIS

Subject Code: BMAT0-F92 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

UNIT-1

Solution of algebraic and transcendental equations: Errors and Approximations: Absolute, Relative, Truncation and round off errors, Floating point arithmetic, Bounds on error, Error propagation in computation.
Solution of algebraic and transcendental equations: Bisection method, Iteration method, Regula-falsi method, Secant method, Newton-Raphson method. Convergence of these methods.

UNIT-2

Methods to Solve System of Linear Equations: System of linear algebraic equations: Guass elimination method, Gauss – Jordon method, LU factorization method, Jacobi and Gauss-Seidal methods. Eigen values and Eigen vectors: Rayleigh power method.

UNIT-3

Interpolation, Numerical Integration: Interpolation: Finite differences, Newton Gregory forward and Backward formula, Central differences formulae: Bessel, Stirling and Everette's formulae. Lagrange's formula, Divided differences Newton's formula
Numerical integration: Newton-Cotes Formulae-Trapezoidal, Simpson's, Boole's and Weddle's rules of integration, Romberg integration, Gaussian integration.

UNIT-4

Methods to Solve Ordinary Differential Equation: Ordinary differential equations: Taylor series and Picard's methods, Euler and modified Euler methods, Runge–Kutta methods, Predictor- Corrector methods: Adams-Bashforth and Milne methods.

Recommended Books

1. B. Bradie, 'A friendly introduction to Numerical Analysis', Pearson Prentice Hall, **2006.**
2. K.E. Atkinson, 'Introduction to Numerical Analysis', 2nd Edn., John Wiley, **1989.**
3. S.D. Conte and C. De Boor, 'Elementary Numerical Analysis: An Algorithmic Approach', 3rd Edn., McGraw Hill, New York, **1980.**
4. J.B. Scarborough, 'Numerical Mathematical Analysis', Oxford & IBH Publishing Co., **2001**

AERODYNAMICS- I

Subject Code: BAEE2-409 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Unit-I

1. Introduction: Fluid statics, Pascal's law, Continuum and free molecular flows, Invisid and viscous flows, incompressible and compressible flows. Newtonian and Non-Newtonian flows. Pitot static tube, measurement of air-speed, pressure coefficient. Aerodynamic force and moments, Dimensional analysis, non-dimensional parameters, M, Re, Fr etc., flow similarity.
2. Description of Fluid Motion: Lagrangian and Eulerian methods, Description of properties in a moving fluid, local and material rate of change. Streamlines, Pathlines, Streaklines, Reynolds Transport theorem, Vorticity and circulation. Laws of vortex motion. Translation, rotation and rate of deformation of fluid particles.

Unit-II

3. Equations of Fluid Motion: Equation of conservation of mass for control volume, special form of equation of conservation of mass, differential form of equation of conservation of mass

Euler's and Navier-Stoke equations. Derivation of Bernoulli's equation for Invisid and viscous flow fields. Momentum equation and angular momentum equation in integral form.

Unit-III

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

Unit-IV

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

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

RECOMMENDED BOOKS:

1. John D. Anderson (Jr.), 'Fundamentals of Aerodynamics', 2nd Edn., McGraw Hill.
2. Gupta and Gupta, 'Fluid Mechanics and its Applications', Wiley Eastern, **1960**
3. H. Schlichting, 'Boundary Layer Theory', 6th Edn., McGraw Hill, **1986.**
4. Frank M. White, 'Fluid Mechanics', 2nd Edn., McGraw Hill, **1986.**

AIRCRAFT STRUCTURE-I

Subject Code: BAEE2-410 **L T P C**
1 0 4 3

Unit-I

Statically Determinate Structures:

Analysis of plane, Truss-Method of joints, 3 D Truss, Plane frames, Composite beam.

Statically Indeterminate Structures:

Propped Cantilever- Fixed-Fixed beams-Clapeyron's Three Moment Equation – Moment Distribution Method.

Unit-II

Energy Methods:

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

Unit-III

Columns:

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

Unit-IV

Failure Theory:

Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum Strain energy theory – Application to aircraft Structural problems.

RECOMMENDED BOOKS:

1. B.K. Donaldson, 'Analysis of Aircraft Structures – An Introduction', McGraw-Hill, **1993**.
2. Timoshenko, Goodier, 'Theory of Elasticity', Tata McGraw Hill.
3. L.S. Srinath, 'Advanced Solid Mechanics', McGraw Hill.

AIRCRAFT PROPULSION-I

Subject Code: BAEE2-411 **L T P C**
1 0 4 3

Unit-I

Fundamentals of Gas Turbine 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.

Unit-II

Subsonic and Supersonic Inlets for Jet Engines: Internal flow and Stall in subsonic inlets – Boundary layer separation – Major features of external flow near a subsonic inlet – Relation between minimum area ratio and eternal deceleration ratio – Diffuser performance – Supersonic inlets – Starting problem on supersonic inlets – Shock swallowing by area variation – External declaration – Models of inlet operation.

Unit-III

Combustion Chambers: 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 – Numerical problems.

Nozzles: Theory of flow in isentropic nozzles – nozzles and choking – Nozzle throat conditions – Nozzle efficiency – Losses in nozzles – Over expanded and under – expanded nozzles - Ejector and variable area nozzles – Interaction of nozzle flow with adjacent surfaces –Thrust reversal.

Unit-IV

Compressors: Principle of operation of centrifugal compressor – Work done and pressure rise – Velocity diagrams – Diffuser vane design considerations – Concept of prewhirl, rotation stall and surge – Elementary theory of axial flow compressor – Velocity triangles – degree of reaction – Three dimensional – Air angle distributions for free vortex and constant reaction designs – Compressor blade design – Centrifugal and Axial compressor performance characteristics.

RECOMMENDED BOOKS

1. P.G. Hill & C.R. Peterson, 'Mechanics & Thermodynamics of Propulsion', Addison – Wesley Longman INC, **1999**.

REFERENCES

1. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H., 'Gas Turbine Theory', Longman, **1989**.
2. G.C. Oates, 'Aero thermodynamics of Aircraft Engine Components', AIAA Education Series, New York, **1985**.
3. 'Rolls Royce Jet Engine', 3rd Edn., **1983**.
4. M.L. Mathur and R.P. Sharma, 'Gas Turbine, Jet and Rocket Propulsion', Standard Publishers & Distributors, Delhi, **1999**.

AIRCRAFT SYSTEM & INSTRUMENTATION

Subject Code: BAEE2-412 **L T P C** **Duration: 34 Hrs.**
3 0 0 3

Unit-I

1. Flight Control Systems: Primary and secondary flight control, flight control linkage systems, push-pull control rod system, cable and pulley systems, high lift control systems, flight control actuation, linear actuator, mechanical actuator, mechanical screw-jack actuator, direct drive actuation, fly-by-wire actuator, electro-hydrostatic actuator, electro-mechanical actuator.

Unit-II

2. Engine Control Systems: Engine technology and principle of operation, fuel flow control, air flow control, control systems, control system parameters, input signals, output signals, engine starting, fuel control, ignition control, engine rotation, throttle levers, starting sequence, engine oil systems.

Unit-III

3. Hydraulic and Environment Control Systems: Hydraulic circuit design, hydraulic actuation, hydraulic fluid, fluid pressure and temperature, fluid flow rate, hydraulic piping and pumps, need for controlled environment, heat sources, ram air cooling, fuel cooling, engine bleed, bleed flow and temperature control, air cycle, refrigeration, humidity control, hypoxia, tolerance.

