Course Structure & Syllabi for 4-year B.E. (Aerospace) Course
Third Semester

	Subjects	**Code**	***Hours/Week***			***Marks***
			L	**T**	**S**	
1.	Mathematics III	MA 301	3	1	0	100
2.	Material Science	PH 301	3	0	0	100
3.	Dynamics of Rigid Bodies	AM 303	3	1	0	100
4.	Fundamentals of Fluid Mechanics	AE 301	3	1	0	100
5.	Fundamentals of Structural Mechanics	AE 302	3	1	0	100
6.	Basic Thermodynamics	ME 301	3	1	0	100
7.	Computer Graphics Practice	DR 352	0	0	2	50
8.	Machine Shop Practice	WS	0	0	2	50
9.	Fluid Mechanics Lab	AE 351	0	0	2	50
10.	Structural Mechanics Lab	AE 352	0	0	2	50
11.	Engineering Thermodynamics Lab	ME 3XX	0	0	2	50
			18	**05**	**10**	**850**
				33		**850**

Mathematics III A (MA 301) [for AE/CE/ME/MN/MT]

Semester Examination :
Time-3 hrs.
Full Marks – 70.

Contact Periods : (3L+ 1 T)
Internal Assessment :
Full Marks – 30.

Group I:
A. Complex variables: Function, Limit and continuity of complex functions, Differentiation of complex functions, Analytic function, Cauchy-Riemann equations, Harmonic functions, Line Integrates, Cauchy-Gourset theorem (No proof required). Cauchy's Integral formula, Derivative of analytic functions, Taylor's and Laurent's series, Zeroes, Singular points: essential and removable, Poles, Residue, Residue Theorem, Contour Integration (simple cases only)

B. Fourier Series:

C. Boundary value and Initial value problems leading to partial differential Equation: Method of solution by separation of variables Technique.

Group II: L.P.P.
Vector and Euclidean spaces, Linea dependence, Bases, Vector space and subspaces, Rank, Point sets, Convex sets, Boundary Points, Extreme points, Linear system – Basic Solutions, Basic matrix, Feasible solution, Basic feasible solution, Linear programming problems, Slack surplus and artificial variables, Graphical method of solution, Simplex method, Charne's Big-M-method.

Material Science (PH 301) [for AE/ME]

Semester Examination :
Time-3 hrs.
Full Marks – 35.

Contact Periods : (3L)
Internal Assessment :
Full Marks – 15.

Atomic structure and Bonding in solids : Atomic models, vector Model, quantum numbers, Pauli's exclusion principle, inter-atomic attractive forces, primary forces of attraction, covalent bonds, ionic bonds, metallic bonds, secondary forces of attraction, molecular polarization, inter-atomic distances, equilibrium distances, bond lengths.

Crystal Geometry & structure : Space lattice, unit cell, crystal systems, co-ordination number, B.C.C., F.C.C. and H.C.P. structures, lattice planes, Miller indices, inter-planer spacing, Bragg's law.

Crystal Imperfection and Metallic phase:
Type of Imperfections: Dislocations, Burger vector, mechanism of slip, cold work and re-crystallization.

Electrical and Magnetic Properties of Materials: Classification of solids on the basis of band structure, P and N type semiconductors, ferro-electricity, piezoelectricity, classification of magnetic materials, magnetic hysteresis.

Corrosion: Factors influencing corrosion, Types of corrosion – control and prevention.

Dynamics of Rigid Bodies (AM303) [for AE/ME]

Semester Examination : Contact Periods : (3L+ 1 T)
Time-3 hrs. Internal Assessment :
Full Marks – 70. Full Marks – 30.

Kinetics of System of Particles: Generalized Newton's Second Law, Work-Energy, Impulse-Momentum, Conservation of Energy and Momentum

Plane Kinematics of Rigid Bodies: Rotation, Absolute Motion, Relative Velocity, Instantaneous Centre of Zero Velocity, Relative Acceleration, Motion Relative to Rotating Axis

Plane Kinetics of Rigid Bodies: Force, Mass and Acceleration: Fixed Axis Rotation, General Plane Motion; **Work and Energy:** Work-Energy Relations, Acceleration from Work-Energy, Virtual Work; **Impulse and Momentum:** Impulse-Momentum Equations

Three-Dimensional Kinematics of Rigid Bodies: Translation, Fixed Axis Rotation, Parallel Plane Motion, Rotation about a Fixed Point, General Motion

Three-Dimensional Kinetics of Rigid Bodies: Angular Momentum, Kinetic Energy, Momentum and Energy Equations of Motion, Parallel-Plane Motion

Fundamentals of Fluid Mechanics (AE 301)/Mechanics of Fluids I (AM 305) [for AE/ME]

Semester Examination : Contact Periods : (3L+ 1 T)
Time-3 hrs. Internal Assessment :
Full Marks – 70. Full Marks – 30.

Introductory Concepts: Dimensions and Units; Fluid properties; Eulerian and Lagrangian description of motion, Flow visualization, Classification of fluid flow. 4

Fluid Statics: Equations for hydrostatic pressure variation, manometers, Hydrostatic force on submerged surface (both plane and curved surface), Buoyancy and stability; Fluids in rigid body motion. 6

Integral/Control volume analysis of fluid flow: Integral and differential analysis of fluid flow, Reynolds transport equation - derivation of governing equations (mass, linear and angular momentum) in integral form, Conservation of mass (continuity) in unidirectional flow, Non-inertial frame. 10

Inviscid flow: Euler's equation for inviscid flow along a streamline, Bernoulli's equation and its applications, head loss, kinetic energy correction factor and momentum correction factor. 5

Flow Measurements: orificemeter, venturimeter, pitot tube etc. 2

Dimensional Analysis and similarity: Buckingham's Pi theorem, geometric, kinetic and dynamic similitudes, dimensionless parameters. 4

Introduction to differential analysis of fluid flow: 3D continuity equation in Cartesian and cylindrical reference frame, Stream function, Kinematics - translation, rotation and deformation of a fluid element (in 2D), Vorticity and Circulation, Equation of motion – 3D Euler's equation. 4

Ideal flow: Irrotational flow and velocity potential, Examples of 2D potential flow, Laplace equation and principle of superposition, Examples of superposition, Bernoulli's equation for inviscid irrotational flow. 7

Fundamentals of Structural Mechanics (AE 302)/ Mechanics of Solids I (AM 304) [for AE/ME]

Semester Examination : Contact Periods : (3L+ 1 T)
Time-3 hrs. Internal Assessment :
Full Marks – 70. Full Marks – 30.

Review of Statics: mechanics of rigid bodies **2**
Concept of rigid body, force, moment, torque, conditions of equilibrium, supports, Simple engineering applications.

Book: Crandall/ Dahl & Lardner Ch. 1.

Introduction to mechanics of deformable bodies **5**
Introduction to deformable body, Analysis of statically determinate system and introduction to compatibility, Statically indeterminate system, Problems on compound systems.

Book: Crandall/ Dahl & Lardner Ch. 2., Timoshenko and Young Ch. 1.

Analysis of stress and strain **10**
Stress, strain and Hooke's law, Variation of stress on oblique plane, Introduction to Bi-axial stress including complex stress, Geometric representation (Mohr's circle), stresses in thin walled pressure vessels, pure shear, Define G, μ and relationships among E, μ and G. Complex strain and strain rosette, Stress-strain diagram, Factor of safety, Problems including thermal stress.

Book: Timoshenko and Young Ch. 2, 3 & 7, Crandall/ Dahl & Lardner Ch. 4, Ch. 5

Stresses in beams (symmetric cases) **8**
Introduction to shear force and bending moment, Interrelationships, stresses in beams due to bending and shear.

Book: Timoshenko and Young Ch. 5., Crandall/ Dahl & Lardner Ch. 3.

Deflection of statically determinate beams **7**
Differential equation of the elastic line: moment-curvature relationship and integration, Macaulay's method, moment area method, Deflection by superposition.

Book: Timoshenko and Young Ch. 8. , Crandall/ Dahl & Lardner Ch. 8.

Torsion **4**
Torsion of a circular shaft, Introduction to combined bending, torsion and axial force.

Book: Timoshenko and Young Ch. 8. , Crandall/ Dahl & Lardner Ch. 6.

Column **5**

Introduction to short and long column, stress due to eccentric loading on a strut, core, concept of elastic stability, Euler's column formula, Elementary empirical formulae

Book: Timoshenko and Young Ch. 8. , Crandall/ Dahl & Lardner Ch. 9.

Curved beam **2**

Elementary theory and simple application

Book: Timoshenko and Young Ch. 6.

Further reading: Engineering Mechanics of Solids by E.P. Popov

Basic Thermodynamics (ME 301) [for ME/AE]

Semester Examination :
Time-3 hrs.
Full Marks – 70.

Contact Periods : (3L+ 1 T)
Internal Assessment :
Full Marks – 30.

Basic concepts. Thermodynamic equilibrium. Quasic-static process. Zeroth law. Work and heat interactions.

First law of thermodynamics: Statement, corollaries and application to closed and open systems. Steady and variable flow processes.

Second law statements. Reversibility. Carnot's theorem. Absolute temperature scale. Inequality of Causius. Entropy principle, available energy. Availability and irreversibility.

Properties of pure substances, phase equilibrium diagrams. Properties of ideal gas and gas mixtures. Reactive mixtures. Air – water vapour mixture.