Unit-IV

4. Pitot Static Instruments & Systems: Pitot static system, air speed indicator, altimeter, mach-meter, mach/airspeed indicator, vertical speed indicator.
5. Gyroscopic Instruments: Gyroscope and its properties, gyro-horizon, turn and bank indicator, turn coordinator, direct reading magnetic compass, directional gyroscope.
6. Navigational Instruments: Very high and ultra-high frequency radio aids, VOR, TACAN, VORTAC, VHF direction finding, instrument landing system, and microwave landing system.

RECOMMENDED BOOKS

1. Ian Moir and Allan Seabridge, 'Aircraft Systems', John Wiley & Sons.
2. E.H.J. Pallet, 'Aircraft Instruments', Pearson.
3. 'Aviation Maintenance Technician Hand Book (General) (AC 65-9A)', Himalayan Books.
4. 'Civil Aircraft Inspection Procedure', English Books Store, Delhi (CAIP – CAA).
5. Scheppler Robert, 'Aircraft Oxygen System', Himalayan Books.

THEORY OF MACHINES

Subject Code: BAEE2-413 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Unit-I

1. Basic Concept of Machines: Link mechanism, kinematic pair and chain, principles of inversion, inversion of a four bar chain, slider-crank-chain, double slider-crank-chain and their inversions, kinematic pairs, Graphical (relative velocity vector and instantaneous center methods) and Analytical methods for finding: Displacement, velocity, and acceleration of mechanisms (including Corliolis).

Unit-II

2. Lower Pairs: Universal joint, calculation of maximum torque, steering mechanisms including Ackerman and Davis approximate steering mechanism, engine indicator, Pentograph, Straight line mechanisms.

3. Belts, Ropes and Chains: Material, types of drives, idle pulley, intermediate or counter shaft pulley, angle and right angle drive, quarter turn drive, velocity ratio, crowning shaft pulley, loose and fast pulley, stepped or cone pulleys, ratio of tension on tight and slack sided of belts, HP transmitted by belts including consideration of creep and slip, centrifugal tensions and its effect on HP transmitted. Use of gravity, idle, flat, V-belts and rope materials, Length of belt, rope and chain drives, type and cone type.

Unit-III

4. Cams: Types of cams and follower, definitions of terms connected with cams, displacement velocity and acceleration diagrams for cam followers. Analytical and Graphical design of cam profiles with various motions (SHM, uniform acceleration and retardation, cycloidal). Analysis of follower motion for circular convex, tangent cam profiles. Calculation of pressure angle.

5. Friction Devices: Concepts of frictions and wear related to bearing and clutches. Types of brakes, Principle of function of Brakes of various types. Braking of front and rear tyres of a vehicle, Problems to determine braking capacity, Types of dynamometers (absorption & transmission).

Unit-IV

6. Flywheels: Turning moment and crank effort diagrams for reciprocating machines, Fluctuations of speed, coefficient of fluctuation of speed and energy, Determination of flywheel mass and dimensions for engines and Punching Machines.

7. Governors: Function, types and characteristics of governors, Watt, Porter and Proell governor, Hartnell and Willson-Hartnell, spring loaded governors, Simple numerical problems on these governors, Sensitivity, stability, isochronisms and hunting of governor, Governor effort and power controlling force curve, effect of sleeve friction

RECOMMENDED BOOKS:

1. Jagdish Lal, 'Theory of Mechanisms & Machines', Metropolitan Book Co. Pvt. Ltd., New Delhi.
2. S.S. Rattan, 'Theory of Machines', Tata McGraw Hill, New Delhi.
3. Thomas Beven, 'Theory of Machines', Longman's Green & Co., London.
4. W.G. Green, 'Theory of Machines', Blackie & Sons, London.
5. Shigley, W.G. Green, 'Theory of Machines', McGraw Hill, New York.

AIRCRAFT STRUCTURE LAB.

Subject Code: BAEE2-414 **L T P C**
0 0 4 2

LIST OF EXPERIMENTS (PERFORM ANY 8 EXPERIMENTS)

1. Determination of Young's modulus of aluminum using electrical extensometers
2. Determination of fracture strength and fracture pattern of ductile & brittle materials.
3. Deflection of beams with various end conditions for different load.
4. Verification of Maxwell's Reciprocal theorem & principle of superposition.
5. Compression tests on long and short columns, Critical buckling loads, South well plot.
6. Wagner beam – Tension field beam.
7. Shear centre location for open sections.
8. Shear centre location for closed sections.
9. Flexibility matrix for cantilever beam.

10. Beam with combined loading.
11. Experiment on Photo- elastic bench.

AIRCRAFT SYSTEMS LAB.

Subject Code: BAEE2-415 **L T P C**
0 0 4 2

Study of any eight of the following aircraft systems:

1. Aircraft "Jacking Up" procedure
2. Aircraft "Levelling" procedure
3. Control System "Rigging check" procedure
4. Aircraft "Symmetry Check" procedure
5. "Flow test" to assess of filter element clogging
6. "Pressure Test" To assess hydraulic External/Internal Leakage
7. "Functional Test" of Hydraulic Actuator for its proper operation, leakage and load test.
8. "Pressure Test" procedure on fuel system components
9. "Brake Torque Load Test" on wheel brake units
10. Maintenance and rectification of snags in pneumatic, hydraulic and fuel systems components and on Aircraft.
11. Functional Test of Fire detection system on aircraft.
12. Functional Test of Aircraft Pressurization System on aircraft.
13. Functional Test of aircraft landing gear retraction system and its relevant indications in the cockpit.
14. Identification of various components, pipelines with color coding on aircraft.
15. Study of combustion chambers of various engines
16. Study of hydraulic systems of various aircraft
17. Study of pneumatic systems of various aircraft
18. Study of brake systems of various aircraft

AIRCRAFT STRUCTURE-II

Subject Code: BAEE2-516 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Unit-I

UNSYMMETRICAL BENDING: General, Principal axis and neutral axis methods- bending stresses in beams of symmetric sections with skew loads- bending stresses in beams of unsymmetrical sections.

Unit-II

SHEAR FLOW IN OPEN SECTIONS: Thin walled beams, Concept of shear flow, shear centre, Elastic axis. With one axis of symmetry, with wall effective and ineffective in bending, unsymmetrical beam sections.

SHEAR FLOW IN CLOSED SECTIONS: Bredt – Batho formula, Single and multi – cell structures - Shear flow in single & multicell structures under torsion. Shear flow in single and multicell under bending with walls effective and ineffective.

Unit-III

BUCKLING OF PLATES: Rectangular sheets under compression, local buckling stress of thin walled section- Crippling stresses by Needham's and Gerard's methods, thin walled column strength sheet stiffener Panels-Effective width.

Unit-IV

STRESS ANALYSIS IN WING AND FUSELAGE: Shear resistant web Beams-Tension field web beams (Wagner's) – Shear and bending moment distribution for cantilever and semi-cantilever types of beams-loads on aircraft –lift Distribution-V-n Diagram-Gust loads.

Recommended Books:

1. T.H.G. Megson, 'Aircraft Structures for Engineering Students', Elsevier.
2. N.G.R. Iyengar, 'Structural Stability of Columns and Plates', Affiliated East-West Press (Pvt.) Ltd.
3. C. Chajis, 'Introduction to Structural Stability', Prentice Hall Inc. Engle Wood Cliff.
4. David J. Perry, 'Aircraft Structures', McGraw Hill.
5. R.M. Rivello, 'Theory and Analysis of Flight Structures', McGraw Hill.
6. T.R. Chandruplata and A.D. Belagundu, 'Introduction to Finite Elements in Engineering', PHI.

AIRCRAFT PROPULSION-II

Subject Code: BAEE2-517 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Unit-I

AIRCRAFT GAS TURBINES: Impulse and reaction blading of gas turbines – Velocity triangles and power output – Elementary theory – Vortex theory – Choice of blade profile, pitch and chord – Estimation of stage performance – Limiting factors in gas turbine design-Overall turbine performance – Methods of blade cooling – Matching of turbine and compressor.

Unit-II

RAMJET PROPULSION: Operating principle – Sub critical, critical and supercritical operation – Combustion in ramjet engine – Ramjet performance – Simple ramjet design calculations – Introduction to scramjet.

Unit-III

FUNDAMENTALS OF ROCKET PROPULSION: Operating principle – Specific impulse of a rocket – internal ballistics- Rocket nozzle classification – Rocket performance considerations.

Unit-IV

CHEMICAL ROCKETS: Solid propellant rockets – Selection criteria of solid propellants – Important hardware components of solid rockets – Propellant grain design considerations – Liquid propellant rockets – Selection of liquid propellants. Cooling in liquid rockets – Hybrid rockets.

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

RECOMMENDED BOOKS

1. G.P. Sutton, 'Rocket Propulsion Elements', 5th Edn., John Wiley & Sons Inc., New York, **1993**.
2. P.G. Hill & C.R. Peterson, 'Mechanics & Thermodynamics of Propulsion', Addison – Wesley Longman INC, **1999**.

REFERENCES

1. H. Cohen, G.F.C. Rogers and H.I.H. Saravanamuttoo, 'Gas Turbine Theory', Longman Co., ELBS Edn., **1989**.

2. C.V. Gorden, 'Aero thermodynamics of Gas Turbine and Rocket Propulsion', AIAA Education Series, New York, **1989**.
3. M. Mathur and R.P. Sharma, 'Gas Turbines and Jet and Rocket Propulsion', Standard Publishers, New Delhi, **1988**.

AERODYNAMICS-II

Subject Code: BAEE2-518 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Unit-I

One Dimensional Compressible Flow: Energy, Momentum, continuity and state equations. Velocity of sound, adiabatic steady state flow equations, Flow through converging, diverging passages. Performance under various back Pressures.

Unit-II

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

Unit-III

Differential Equations of Motion for Steady Compressible Flows: Small perturbation potential theory, solutions for supersonic flows, Mach waves and Mach angles, Prandtl-Glauert affine transformation, relations for subsonic flows, Linearized two dimensional supersonic flow theory, Lift, drag pitching moment and center of pressure of supersonic profiles.

Unit-IV

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

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

RECOMMENDED BOOK

1. E. Rathakrishnan, 'Gas Dynamics', Prentice Hall of India, **2003**.

REFERENCES

1. A.H. Shapiro, 'Dynamics and Thermodynamics of Compressible Fluid Flow', Ronald Press, **1982**.
2. M.J. Zucrow and J.D. Anderson, 'Elements of Gas Dynamics', McGraw-Hill Book Co., New York, **1989**.
3. Anderson Jr., D., 'Modern Compressible Flows', McGraw-Hill Book Co., New York, **1999**.

CONTROL ENGINEERING

Subject Code: BAEE2-519 **L T P C** **Duration: 34 Hrs.**
3 0 0 3

Unit-I

1. INTRODUCTION: Concept of automatic controls, open and closed loop systems, concepts of feedback, requirement of an ideal control system. Types of controllers– Proportional, Integral, Proportional Integral, Proportional Integral Differential controllers.

2. MATHEMATICAL MODELS: Transfer function models, models of mechanical systems, models of electrical circuits, DC and AC motors in control systems, models of thermal systems, models of hydraulic systems. Pneumatic system. Analogous systems: Force voltage, Force current.

Unit-II

3. BLOCK DIAGRAMS AND SIGNAL FLOW GRAPHS: Transfer Functions definition, function, block representation of system elements, reduction of block diagrams, Signal flow graphs: Mason's gain formula.

4. TRANSIENT AND STEADY STATE RESPONSE ANALYSIS: Introduction, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response. System stability: Routh's-Hurwitz Criterion.

Unit-III

5. FREQUENCY RESPONSE ANALYSIS: Polar plots, Nyquist Stability Criterion, Stability Analysis, Relative stability concepts, phase and gain margin, M & N circles.

6. FREQUENCY RESPONSE ANALYSIS USING BODE PLOTS: Bode attenuation diagrams, Stability Analysis using Bode plots, Simplified Bode Diagrams.

Unit-IV

7. ROOT LOCUS PLOTS: Definition of root loci, general rules for constructing root loci, Analysis using root locus plots.

8. CONTROL ACTION AND SYSTEM COMPENSATION: Series and feedback compensation, Physical devices for system compensation.

RECOMMENDED BOOKS:

1. Katsuhiko Ogata, 'Modern Control Engineering', Pearson Education, **2004**.
2. M. Gopal, 'Control Systems Principles and Design', TMH, **2000.**

REFERENCE BOOKS:

1. 'Feedback Control Systems', Schaum's Series, **2001**.
2. I.J. Nagarath & M. Gopal, 'Control Systems', New Age International Publishers, **2002**.
3. B.C. Kuo, F. Golnaraghi, 'Automatic Control Systems', John Wiley & Sons, **2003**.

FLIGHT DYNAMICS-I

Subject Code: BAEE2-520 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Unit-I

ATMOSPHERE: International standard atmospheric, geopotential and geometric altitude, troposphere and stratosphere, stability of atmosphere. Pressure altitude, equivalent, calibrated, and indicated air speed, primary flight instruments, ASI, VSI, Turn-bank indicator.

Unit-II

AERODYNAMIC CHARACTERISTICS-I: Drag aerodynamics, Drag polar, Estimation of drag. Forces and moments from dimensional analysis, Pressure distribution over airfoils, variation with angle of attack, aerodynamic centre of pressure related problems.

AERODYNAMIC CHARACTERISTIC-II: Estimation of CL, CD and CM from pressure distribution, variation of aerodynamic coefficients with Reynolds number and Mach number. Effect of span, aspect ratio, platform, sweep, taper and twist on aerodynamic characteristics V/STOL configurations

Unit-III

AIRPLANE PERFORMANCE IN STEADY & LEVEL FLIGHT: Equation of motion of aircraft, variation of drag with flight, power required and power available, minimum drag and minimum power conditions, climbing and gliding performance,

Unit-IV

AIRPLANE PERFORMANCE IN ACCELARATED FLIGHT: Take-off and landing, steady climb and descent, absolute and service ceiling, cruise, cruise climb, range and endurance, load factor, V-n diagram, jet assisted take-off, effect of head, tail and cross winds. Turning flight performance

Recommended Books:

1. J.D. Anderson, 'Introduction to Flight', McGraw Hill.
2. J.D. Anderson, 'Fundamentals of Aerodynamics', McGraw Hill.
3. E.L. Houghton and N.B. Carruthers, 'Aerodynamics for Engineering Students', Arnold Publisher.

AIRCRAFT PROPULSION LAB.

Subject Code: BAEE2-521 **L T P C**
0 0 4 2

LIST OF EXPERIMENTS (PERFORM ANY 8 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 magneto and ignition system.
3. Study of an aircraft jet engine compressor.
4. Study of jet engine combustion chamber.
5. Study of jet engine turbine.
6. Study of forced convective heat transfer over a flat plate.
7. Study of free convective heat transfer over a flat plate
8. Study of free jet.
9. Study of wall jet.
10. Study of ramjet.

AERODYNAMICS LAB.

Subject Code: BAEE2-522 **L T P C**
0 0 4 2

LIST OF EXPERIMENTS (PERFORM ANY 8 EXPERIMENTS)

1. Calibration of a subsonic wind tunnel: test section static pressure and total head distributions.
2. Smoke flow visualization studies on a two-dimensional circular cylinder at low speeds.