Fourth Semester

	Subjects	**Code**	***Hours/Week***			***Marks***
			L	**T**	**S**	
1.	Mathematics IV	MA 401	3	1	0	100
2.	Low Speed Aerodynamics	AE 401	3	1	0	100
3.	Aerospace Structure I	AE 402	3	1	0	100
4.	Introduction to heat and mass transfer	AE 403	3	0	0	100
5.	Dynamics for Aerospace Engineers	AE 404	3	1	0	100
6.	Introduction to Aerospace Engineering	AE 405	3	0	0	100
7.	Low Speed Aerodynamics Lab	AE 451	0	0	3	50
8.	Structures Lab I	AE 452	0	0	3	50
9.	Heat and Mass Transfer Lab	AE 453	0	0	3	50
			18	**04**	**09**	**750**
					31	**750**

Mathematical Techniques (MA 401) [for AE/ETC]

Semester Examination : Contact Periods : (3L+ 1T)
Time-3 hrs. Internal Assessment :
Full Marks – 70. Full Marks – 30.

A. Matrix Theory - Partition of a matrix, Eigen values, Eigen vectors of various types of matrices, Properties of matrices, Similarity and Orthogonal transformation. Diagonalization and triangularization. Quadratic form and reduction to orthogonal transformation and applications.

B. Fourier transform, Fourier sine and cosine transform.

C. Laplace Transform, Transform of elementary functions, Convolution Theorem, Inverse transform, z transform

D. Calculus of Variation: Euler Lagrange differential equation for fixed end points, Application to Brachistochrone problem, Euler Lagrange equation for variable end points.

Low Speed Aerodynamics (AE 401)

Semester Examination : Contact Periods : (3L+ 1T)
Time-3 hrs. Internal Assessment :
Full Marks – 70. Full Marks – 30.

Basic Concepts and Equations in Ideal flow: 10
Equation of Continuity; Stream Function; Euler's Equation of Motion; Rotational and Irrotational flow; velocity potential, Circulation and vorticity, vortex tube, Kelvin's circulation theorem, Stokes' Integral Theorem; Helmholtz theorem of vorticity; Generalized Bernoulli's equation.

Applications: 10
Examples of 2D potential flow, Laplace equation and principle of superposition, Complex Potential Function and Conformal mapping, Solution of 2D potential flow problems using complex analysis, Flow with Circulation; Kutta–Joukowski theorem; The Joukowski transformation and Joukowski airfoils; Vortex Motion.

Aerofoil characteristics: 5
Wing and Aerofoil Section Geometry; Aerodynamic Forces and Moments.

Elements of Two Dimensional Aerofoil Theory: 8
Classical Aerofoil Theory – Camber and Thickness Problems; Source and Vortex Panel Numerical Methods.

Finite Aerofoil Theory: 8
Elements of Prandtl's lifting line theory; Lifting surface theory; Vortex lattice method and general 3-D panel method.

Books:

1. An Introduction to Fluid Dynamics, G K Batchelor, Cambridge University Press
2. Fluid Mechanics, W. Kaufmann, Tata McGraw Hill
3. Fundamentals of Aerodynamics, J D Anderson, Jr., McGraw-Hill International
4. Aerodynamics for Engineering Students, E L Houghton and A E Brock, Edward Arnold
5. Aerodynamics for Engineering Students, E L Houghton and N B Carpenter, Edward Arnold
6. Low Speed Aerodynamics, J Katz and A E Plotkin, Cambridge University Press

Aerospace Structure – I (AE 402)

Semester Examination : Contact Periods : (3L+ 1T)
Time-3 hrs. Internal Assessment :
Full Marks – 70. Full Marks – 30.

Basic Elasticity: **16**
Introduction to tensor – generalized coordinate transformation – stress tensor at a point – principal stress & stress invariant – analysis of strain – constitutive & compatibility equation in Cartesian & polar coordinate –generalised Hooke's law – introduction to plane stress – introduction to plane strain – octahedral stress theory – strain energy & complimentary energy – theories of failure

Energy Methods: **10**
Virtual work – total potential energy – principle of stationary value – application to determinate & indeterminate problems – Castigliano's theorem – unit load method – Maxwell-Betti reciprocal theorem

Structural Instability: **10**
Instability of column & beam-column – bucking of frame – transverse buckling – flexural & torsional buckling of thin-walled columns – complete diagonal tension – incomplete diagonal tension

Books recommended**:**

1. Elasticity, Martin H. Sadd
2. Theory of elasticity, Timoshenko & Goodier
3. Aircraft structures, T.H.G. Megson
4. Applied elasticity, Zhi Lun Xu
5. Foundations of solid mechanics, Y.C. Fung

Introduction of Heat and Mass Transfer (AE 403)

Semester Examination : Contact Periods : (3L+ 1T)
Time-3 hrs. Internal Assessment :
Full Marks – 70. Full Marks – 30.

Heat Conduction: 11
Basic Modes of Heat Transfer – One dimensional steady state heat conduction: Composite Medium Critical Thickness – Effect of Variation of Thermal Conductivity – Extended Surfaces – Unsteady State.
Heat Conduction: Lumped System Analysis – Heat Transfer in Semi Infinite and Infinite Solids – Temperature Charts – Application of numerical techniques.

Convective Heat Transfer: 10
Introduction – Free convection in atmosphere free convection on a vertical flat plate – Empirical relation in free convection – Forced convection – Laminar and turbulent convective heat transfer analysis in flows between parallel plates, over a flat plate and in a circular pipe. Empirical relations, application of numerical techniques in problem solving.

Radiative Heat Transfer: 8
Introduction to Physical mechanism – Radiation properties – Radiation shape factors – Heat exchange between non-black bodies – Radiation shields.

Heat Exchangers: 8
Classification – Temperature Distribution – Overall heat transfer coefficient, Heat Exchange Analysis by Different Methods.

Heat Transfer Problems In Aerospace Engineering: 8

High-Speed flow Heat Transfer, Heat Transfer problems in gas turbine combustion chambers – Aerodynamic heating – Ablative heat transfer.

Text Books

1. Heat Transfer – A practical approach (2nd ed.), Yunus A. Cengel., Tata McGraw-Hill.
2. Introduction to Heat Transfer, Incropera.F.P. and Dewitt. D.P., John Wiley and Sons, 2002.

References

1. A Heat Transfer Text Book, Lienhard, J.H., Prentice Hall Inc., 1981.
2. Heat Transfer (6th ed.), Holman, J.P., McGraw-Hill Book Co. Inc., New York, 1991.
3. Fundamentals of Engineering Heat & Mass Transfer, Sachdeva, S.C., Wiley Eastern Ltd., New Delhi, 1981.
4. Gas Turbine and Jet and Rocket Propulsion, Mathur, M. and Sharma, R.P., Standard Publishers, New Delhi, 1988.

Dynamics for Aerospace Engineers (AE 404)

Semester Examination : Contact Periods : (3L+ 1T)
Time-3 hrs. Internal Assessment :
Full Marks – 70. Full Marks – 30.

Three Dimensional Dynamics of Rigid Bodies:

- Kinematics 08
- Kinetics 08

Text Book: Engineering Mechanics – Dynamics, Meriam & Kraige

Dynamics of Gyroscopic Instruments:

- Small Oscillations of Gyro
- The Gyrocompass
- Oscillation of the Gyrocompass
- Stable Platform
- Inertial Navigation 10

Text Book: Introduction to Dynamics, W. T. Thomson

Dynamics of Non-rigid Systems:

- Introduction
- Steady Mass Flow
- Variable Mass
- Wave Propagation 10

Text Book: Engineering Mechanics - Dynamics, Meriam & Kraige

Generalised Theories of Mechanics:

- Introduction
- Generalised Coordinates
- Holonomic and Nonholonomic Systems
- Lagrange's Equations
- Missile Dynamic Analysis 08

Text Book: Introduction to Dynamics, W. T. Thomson

Introduction Aerospace Engineering (AE 405)

Semester Examination : Contact Periods : (3L+ 1T)
Time-3 hrs. Internal Assessment :

Full Marks – 70. Full Marks – 30

Fundamental Thoughts: **5**
Fundamental Physical Quantities of a Flowing Gas; The source of all aerodynamic Forces; Anatomy of an Airplane; Anatomy of a Space Vehicle.

The Standard Atmosphere: **4**
Definition of Altitude; Hydrostatic Equation; Geopotential and Geometric Altitudes and their relation; The standard Atmosphere.

Basic Aerodynamics: **4**
Conservation Laws; Elementary Thermodynamics; Measurement of Airspeed; Wind Tunnels.

Airfoils, Wings and Other Aerodynamic Shapes: **4**
Airfoil Nomenclature; Force, Moment and Pressure Coefficients; Finite Wings; Swept Wings; Mechanisms for High Lift.

Elements of Airplane Performance: **8**
Introduction; Equations of Motions; Thrust and Power Required for Level and Accelerated Flight; Thrust and Power Available and Maximum Velocity; Altitude Effects; Gliding Flight; Range and Endurance; Takeoff Performance; Landing Performance; Turning Flight.

Principles of Stability and Control: **8**
Definition of Stability and control; Moments on the Airplane; Longitudinal Static Stability; Directional Static Stability; Lateral Static Stability; Control of Different Stabilities.

Propulsion: **10**
Introduction; Propeller; Reciprocating Engine; Jet Propulsion; Turbojet Engines; Turbofan Engines; Ramjet Engines; Rocket Engines; Propellants; Electric Propulsion..