3. Smoke flow visualization studies on a two dimensional airfoil at different angles of incidence at low speeds
4. Tuft flow visualization on a wing model at different angles of incidence at low speeds: identify zones of attached and separated flows.
5. Surface pressure distributions on a two-dimensional circular cylinder at low speeds and calculation of pressure drag.
6. Surface pressure distributions on a two-dimensional symmetric airfoil at zero incidence at low speeds.
7. Surface pressure distributions on a two-dimensional cambered airfoil at different angles of incidence and calculation of lift and pressure drag.
8. Calculation of total drag of a two-dimensional circular cylinder at low speeds using pitot static probe wake survey.
9. Calculation of total drag of a two-dimensional cambered airfoil at low speeds at incidence using pitot-static probe wake survey.
10. Measurement of a typical boundary layer velocity profile on the tunnel wall (at low speeds) using a pitot probe and calculation of boundary layer displacement and momentum thickness.

EXPERIMENTAL STRESS ANALYSIS

Subject Code: BAEE2-624 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Unit-I

MEASUREMENTS & EXTENSOMETER: Principles of measurements, Accuracy, Sensitivity and range of measurements. Mechanical, Optical Acoustical and Electrical extensometers and their uses, Advantages and disadvantages.

Unit-II

ELECTRICAL RESISTANCE STRAIN GAUGES: Principle of operation and requirements, Types and their uses, Materials for strain gauge. Calibration and temperature compensation, cross sensitivity, Rosette analysis, Wheatstone Bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators.

Unit-III

PHOTOELASTICITY: Two dimensional photo elasticity, Concept of light – photoelastic effects, stress optic law, Interpretation of fringe pattern, Compensation and separation techniques, Photo elastic materials. Introduction to three dimensional photo elasticity.

Unit-IV

BRITTLE COATING AND MOIRE METHODS: Introduction to Moire techniques, brittle coating methods and holography.

NON – DESTRUCTIVE TESTING: Fundamentals of NDT, Radiography, ultrasonic, magnetic particle inspection, Fluorescent penetrant technique, Eddy current testing, Acoustic Emission Technique.

RECOMMENDED BOOKS

1. L.S. Srinath, M.R. Raghava, K. Lingaiah, G. Garagesha, B. Pant and K. Ramachandra, 'Experimental Stress Analysis', Tata McGraw-Hill, New Delhi, **1984**.

REFERENCES

1. J.W. Dally and W.F. Riley, 'Experimental Stress Analysis', 4th Edn., McGraw-Hill Inc., New York, **2005**.
2. M. Hetyenyi, 'Hand book of Experimental Stress Analysis', John Wiley and Sons Inc., New York, **1972**.

3. A.A. Pollock, 'Acoustic Emission in Acoustics and Vibration Progress', Ed. R.W.B. Stephens, Chapman and Hall, **1993.**

COMPUTATIONAL FLUID DYNAMICS

Subject Code: BAEE2-625 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Unit-I

INTRODUCTION: Insight into power and philosophy of CFD. CFD ideas to understand. CFD application. Need for parallel computers for CFD algorithms. Models of flows. Substantial derivative, Divergence of velocity

GOVERNING EQUATIONS: Continuity, Momentum and Energy equations; derivation in various forms. Integral versus Differential form of equations. Comments on governing equations. Physical boundary conditions. Forms of the governing equations particularly suited for CFD work: Shock fitting and Shock capturing methods. Generic form of equations.

Unit-II

MATHEMATICAL BEHAVIUOR OF PARTIAL DIFFERENTIAL EQUATIONS: THE IMPACT ON CFD: Classification of partial differential equations. Cramer rule and Eigen value method. Hyperbolic, parabolic and elliptic forms of equations. Impact on physical and computational fluid dynamics; case studies: steady inviscid supersonic flow; unsteady invisid flow; steady boundary layer flow; and unsteady thermal conduction.

Unit-III

DISCRETIZATION: Essence of discretization. Taylor series approach for the construction of finite-difference quotients. Higher order difference quotients. Up-wind differencing. Midpoint leap frog method. Reflection boundary condition. Difference equations. Explicit and Implicit approach: definition and contrasts. Errors and analysis of stability. Error propagation. Stability properties of Explicit and Implicit methods.

GRID GENERATION: Body –fitted coordinate system. Need for grid generation. Essential properties of grids. Types of grids (O-type, C-type and H-type). Various grid generation techniques - Algebraic, and Numerical grid generation. Elliptic grid generation. Structured, Un-structured grids, Adaptive grids, Grid collapse. Multi-Grid methods. Grid accuracies.

Unit-IV

APPROPRIATE TRANSFORMATION: General transformation of equations. Metrics and Jacobians. Generic form of the governing flow equations with strong conservative form in the transformed space. Transformation of continuity equation from physical plane into computational plane; application of Grids stretching.

FINITE VOLUME TECHNIQUES: Finite Volume Discretization - Cell Centered Formulation. High resolution finite volume upwind Scheme. Runge – Kutta Time Stepping. Multi - Time –Step Integration scheme. Cell Vertex Formulation. Numerical dispersion.

CFD APPLICATION TO SOME PROBLEMS: Time and space marching. LAX-WENDROFF Technique. Relaxation technique. Point iterative method. Successive over relaxation/ under relaxation. Aspects of numerical dissipation and dispersion; artificial viscosity. The Alternating-Direction- (ADI) Implicit Technique. Approximate factorization scheme. Upwind schemes; Flux vector splitting.

RECOMMENDED BOOKS:

1. John D. Anderson Jr., 'Computational Fluid Dynamics - The Basics with Applications`, McGraw Hill International Edn, **1995**.
2. Tapan K. Sengupta, `Fundamentals of Computational Fluid Dynamics`, Universities Press (India) Private Limited, **2005**.

REFERENCES BOOKS:

1. F. Wendt, 'Computational Fluid Dynamics - An Introduction', Springer – Verlag, Berlin, **1992**.
2. Charles Hirsch, 'Numerical Computation of Internal and External Flows', Vols. I, II, John Wiley & Sons, New York, **1988**.
3. Jiyuan Tu, Guan Heng Yeoh, and Chaoqun Liu, `Computational Fluid Dynamics - A Practical Approach`, Elsevier Inc., **2008**.

FLIGHT DYNAMICS-II

Subject Code: BAEE2-626 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Unit-I

CRUISING FLIGHT PERFORMANCE: International Standard Atmosphere - Forces and moments acting on a flight vehicle - Equation of motion of a rigid flight vehicle - Different types of drag –estimation of parasite drag co-efficient by proper area method- Drag polar of vehicles from low speed to high speeds - Variation of thrust, power with velocity and altitudes for air breathing engines. Performance of airplane in level flight - Power available and power required curves. Maximum speed in level flight - Conditions for minimum drag and power required

Unit-II

MANOEUVERING FLIGHT PERFORMANCE: Range and endurance - Climbing and gliding flight (Maximum rate of climb and steepest angle of climb, minimum rate of sink and shallowest angle of glide) -Turning performance (Turning rate turn radius). Bank angle and load factor – limitations on turn - V-n diagram and load factor.

Unit-III

STATIC LONGITUDINAL STABILITY: Degree of freedom of rigid bodies in space - Static and dynamic stability - Purpose of controls in airplanes -Inherently stable and marginal stable airplanes – Static, Longitudinal stability - Stick fixed stability - Basic equilibrium equation - Stability criterion - Effects of fuselage and nacelle - Influence of CG location - Power effects - Stick fixed neutral point - Stick free stability-Hinge moment coefficient - Stick free neutral points-Symmetric manoeuvres - Stick force gradients - Stick _ force per 'g' - Aerodynamic balancing.