Flight Vehicle Structures and Materials: **4**
Introduction; Some Physics of solid Materials; Some Elements of Aircraft Structure; Materials; fatigue; Some Comments

Book:
Introduction to Flight, J D Anderson, Jr., McGraw-Hill International

Fifth Semester

	Subjects	**Code**	***Hours/Week***			***Marks***
			L	**T**	**S**	
1.	Economics & Accountancy	HU 5601	2	0	0	50
2.	High Speed Aerodynamics	AE 501	3	1	0	100
3.	Aerospace Structure II	AE 502	3	1	0	100
4.	Introduction to Propulsion	AE 503	3	0	0	100
5.	Aircraft Dynamics	AE 504	3	1	0	100
6.	Manufacturing Technology	AE 505	3	1	0	100
7.	High Speed Aerodynamics Lab	AE 551	0	0	3	100
8.	Structures Lab II	AE 552	0	0	3	100
9.	Propulsion Lab	AE 553	0	0	3	100
10.	Manufacturing Technology Lab	AE 555	0	0	2	50
			17	**04**	**11**	**900**
					32	**900**

Economics and Accounts (HU 5601)

Semester Examination : Contact Periods : (2L)
Time-2 hrs. Internal Assessment :
Full Marks – 35. Full Marks – 15

Economics (1st Half)
A. General : Introduction ; markets – The market Forces of Supply and Demand; Elasticity of Demand.
B. Microeconomic Theory : Consumer Behaviour ; Production : Cost Curves ; Types of Industry and Profit Maximization.
C. Macroeconomic Theory : Macroeconomic Data; Measuring national Income ; Simple Income Determination ; Government Policy ; Major Macroeconomics Problems.

Reference : Principles of Economics, Lipsey & Chrystal

Accounts (2nd half)
1. Financial Accounting : Definition basic accounting process ; preparation of Final Account ; Trading, Profit & Loss Account Balance Sheet.
2. Cost and Management Accounting : Definition, Cost terms – Cost Classifications;
3. Accounting for Overhead Cost : Concept – Allocation, Apportionment and Absorption.
4. Methods of Costing – Unit / Ouput Costing ;
5. Techniques of Costing : Overview Marginal Costing and CVP Analysis ; Overview of Budgets.

Text Books :
1. Accountancy, Hanief and Mukherjee, TMH Publication
2. Cost Accounting, Jain and Narang, Kalyani Publishers
3. Cost Accounting, Prof. B. Banerjee, World Press

Reference Books :
1. Cost Accounting : a managerial emphasis, C.T. Horngren, G. Foster and S.M.Datar, PHI
2. Cost & Management Accounting, Collin Drury

High Speed Aerodynamics (AE 501)

Semester Examination : Contact Periods : (3L+ 1T)
Time-3 hrs. Internal Assessment :
Full Marks – 70. Full Marks – 30

Compressible Flow: **2**
Introduction; Flow Regimes; Definition of Compressible Flow; A Brief Review of Thermodynamics.

Conservation Equations for Inviscid Flows: **4**
Integral and Differential Approaches; Continuity Equation; Momentum Equation; Energy equation; Applications.

One Dimensional Flow: **5**
One Dimensional Flow Equations of Conservation Principles; Some Conveniently Defined Flow Parameters; Alternative Forms of Energy Equations; Normal Shock Relations; Hugoniot Equations; One Dimensional Flow with Heat Transfer; One Dimensional Flow with Friction.

Two Dimensional Flow: **6**
Introduction; Source of Oblique Waves; Oblique shock relations; Shock Polar; Shock Reflection and Intersection; Bow Shock in front of a Blunt Body; Three Dimensional Shock Waves; Prandtl-Meyer Expansion Waves; Shock-Expansion Theory.

Quasi-One Dimensional Flow: Introduction; Governing Equations; Nozzles; Diffusers. 5

Unsteady Wave Motion: **10**
Introduction; Moving Normal Shock Waves; Reflected Shock Waves; Elements of Acoustic Theory; Finite Waves; Incident and Reflected Expansion Waves; Shock tube Relations; Finite Compression Waves.

Linearised Flow: **8**
Introduction; Differential Conservation equations for Inviscid Flow; Crocco's Theorem; Velocity Potential Equation: Linearised Velocity Potential Equation; Linearised Subsonic Flow; Linearised Supersonic Flow; Supersonic Panel Methods; Method of Characteristics.

Three Dimensional Flow: Cones at Angle of Attack; Blunt Bodies at Angle of attack. 5

Text Book: Modern Compressible Flow with Historical Perspective, J. D. Anderson Jr., McGraw Hill

Aerospace Structure – II (AE 502)

Semester Examination : Contact Periods : (3L+ 1T)
Time-3 hrs. Internal Assessment :
Full Marks – 70. Full Marks – 30

Plate Analysis: **16**
Pure bending of thin plate – plate subjected to bending & twist – governing differential equation of equilibrium – boundary conditions (simply supported, clamped, free, elastically supported) – Navier's solution – Levy's solution (only derivation) – principle of minimum potential energy in plate analysis – equilibrium equation of orthotropic plates – equilibrium equation for transverse & in-plane loading – simple buckling of plates – inelastic buckling of plates – failure stress in plates & stiffened panels

Airframe Loads: **08**
Inertia loads analysis – analysis of manoeuvre loads (including acceleration) – analysis of gust loads – safe life – fatigue design – fatigue strength – aircraft fatigue life – crack propagation

Analysis of open & closed section beam: **14**
Unsymmetrical bending – bending approximation for thin walled section – stress-strain-displacement relation for open & closed thin walled beam – shear of open section beam – shear of closed section beam – torsion of closed section beam – torsion of open section beam using membrane analogy – analysis of combined open & closed section – deflection of open & closed section beams

Books recommended:

1. Thin plates and shells, Ventsel & Krauthammer
2. Theory of plates and shells, Timoshenko & Krieger
3. Beams, plates and shells, L.H. Donnel
4. Aircraft structures, T.H.G. Megson
5. Applied elasticity, Zhi Lun Xu

Introduction to Propulsion (AE 503)

Semester Examination : Contact Periods : (3L+ 1T)
Time-3 hrs. Internal Assessment :
Full Marks – 70. Full Marks – 30

Propellers and Propulsion: 8

Introduction; Froude's Momentum Theory of Propulsion; Airscrew Coefficients; Airscrew Pitch; Blade Element Theory; The momentum Applied to Helicopter Rotor.

Thermodynamics Review: 12

Equations of State; Basic Laws for a Control Mass System; Relation between System and Control Volume; Conservation of Mass Equation; Steady Flow Energy Equation; Steady Flow Entropy Equation; Momentum Equation; Summary of Laws for a Fluid Flow.

Aircraft Gas Turbine Engines: 8

Introduction; Thrust Equation; Note on Propulsive Efficiency; Gas Turbine Engine Components; Brayton Cycle; Aircraft Engine Design.

Ideal Gas Power Cycles and its Parametric Analysis: 12

Basic Consideration in the Analysis of Power Cycles; The Carnot cycle and its Value in Engineering; An Overview of Reciprocating Engines; Otto Cycle; Diesel Cycle; Stirling and Ericsson Cycle; Brayton Cycle; Ideal Jet Propulsion Cycles; Second Law Analysis of Gas Power Cycles.

Text Books:

1. Elements of Gas Turbine Propulsion, J. D. Mattingley, Tata McGraw Hill
2. Thermodynamics: An Engineering Approach, Y. A. Cengel & M. A. Boles, McGraw Hill
3. Aerodynamics for Engineering Students, E. L. Houghton & P. W. Carpenter, Elsevier

Aircraft Dynamics (AE 504)

Semester Examination :
Time-3 hrs.
Full Marks – 70.

Contact Periods : (3L+ 1T)
Internal Assessment :
Full Marks – 30

Introduction: Overview, General Considerations.

System of Axes and Notation: Earth Axes; Aircraft Body Fixed Axes; Euler Angles and Aircraft Attitude; Aircraft Reference Geometry; Aerodynamic Reference Centres.

Static Equilibrium and Trim: Trim Equilibrium; The Pitching Moment Equation; Static Stabilities.

The Equations of Motion: The Equation of Motion of a Rigid Symmetric Aircraft; Linearised Equations of Motion; The Decoupled Equations of Motion; Alternative Forms Equations of Motion.

Solution of the Equations of Motion: Methods of Solution; Aircraft Response Transfer Functions; Response to Controls; Acceleration Response Transfer Functions; The State Space Method; State Space Model Augmentation.

Longitudinal Dynamics: Response to Controls; The dynamic Stability Modes; Reduced Order Models; Frequency Response; Flying and Handling Qualities; Mode Excitation.

Lateral-directional Dynamics: Response to Controls; The dynamic Stability Modes; Reduced Order Models; Frequency Response; Flying and Handling Qualities; Mode Excitation.

Maneuverability: Introduction; Steady Pull-up Maneuver; The Pitching Moment Equation; Longitudinal Maneuver Stability; Aircraft Dynamics and Maneuverability.

Text Book: Flight Dynamics Principles (2nd ed.), M. V. Cook, Elsevier

Manufacturing Technology (AE 505)

Semester Examination : Contact Periods : (3L+ 1T)
Time-3 hrs. Internal Assessment :
Full Marks – 70. Full Marks – 30

1. Various types of molding and casting, Pattern design, Riser and gating design. Various metal forming technology.
2. Various joining processes: welding, brazing, soldering.
3. Cutting tools: Materials, geometry and nomenclature, tool wear, tool life.
4. Principles of metal cutting, mechanics of metal cutting, cutting tools, cutting processes.
5. Basic metal cutting processes: Turning, Drilling, Milling, Boring.
6. Surfaces finishing processes.
7. Computer Aided Manufacturing (CAD), CNC Technology and Programming, DNC, Adaptive Control.
8. Non-traditional Machining: Principle and various processes- EDM, Wire EDM, ECM, AJM, LJM, Plazma Machining, Abrasive Water jet machining.
9. Concept of CIM and FMS, Industrial Automation, Automated Material Handling, Assembly and Inspection, Computer Aided Process Planning, Group Technology and Cellular Manufacturing.