Unit-IV

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

DYNAMIC STABILITY: Introduction to dynamic longitudinal stability: - Modes of stability, effect of freeing the stick - Brief description of lateral and directional. Dynamic stability - Spiral, divergence, Dutch roll, auto rotation and spin.

RECOMMENDED BOOKS

1. C.D. Perkins, and R.E. Hage, 'Airplane Performance stability and Control', John Wiley & Son., Inc, NY, **1988**.
2. R.C. Nelson, 'Flight Stability and Automatic Control', McGraw-Hill Book Co., **2004**.
3. Mc Cornick. W., 'Aerodynamics, Aeronautics and Flight Mechanics', John Wiley, NY, **1979**.

REFERENCES
1. B. Etkin, 'Dynamics of Flight Stability and Control', 2nd Edn., John Wiley, NY, **1982**.
2. A.W. Babister, 'Aircraft Dynamic Stability and Response', Pergamon Press, Oxford, **1980**.
3. D.O. Dommasch, S.S. Sherby and T.F. Connolly, 'Aeroplane Aero Dynamics', 3rd Edn., Issac Pitman, London, **1981**.
4. B.W. Mc Cornick, 'Aerodynamics, Aeronautics and Flight Mechanics', John Wiley, NY, **1995**.

AVIONICS

Subject Code: BAEE2-627 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Unit-I

AVIONICS TECHNOLOGY: Processors, Memory Devices, Digital Data Buses –MIL-STD-1553B, ARINC 429, ARINC 629, Fiber Optic Buses, LRU architecture for avionics packaging, software, environmental effects, difference in avionics architecture of commercial and military aircraft.

Unit-II

SENSORS: Air Data Sensing – Use of pitot static probe, static probe to derive air data indications; Role of Air Data Computer (ADC), Magnetic Sensing – Magnetic Heading Reference System (MHRS), Inertial Sensing – Position Gyros, Rate Gyros, Accelerometers, Radar Sensing – Radar Altimeter (RADALT), Doppler Radar, Weather Radar.

Unit-III

DISPLAY: Comparison of earlier flight deck (Electromechanical type instruments) to modern flight deck (glass fight deck), Cathode Ray Tube (CRT), Active Matrix Liquid Crystal Display (AMLCD), Head Down Display (HDD), Head Up Display (HUD), Helmet Mounted Display (HMD), Integrated Standby Instrument System (ISIS).

Unit-IV

COMMUNICATION: HF, U/VHF, Satellite Communication, Air Traffic Control (ATC) Transponder, Traffic Collision & Avoidance System (TCAS), Identification of Friend & Foe (IFF).

NAVIGATION: Automatic Direction Finding, Very High Frequency Omni-Range (VOR), Distance Measuring Equipment (DME), Tactical Air Navigation (TACAN), VORTAC (VOR+TACAN) Satellite Navigation System-Global Positioning System (GPS), Differential GPS Instrument Landing System (ILS), Transponder Landing System (TLS), Microwave Landing System (MLS), Astronavigation.

AUTOMATIC FLIGHT CONTROL SYSTEM: Longitudinal, Lateral & Direction Autopilot.

Recommended Books:

1. Ian Moir, Allan Seabridge, 'Civil Avionics Systems', AIAA Education Series.
2. Ian Moir & Allan Seabridge, 'Aircraft System', John Wiley.
3. T.K. Eismin, 'Aircraft Electricity & Electronics', Macmillan.

THEORY OF ELASTICITY

Subject Code: BAEE2-656 **L T P C** **Duration: 34 Hrs.**
3 0 0 3

Unit-I

2-D PROBLEMS IN RECTANGULAR COORDINATES: Solution by polynomials, bending of cantilever loaded at end, bending of beam by uniform load, Symmetrical stress distribution.

2-D PROBLEMS IN POLAR COORDINATES: Pure bending of curved bars, Strain components in polar coordinates, General equations in polar coordinates, Displacements for symmetrical stress distributions, rotating disks, Bending of curved bar by a force at the end, Effect of circular holes on stress distribution in plates.

Unit-II

PHOTOELASTICITY: Photoelastic stress measurement, Circular polariscope, Photoelastic stress determination, determination of principal stresses, 3-D Photoelasticiy.

Unit-III

3-D STRESS-STRAIN ANALYSIS: Introduction, Stress ellipsoid and stress-director surface, Determination of principal stresses, Stress invariants, Determination of maximum shearing stresses, Homogeneous deformation, Strain at a point, Principal axes of strain, Rotation.

3-D PROBLEMS OF ELASTICITY: Uniform stress, stretching of prismatic bar, Twist of circular shafts, Pure bending of prismatic bars and plates.

Unit-IV

TORSION: Torsion of straight bars, elliptic cross section and other elementary solutions, Membrane analogy, Torsion of bar with narrow rectangular cross section, Torsion of rectangular bars, Torsion of rolled profile sections, Torsion of hollow shafts, Torsion of thin tubes, Torsion of circular shafts of variable diameter.

Recommended Books:

1. S.P. Timoshenko & J.N. Goodier, 'Theory of Elasticity', McGraw Hill.
2. T.H.G. Megson, 'Aircraft Structures for Engineering Students', Elsevier.
3. A.E.H. Love, 'Theoretical Elasticity'.

HELICOPTER ENGINEERING

Subject Code: BAEE2-657 **L T P C** **Duration: 34 Hrs.**
3 0 0 3

Unit-I

Theory of Flight: Rotary Wing Aerodynamics: Terminology; Effects of gyroscopic precession; Torque reaction and directional control; Dissymmetry of lift, Blade tip stall; Translating tendency and its correction; Coriolis effect and compensation; Vortex ring state, power settling, overpitching; Auto-rotation; Ground effect.

Unit-II

Flight Control Systems: Cyclic control; Collective control; Swashplate; Yaw control: Anti-Torque Control, Tail rotor, bleed air; Main Rotor Head: Design and Operation features; Blade Dampers: Function and construction; Rotor Blades: Main and tail rotor blade construction and attachment; Trim control, fixed and adjustable stabilisers; System operation: manual, hydraulic, electrical and flyby-wire; Artificial feel; Balancing and Rigging.

Unit-III

Blade Tracking and Vibration Analysis: Rotor alignment; Main and tail rotor tracking; Static and dynamic balancing; Vibration types, vibration reduction methods; Ground resonance

Transmissions: Gear boxes, main and tail rotors; Clutches, free wheel units and rotor brake. Tail rotor drive shafts, flexible couplings, bearings, vibration dampers and bearing Hangers

Unit-IV

Helicopter Structures: Airworthiness requirements for structural strength; Structural classification, primary, secondary and tertiary, fail safe, safe life, damage tolerance concepts; Zonal and station identification systems; Stress, strain, bending, compression, shear, torsion, tension, hoop stress, fatigue; Drains and ventilation provisions; System installation provisions; Lightning strike protection provision. Construction methods of: stressed skin fuselage, formers, stringers, longerons, bulkheads, frames, doublers, struts, ties, beams, floor structures, reinforcement, and methods of skinning and anti-corrosive protection. Pylon, stabiliser and undercarriage attachments

Recommended Books:

1. A.R.S. Bramwell, 'Helicopter Dynamics', John Wiley and Sons.
2. Lalit Gupta, 'Helicopter Engineering', Himalayan Publishers.
3. Jacob Shapiro, 'Principles of Helicopter Engineering', McGraw Hill.
4. M.E. Drier, 'Introduction to Helicopter and Tilt Rotor Flight Simulation', AIAAA Education Series.