Books:

1. Manufacturing Science, A. Ghosh and A. K. Mallik
2. Metal Cutting Theory and Practice, A. Bhattacharyya
3. Production Technology, Hindustan Machine Tools
4. Fundamentals of Modern Manufacturing, Materials, Processes and Systems, M. P. Groover
5. Modern Machining Processes, P. C. Pandey and H. S. Shah
6. Advanced Machining Processes, V. K. Jain
7. Automation, Production Systems and Computer Integrated Manufacturing, M. P. Groover

Sixth Semester

	Subjects	**Code**	***Hours/Week***			***Marks***
			L	**T**	**S**	
1.	Principle of Management	HU 5602	2	0	0	50
2.	Viscous Fluid Flow	AE 601	3	1	0	100
3.	Mechanical Vibration	AE 602	3	1	0	100
4.	Theory of Jet Propulsion	AE 603	3	1	0	100
5.	Aircraft Stability and Control	AE 604	3	1	0	100
6.	Composites and Structures	AE 605	3	1	0	100
7.	Viscous Fluid Flow Lab	AE 651	0	0	3	100
8.	Mechanical Vibration Lab	AE 652	0	0	3	100
9.	Jet Propulsion Lab	AE 653	0	0	3	100
10.	Stability and Control Lab	AE 654	0	0	3	100
11.	Summer Training	AE 660	-	-	-	000
			17	**04**	**12**	**950**
				33		**950**

Principles of Management (HU 5602)

Semester Examination : Contact Periods : (2L)
Time-2 hrs. Internal Assessment :
Full Marks – 35. Full Marks – 15

A. Introduction to Management : **8**
What is management ? Scope and process of management; functional areas of management ; business environment ; value chain analysis; SWOT; objectives, strategies and plans.

B. Marketing Management : **8**
The marketing concept ; marketing environment; marketing objectives and strategies; marketing mix variables, PLC, marketing planning and control.

C. Organizational Behaviour : 8
Scope, Learning, Attitude, Perception, Cooperation & Conflict, Motivation, Leadership, Gender Issues, Work Culture.

D. Financial Management : 8
Definition and scope of finance function; objectives of FM; fundamental of working capital management; capital budgeting / project evaluation techniques.

Reference Books:

For A. 1. Management Today, Burton & Thakur
2. Management by Stoner, Freeman & Gilbert.
For B. 1. Marketing Management, Philip Kotler.
2. Marketing Management, Ramswamy & Namakumari
For C. 1. Organisational Behaviour, Fred Luthans
2. Organisational behaviour by Stephen P. Robins.
For D. 1. Finance Management, Khan & Jain
2. Finance Management, Prasanna Chandra.

Viscous Fluid Flow (AE 601)

Semester Examination : Contact Periods : (3L+ 1T)
Time-3 hrs. Internal Assessment :
Full Marks – 70. Full Marks – 30

Fundamental Equations of Viscous Flow:
Continuity Equation, Stokes' Constitutive Laws, Derivation of Navier-Stokes Equation for Newtonian Flow in Different Co-ordinate Systems; Energy Equation; Nondimensionalizing the basic equations, Similarity Laws; Vorticity Transport Equation and Vorticity Dynamics;

Exact Solutions of Incompressible and Compressible Newtonian Viscous-Flow Equation: Flow between Parallel Plates; Steady Flow in Pipes; Flow between Two Concentric Rotating Cylinders; Application of Parallel Flow Theory; Theory of Very Slow Motion; Unsteady Motion of a Flat Plate.

Incompressible and Compressible Laminar Boundary Layer Theory:

Boundary Layer approximation, Prandtl's Boundary Layer equation; Blasius Solution for Flat plate, The Falkner-Skan Wedge Flows; Asymptotic Behaviour of Solutions Downstream; Integral Relations of Boundary Layer over a Flat Plate

with Zero and Nonzero Pressure Gradient, First and Second-order Boundary Layer Theory; Boundary Layer Separation; Thin Shear Layer Flows.

Flow over Immersed bodies:
Flow past a Circular Cylinder, Drag coefficient; Flow over an Airfoil;

Free-Shear Flows:
Free-Shear layer between two Different Streams; Plane laminar Jet and Wake Flows;

Books:

1. An Introduction to Fluid Dynamics, G K Batchelor, Cambridge University Press
2. Viscous Fluid Flow, F M White, McGraw-Hill International
3. Boundary Layer Theory, H Schlichting, McGraw-Hill
4. Mechanics of Fluids, I. H. Shames, McGraw-Hill
5. Foundations of Fluid Mechanics, S. W. Yuan, Prentice Hall of India
6. Modern Developments in Fluid Dynamics – Vol. 1 & 2, S Goldstein, Oxford University Press
7. Numerical Solutions of Boundary Layers Flow, Cebeci, T., Springer-Verlag
8. An Introduction to Boundary Layer Flows for Aeronautical Engineering Students, van Ingen, J.L., Delft

Mechanical Vibration (AE 602)

Semester Examination : Contact Periods : (3L+ 1T)
Time-3 hrs. Internal Assessment :
Full Marks – 70 Full Marks – 30

Introduction: Oscillatory motion – Harmonic motion, Periodic motion, Vibration Terminology. 1

Free Vibration of Single Degree of Freedom System: Vibration model and equations of motion, Natural frequency, Energy method, Rayleigh method, Different Kinds of Damping. 4

Forced vibration of Single Degree of Freedom System: Forced harmonic vibration, Rotatiing unbalance, Rotor unbalance, Whirling of rotating shafts, Support motion, Vibration isolation, Energy dissipation, Equivalent viscous damping, Structural damping, Vibration measuring instruments. 6

Transient vibration: Impulse excitation, Arbitrary excitation, Laplace transform formulation, Response spectrum. 3

Multi-degree of freedom systems: Normal mode vibration, Coordinate coupling, Forced harmonic excitation. 3

Properties of vibrating systems: Flexibility matrix, Stiffness matrix, Stiffness of beam elements, Eigen values and eigenvectors, Orthogonal properties of eigenvectors, Modal matrix, Modal damping in forced vibration. 8

Lagrange's Equation: Generalized coordinates, Lagrange's equation, Kinetic energy, Potential Energy and generalized force. 5

Normal mode vibration of continuous systems: Vibrations of rods, Euler equation of beams, Membranes and Plates. 5

Approximate numerical methods: Rayleigh method, Dunkerley's method, Rayleigh-Ritz method, Method of matrix iteration, Calculation of higher modes. 5

Books:

1. Theory of Vibration with Applications, W T Thompson, George Allen
2. Analytical Methods in Vibration, L Meirovitch, MacMillan

3. Introduction to the Theory of Aeroelasticity, Y C Fung
4. Principle of Aeroelasticity, R L Bisplinghoff, H Ashley, Wiley
5. A Modern Course on Aeroelasticity, E H Dowell and H C Curtiss, Klüwer Academic Publishers

Theory of Jet Propulsion (AE 603)

Semester Examination : Contact Periods : (3L+ 1T)
Time-3 hrs. Internal Assessment :
Full Marks – 70 Full Marks – 30

Component Performance: 6
Introduction; Variation of Gas Properties; Component Performance; Inlet and Diffuser Pressure Recovery; Compressor and Turbine Efficiencies; Burner Efficiency and Pressure Loss; Exit Nozzle Loss.

Parametric Cycle Analysis of Real Engines: 10
Introduction; Turbojet; Turbojet with Afterburner; Turbofan – Separate Exhaust System; Turbofan with Afterburning - Separate Exhaust System; Turbofan with Afterburning - Mixed Exhaust Stream; Turboprop Engine; Variable Gas Properties.

Engine Performance Analysis: 10
Introduction; Gas Generator; Turbojet Engine; Turbojet with Afterburning; Turbofan Engine - Separate Exhausts and Convergent Nozzles; Turbofan with Afterburning – Mixed-Flow Exhaust Steam; Turboprop Engine; Variable Gas Properties.

Turbomachinery: 8
Introduction; Euler's Turbomachinery Equations; Axial Flow Compressor Analysis; Centrifugal-Flow Compressor Analysis; Axial Flow Turbine Analysis; Centrifugal-Flow Turbine Analysis.

Inlets, Nozzles and Combustion systems: 6
Introduction to Inlets and Nozzles; Inlets; Subsonic and Supersonic Inlets; Exhaust Nozzles; Introduction to Combustion systems; Main and after Burners.

Text Book: Elements of Gas Turbine Propulsion, J. D. Mattingley, Tata McGraw Hill

Aircraft Stability and Control (AE 604)

Semester Examination : Contact Periods : (3L+ 1T)
Time-3 hrs. Internal Assessment :
Full Marks – 70 Full Marks – 30

Stability:
Introduction; The Characteristics Equation; The Routh-Hurwitz Stability Criterion; The Stability Quartic; Graphical Interpretation of Stability

Flying and Handling Qualities:
Introduction; Short Term Dynamic Models; Flying Qualities Requirements; Aircraft Role; Longitudinal Flying Qualities Requirements; Control Anticipation Parameter; Lateral Directional Flying Qualities Requirements; Flying Qualities Requirements on the s-Plane.

Stability Augmentation:

Introduction; Augmentation System Design; Closed Loop System Analysis; The Root Locus Plot; Longitudinal Stability Augmentation; Lateral-directional Stability Augmentation; The Pole Placement Method.

Aerodynamic Modeling:
Introduction; Quasi-static Derivatives; Derivative Estimation, The Effect of Compressibility; Limitation of Aerodynamic Modeling.

Aerodynamic Stability and Control Derivatives:
Introduction; Longitudinal Aerodynamic Stability Derivatives; Lateral-directional Aerodynamic Stability Derivatives; Aerodynamic Control Derivatives

Text Book: Flight Dynamics Principles (2nd ed.), M. V. Cook, Elsevier

Composites and Structures (AE 605)

Semester Examination :
Time-3 hrs.
Full Marks – 70

Contact Periods : (3L+ 1T)
Internal Assessment :
Full Marks – 30

[To be uploaded later]