AEROELASTICITY

Subject Code: BAEE2-658 **L T P C** **Duration: 34 Hrs.**
3 0 0 3

Unit-I

INTRODUCTION: Definition and historical background, Static and dynamic aero elastic phenomenon, Integration of aerodynamic, elastic and inertia forces, Influence of aero elastic phenomenon on aircraft design, Comparison of critical speeds.

DIVERGENCE OF LIFTING SURFACE: The phenomenon of divergence, divergence of 2-D wing section, divergence of an idealized cantilever wing, Solution based on semi-rigid assumptions, Solution in generalized co-ordinates, Method of successive approximation, use of Numerical Methods.

Unit-II

STEADY STATE AERO-ELASTICITY PROBLEMS IN GENERAL: Loss and reversal of aileron Control, 2-D case, aileron reversal general case, Lift distribution on a rigid and elastic wing, Effect on Static Longitudinal stability of airplane.

Unit-III

INTRODUCTION TO FLUTTER AND BUFFETING: The phenomenon of flutter, flutter of a cantilever wing, approximate determination of critical speed by Galerkin's Method, Introduction to buffeting and stall flutter.

Unit-IV

NON-AERONAUTICAL PROBLEMS: Some typical example in civil engineering, Flow around an oscillating circular cylinder, applications to H-shaped sections, Prevention of aero-elastic instabilities.

Recommended Books:

1. Y.C. Fung, 'An Introduction to the Theory of Aero Alasticity', Dover Publications.
2. R.L. Bisplinghoff, Holt Ashley, R.L. Halfman, 'Aero Elasticity', Addison –Wesley Publishing Co. Reading Mass.
3. T.H.C. Megson, 'Aircraft Structures for Engineering Students', Elsevier.

CAD/CAM LAB.

Subject Code: BAEE2-628 **L T P C**
0 0 2 1

LIST OF EXPERIMENTS

1. Design and Modelling of rectangular plate with hole.
2. Design and Modelling of spar components.
3. Design and Modelling of Aerofoil structures.
4. Design and Modelling of cut section for wings.
5. Design and Modelling of Machine component.
6. Design and Modelling of Machine components.
7. Design and Analysis of a Truss.
8. Design and Analysis of Beam distributed load.
9. Facing.
10. Turning (Taper, Step)

AIRCRAFT DESIGN

Subject Code: BAEE2-629 **L T P C**
0 0 2 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

MECHANICS OF COMPOSITE MATERIALS

Subject Code: BAEE2-730 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Unit-I

Introduction to Composite Materials: Classification of composites, particulate composites, fibrous composites. Use of fiber reinforced composites; Fibers, matrices and manufacture of composites; properties of various type of fibers like glass, Kevlar, Carbon and Graphite, Methods of manufacture, surface treatment of fibers, various forms of fibers, matrix materials, polymers: Thermosetting and thermoplastic polymers, properties of polymers like epoxies, phenolics, polyester peek etc.

Unit-II

Manufacture of Composites: Hand layup technique, pressure bag and vacuum bag moulding techniques, puftrusion, resin-transfer moulding, injection moulding, Bulk moulding compound, sheet moulding compound. Application of composites in Aircraft Industry.

Behavior of Unidirectional Composites: Volume traction, weight traction, density of composites, Micromechanics approach, longitudinal strength and stiffness factors affecting longitudinal strength and stiffness, Transverse strength and stiffness, shear modulus and strength, Poisson's ratio, effect of fiber dimension and distribution on strength and stiffness, Halpin-Tsai equations.

Unit-III

Analysis and Strength of an Orthotropic Lamina: Strain relations and engineering constants, relation between engineering constants and stiffness coefficients, strength of an orthotropic lamina, failure theories, Analysis of laminated composites, laminate orientation code, stress and strain variation in a laminate, properties of symmetric, cross ply angle-ply and quasi isotropic analysis of laminate after initial failure, hygrothermal behaviour of laminates. Thermal and moisture expansion coefficients, transports properties, mass diffusion. Short fiber composites: approximate analysis of stress transfer, average fiber stress, modules and strength of short composites.

Unit-IV

Maintenance of Composites: Assessment and Repair – Classification of damage, Inspection Methodology, Repair operation, Repair procedures. Types of Repairs – Repair failures, typical repair procedures, Delaminations, Damage to laminate structures, Repair to sandwich structures, Repair to Honycomb structures, lightning protection, painting the composite part, Quality control.

RECOMMENDED BOOKS

1. R.M. Jones, 'Mechanics of Composite Materials', Technomic Publication.
2. B.D. Agarwal and L.J. Broutman, 'Analysis and Performance of Fiber Composites', John Wiley & Sons.

REFERENCE BOOKS

1. R.F. Gibson, 'Principles of Composite Material Mechanics', McGraw Hill International Edition, **2004.**
2. Lalit Gupta, 'Advance Composite Materials', Himalyans Books, New Delhi**, 1998.**
3. Joppesen, 'Advance Composites'.

AEROSPACE QUALITY ASSURANCE

Subject Code: BAEE2-731 **L T P C** **Duration: 45 Hrs.**

3 1 0 4

Unit-I

QUALITY CONCEPTS: Concepts and definition, design specifications, manufacture in conformance with design applications, role of quality assurance during usage of aircraft.

QUALITY ASSURANCE DURING OVERHAUL: Quality assurance during overall / repair of aircraft and its aggregates, concession and deviations. Production permits.

QUALITY CONTROL: Units of measure, measuring actual performance. Continuous process regulation. Strategic quality management. Role of quality director. Quality culture.

Unit-II

PROBABILITY CONCEPTS: Concept of variation. Quantitative methods of summarizing data. Normal curve, Exponential Probability distribution. Weibull probability distribution.

Poisson distribution. Binomial distribution. Scope for data analysis. Sample size. Regression analysis.

DESIGNING FOR QUALITY: Early warning concepts and design assurance. Designing for basic function requirements. Design for Time- Oriented performance. Designing for safety. Designing for maintainability.

Unit-III

MANUFACTURE & RELIABILITY PREDICTION: Initial planning for qualities. Failure patterns. Predicting reliability during design. Exponential formula. Setting specification limits. Process quality audits. Self-inspection.

INSPECTION, TEST & MEASUREMENTS: Sampling risk. Analysis of some rule to thumb. Sampling plot. Evaluation of parameters affecting field performance. Acceptance sampling plan. Feedback. Field data.

Unit-IV

QUALITY AND AIRWORTHINESS ASSURANCE: Zero defect analogy, FMECA, Fault Tree Analysis, bench marking, quality circles, quality audit. Quality standards ISO 9000, TQM, CMM, Six Sigma. Quality organizational set up in production / repair / operational set up.

RECOMMENDED BOOKS:

1. J.M. Juran, Frank M. Gryna, `Quality Planning and Analysis`, TMH Publications, **2005.**

REFERENCE BOOKS:

1. M. Fox, `Quality Assurance Management`, McGraw Hill Publications.
2. Oalela, `ISO 9000 A, Manual for TQM`, Pargaman Publishers.
3. S.C. Keshu and K.K. Ganapathi, `Aircraft Production Technology and Management`, Interline Publishers, **1993**

FINITE ELEMENT METHODS

Subject Code: BAEE2-732 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Unit-I

Introduction to FEM and its Applicability, Review of Mathematics: Matrix algebra, Gauss elimination method, Uniqueness of solution, banded symmetric matrix and bandwidth.

Structure Analysis: Two-force member element, Local stiffness matrix, coordinate transformation, Assembly, Global stiffness matrix, imposition of Boundary conditions, Properties of stiffness matrix.

Unit-II

One-dimensional Finite Element Analysis: Basics of structural mechanics, stress and strain tensor, constitutive relation, Principle of minimum Potential, General steps of FEM, Finite element model concept /Discretization, Derivation of finite elements equations using potential energy approach for linear and quadratic, 1-D bar element and beam element, shape functions and their properties, Assembly, Boundary conditions, Computation of stress and strain.

Unit-III

Two Dimensional Finite Element Analysis: Finite element formulation using three nodded triangular (CST) element and four nodded rectangular elements, Plane stress and Plain strain problems, Shape functions, node numbering and connectivity, Assembly, Boundary conditions, Isoparametric formulation of 1-D bar elements, Numerical integration using gauss quadrature formula, computation of stress and strain.

Finite Element Formulation from Governing Differential Equation: Method of Weighted Residuals, Collocation, Sub domain method, Least Square method and Galerkin's method,

Application to one dimensional problems, one-dimensional heat transfer, etc. introduction to variation formulation (Ritz Method.)

Unit-IV

Higher Order Elements: Lagrange's interpolation formula for one and two independent variables, Convergence of solution, compatibility, element continuity, static condensation, p and h methods of mesh refinement, Aspect ratio and element shape, Application of FEM, Advantages of FEM, Introduction to concept of element mass matrix and Damping matrix in dynamic analysis, Calculation of natural frequencies and modes.

RECOMMENDED BOOKS

1. P. Seshu, 'Text Book of Finite Element Analysis', Prentice Hall India.
2. K.J. Bathe, 'Finite Element Procedure in Engineering Analysis', Prentice Hall India.

REFERENCE BOOKS

1. J.N. Reddy, 'An Introduction to the Finite Element Method', Tata McGraw-Hill, New Delhi, **2005.**
2. Cook, Malkus, Plesha and Witt, 'Concepts & Applications of Finite Element Analysis', Willey India, New Delhi, **2007.**
3. Chandupatla and Belegundu, 'Introduction to Finite Elements in Engineering', Prentice Hall India.

SPACE MECHANICS

Subject Code: BAEE2-759 **L T P C** **Duration: 34 Hrs.**

3 0 0 3

Unit-I

BASIC CONCEPTS: The Solar System – References Frames and Coordinate Systems – The Celestial Sphere– The Ecliptic – Motion of Vernal Equinox – Sidereal Time – Solar Time – Standard Time – The Earth's Atmosphere.

THE GENERAL N-BODY PROBLEM: The many body Problem – Lagrange – Jacobian Identity –The Circular Restricted Three Body Problem – Libration Points- Relative Motion in the N-body Problem –Two –Body Problem – Satellite Orbits – Relations Between Position and Time – Orbital Elements.

Unit-II

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

Unit-III

INTERPLANETARY TRAJECTORIES: Two Dimensional Interplanetary Trajectories – Fast Interplanetary Trajectories – Three Dimensional Interplanetary Trajectories – Launch if Interplanetary Spacecraft –Trajectory about the Target Planet.

Unit-IV

BALLISTIC MISSILE TRAJECTORIES AND MATERIALS: The Boost Phase – The Ballistic Phase –Trajectory Geometry- Optimal Flights – Time of Flight – Re – entry Phase – The Position of the Impact Point – Influence Coefficients. Space Environment – Peculiarities – Effect of Space Environment on the Selection of Spacecraft Material.

RECOMMENDED BOOKS

1. J.W. Cornelisse, 'Rocket Propulsion and Space Dynamic', W.H. Freeman & Co., **1984**.

REFERENCES

1. G.P. Sutton, 'Rocket Propulsion Elements', John Wiley, **1993**.

2. P. Van de Kamp, 'Elements of Astro-Mechanics', Pitman, **1979**.
3. E.R. Parker, 'Materials for Missiles and Spacecraft', McGraw-Hill Book Co. Inc., **1982**.

GUIDANCE AND NAVIGATION

Subject Code: BAEE2-760 **L T P C** **Duration: 34 Hrs.**
3 0 0 3

Unit-I

INTRODUCTION: Concepts of navigation, guidance and control. Introduction to basic principles. Air data information.

RADAR SYSTEMS: Principle of working of radar. MTI and Pulse Doppler radar. Moving target detector. Limitation of MTI performance. MTI from a moving platform (AMTI).

TRACKING WITH RADAR: Mono pulse tracking. Conical scan and sequential lobbing. Automatic tracking with surveillance radar (ADT).

Unit-II

OTHER GUIDANCE SYSTEMS: Gyros and stabilised platforms. Inertial guidance and Laser based guidance. Components of Inertial Navigation System. Imaging Infrared guidance. Satellite navigation. GPS.

TRANSFER FUNCTIONS: Input-output Transfer function. Basic altitude reference. Concepts of Open loop and Close Loop.

Unit-III

MISSILE CONTROL SYSTEM: Guided missile concept. Roll stabilisation. Control of aerodynamic missile. Missile parameters for dynamic analysis. Missile autopilot schematics. Acceleration command and root locus.

MISSILE GUIDANCE: Proportional navigation guidance; command guidance. Comparison of guidance system performance. Bank to turn missile guidance.

Unit-IV

INTEGRATED FLIGHT/FIRE CONTROL SYSTEM: Director fire control system. Tracking control laws. Longitudinal flight control system. Lateral flight control system. Rate of change of Euler angle, Auto Pilot.

RECOMMENDED BOOKS:

1. Merrilh I. Skolnik, `Introduction to Radar Systems`, 3rd Edn., Tata McGraw Hill, **2001**.
2. John H. Blakelock, `Automatic Control of Aircraft & Missiles`, 2nd Edn., Wiley–Inter Science Publication, **1990**.

REFERENCE BOOKS:

1. R.B. Underdown & Tony Palmer, `Navigation`, Black Well Publishing, **2001.**

APPLIED GAS DYNAMICS

Subject Code: BAEE2-761 **L T P C** **Duration: 34 Hrs.**
3 0 0 3

Unit-I

ONE DIMENSIONAL COMPRESSIBLE FLOW: Basic equations of compressible flow. Steady one-dimensional flow. Discharge from reservoir. De Laval Nozzle. Flow through converging, diverging passages; Performance under various back pressures. Diffusers. Dynamic head measurements in compressible flow.

NORMAL, OBLIQUE SHOCKS AND EXPANSION WAVES: Governing Equations of Normal Shock Wave. Prandtl relation and Rankine - Hugoniot equation. Oblique shocks and corresponding relations. Shock polar & Hodograph plane. Supersonic flow over a wedge.

Supersonic compression and supersonic expansion. Detached shocks. Mach reflection. Intersection of waves of same and opposite families. Introduction to the Method of Characteristic.

Unit-II

FANNO FLOW: Flow with friction in constant area duct. Fanno lines. Fanno equation. Definition of friction constant, Friction loss. Effect of wall friction on flow properties. Friction parameter. Local flow properties in terms of local Mach number.

RAYLEIGH FLOW: Flow with heating or cooling in ducts. Governing equations. Heating relations for a perfect gas. Slope of Rayleigh line. Entropy considerations. Maximum heat transfer.

Unit-III

DIFFERENTIAL EQUATIONS OF MOTION FOR STEADY COMPRESSIBLE FLOWS: Basic potential equations for compressible flow. Linearization of potential equation-small perturbation theory. Methods for solution of nonlinear potential equation -Introduction. Boundary conditions. Pressure coefficient expression.

Unit-IV

SIMILARITY RULES: Two-dimensional flow. Prandtl - Glauert rule for subsonic and supersonic flow. Von-Karman rule for transonic flow. Gothert rules. Application to wings of finite span. Aerodynamic characteristics for actual and transformed bodies. Effect of thickness and camber. Lift and drag divergence. Shock induced flow separation. Prandtl – Meyer expansion fan. Lift, drag, pitching moment and center of pressure of supersonic profiles.

FLOW OF REAL FLUIDS: Shock Wave – Boundary layer interaction. Experimental characteristics of airfoils in compressible flow. Nature of pressure distribution.

MEASUREMENTS IN COMPRESSIBLE FLOW: High Speed Wind tunnels: In-draft, Induction, Continuous and Shock tubes. Optical methods of flow visualization. Wind tunnel Instrumentation and measurements.

RECOMMENDED BOOKS:

1. E. Rathakrishnan, 'Gas Dynamics', Prentice Hall of India, **1995**.
2. S.M. Yahya, 'Fundamentals of Compressible Flow', Wiley Eastern, **2003**.

REFERENCE BOOKS:

1. John D. Anderson, 'Modern Compressible Flow', McGraw Hill, **1999**.

EXPERIMENTAL AERODYNAMICS

Subject Code: BAEE2-862 **L T P C** **Duration: 34 Hrs.**

3 0 0 3

Unit-I

WIND TUNNEL TESTING: Low speed wind tunnels-estimation of energy ratio and power required supersonic wind tunnels-calculation of running time and storage tank requirements.

Unit-II

EXPERIMENTS IN SUBSONIC WIND TUNNELS: Estimation of flow angularity and turbulence factor-calculation of CL and CD on aero foils from pressure distribution- CD from wake Survey-Test section average velocity using traversing rakes-span wise load distribution for different taper ratios of wing

Unit-III

EXPERIMENTS IN HIGH SPEED TUNNELS: Mach number estimation in test section by pressure measurement and using a wedge – preliminary estimates of blowing and running pressures, nozzle area ratios, and mass flow for a given test section size and Mach number-starting problem and starting loads.

Unit-IV

MEASUREMENT TECHNIQUES: Hot wire anemometer and laser Doppler anemometer for turbulence and velocity Measurements-Use of thermocouples and pyrometers for measurement of static and total Temperatures-Use of pressure transducers, Rotameters and ultrasonic flow meters.

SPECIAL PROBLEMS: Pitot-static tube correction for subsonic and supersonic Mach numbers-boundary layer velocity profile on a flat plate by momentum-integral method - Calculation of CD from wall shear Stress-Heating requirements in hypersonic wind Tunnels-Re-entry problems.

Recommended Books:

1. W.H. Rae and A. Pope, 'Low Speed Wind Tunnel Testing', John Wiley Publication, **1984.**
2. A. Pope and L. Goin, 'High Speed Wind Tunnel Testing', John Wiley, **1985.**
3. E. Rathakrishnan, 'Instrumentation, Measurement and Experiments in Fluids', CRC Press, London, **2007.**

ROCKET AND MISSILES

Subject Code: BAEE2-863 **L T P C** **Duration: 34 Hrs.**

3 0 0 3

Unit-I

ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD: One Dimensional and Two Dimensional rocket Motions in Free Space and Homogeneous Gravitational Fields – description of Vertical, Inclined and Gravity Turn Trajectories – Determination of range and Altitude Simple Approximations to Burnout Velocity.

Unit-II

STAGING AND CONTROL OF ROCKETS AND MISSILES: Multistaging of rockets – Vehicle Optimization – Stage Separation Dynamics – Separation Techniques. Rocket Thrust Vector Control Methods.

Unit-III

AERODYNAMICS OF ROCKETS AND MISSILES: Airframe Components of Rockets and Missiles – Forces Acting on a Missile While Passing Through Atmosphere – Classification of Missiles – methods of Describing Aerodynamic Forces and Moments – Lateral Aerodynamic Moment – Lateral Damping Moment and Longitudinal Moment of a Rocket – lift and Drag Forces – Drag Estimation.

Unit-IV

ROCKET PROPULSION SYSTEMS: Ignition System in rockets – types of Igniters – Igniter Design Considerations – Design Consideration of liquid Rocket Combustion Chamber, Injector Propellant Feed Lines, Valves, Propellant Tanks Outlet and Helium Pressurized and Turbine Feed Systems – Propellant Slash and Propellant Hammer – Elimination of Geysering Effect in Missiles –

Combustion System of Solid Rockets.

MATERIALS FOR ROCKETS AND MISSILES: Selection of Materials – Special Requirements of Materials to Perform under Adverse Conditions.

RECOMMENDED BOOKS

1. G.P. Sutton, et al., 'Rocket Propulsion Elements', John Wiley & Sons Inc., New York, **1993**.

REFERENCES

1. M. Mathur and R.P. Sharma, 'Gas Turbines and Jet and Rocket Propulsion', Standard Publishers, New Delhi, **1998**.

2. J.W. Cornelisse, 'Rocket Propulsion and Space Dynamics', J.W., Freeman & Co. Ltd., London, **1982**.
3. E.R. Parker, 'Materials for Missiles and Spacecraft', McGraw-Hill Book Co. Inc., **1982**.

AERO ENGINE MAINTENANCE & REPAIR

Subject Code: BAEE2-864 **L T P C** **Duration: 34 Hrs.**
3 0 0 3

Unit-I

CLASSIFICATION OF PISTON ENGINE COMPONENTS: Types of piston engines – Principles of operation – Function of components – Materials used – Details of starting the engines – Details of carburetion and injection systems for small and large engines – Ignition system components – Spark plug details – Engine operating conditions at various altitudes – Maintenance and inspection check to be carried out.

Unit-II

INSPECTIONS OF PISTON ENGINES: Inspection and maintenance and troubleshooting – Inspection of all engine components – Daily and routine checks – Overhaul procedures – Compression testing of cylinders – Special inspection schedules – Engine fuel, control and exhaust systems – Engine mount and super charger – Checks and inspection procedures.

OVERHAULING OF PISTON ENGINES: Symptoms of failure – Fault diagnostics – Case studies of different engine systems – l: Tools and equipment requirements for various checks and alignment during overhauling – Tools for inspection – Tools for safety and for visual inspection – Methods and instruments for non-destructive testing techniques – Equipment for replacement of part and their repair. Engine testing: Engine testing procedures and schedule preparation – Online maintenance.

Unit-III

CLASSIFICATION OF JET ENGINE COMPONENTS: Types of jet engines – Principles of operation – Functions of components – Materials used – Details of starting and operating procedures – Gas turbine engine inspection & checks –Use of instruments for online maintenance – Special inspection procedures: Foreign Object Damage – Blade damage – etc. Maintenance procedures of gas turbine engines – Trouble shooting and rectification procedures – Component maintenance procedures – Systems maintenance procedures. Gas turbine testing procedures – test schedule preparation – Storage of Engines – Preservation and de-preservation procedures.

Unit-IV

OVERHAUL PROCEDURES: Engine Overhaul procedures – Inspections and cleaning of components – Repairs schedules for overhaul – Balancing of Gas turbine components. Trouble Shooting - Procedures for rectification – Condition monitoring of the engine on ground and at altitude – engine health monitoring and corrective methods.

RECOMMENDED BOOKS

1. Kroes & Wild, 'Aircraft Power Plants', 7th Edn., McGraw Hill, New York, **1994**.

REFERENCES

1. Turbomeca, 'Gas Turbine Engines', The English Book Store, New Delhi, **1993**.
2. Pratt & Whitney, 'The Aircraft Gas Turbine Engine and its Operation', The English Book Store, New Delhi.