SCHEME OF TEACHING AND EXAMINATION
B.E. AERONAUTICAL ENGINEERING

V SEMESTER

Sl. No	Sub-Code	Title	Teaching Dept.	Teaching hours / week		Examination			
				Theory	Pract.	Duration	I.A. Marks	Theory/ Pract.	Total Marks
1	06AL51	Management and Entrepreneurship	@	04	--	03	25	100	125
2	06AE52	Elements of Aeronautics	AE	04	--	03	25	100	125
3	06AE53	Dynamics of Machines	ME	04	--	03	25	100	125
4	06AE54	Aerodynamics – I	AE	04	--	03	25	100	125
5	06AE55	Aircraft Propulsion	AE	04	--	03	25	100	125
6	06AE56	Aircraft Structures – I	AE	04	--	03	25	100	125
7	06AEL57	Structures Laboratory	AE	--	03	03	25	50	75
8	06AEL58	Energy Conversion Lab	AE/ME	--	03	03	25	50	75
TOTAL				**24**	**06**	**24**	**200**	**700**	**900**

Note: One question has to be set for every 6 to 8 hours of teaching.

@ **-** Indicates that teaching department can be any engineering department / department of management studies

SCHEME OF TEACHING AND EXAMINATION
B.E. AERONAUTICAL ENGINEERING

VI SEMESTER

Sl. No	Sub-Code	Title	Teaching Dept.	Teaching hours / week		Examination			
				Theory	Pract.	Duration	I.A. Marks	Theory / Pract.	Total Marks
1	06AE61	Introduction to Composite Materials	ME/IEM	04	--	03	25	100	125
2	06AE62	Aircraft Structures - II	AE	04	--	03	25	100	125
3	06AE63	Aerodynamics – II	AE	04	--	03	25	100	125
4	06AE64	Finite Element Analysis	AE/ME	04	--	03	25	100	125
5	06AE65	Theory of Vibrations	ME	04	--	03	25	100	125
6	06AE66x	**Elective - I (Group A)**	AE/IEM	04	--	03	25	100	125
7	06AEL67	Aerodynamics Laboratory	AE	--	03	03	25	50	75
8	06AEL68	Propulsion Laboratory	AE	--	03	03	25	50	75
TOTAL				**24**	**06**	**24**	**200**	**700**	**900**

Note: One question has to be set for every 6 to 8 hours of teaching.

***ELECTIVE 1 (Group A)**	
06AE661	Numerical Methods
06AE662	Aircraft Materials
06AE663	Combustion
06AE664	Reliability Engineering
06AE665	Industrial Management

*** Students shall register for one subject from Group A Electives**

SCHEME OF TEACHING AND EXAMINATION
B.E. AERONAUTICAL ENGINEERING

VII SEMESTER

Sl No	Subject Code	Title	Teaching Dept.	Teaching Hours / week		Examination			
				Th.	Pr.	Dura-tion	I.A Marks	Theory/ Practical	Total Marks
1	06AE71	Control Engineering	AE/ME	04	--	03	25	100	125
2	06AE72	Applied Gas Dynamics	AE	04	--	03	25	100	125
3	06AE73	Performance, Stability & Control	AE	04	--	03	25	100	125
4	06AE74	GasTurbine Technology	AE	04	--	03	25	100	125
5	06AE75	**Electives II (Group B)**	AE	04	--	03	25	100	125
6	06AE76x	**Electives III (Group C)**	AE	04	--	03	25	100	125
7	06AEL77	Modeling and Analysis Laboratory	AE	--	03	03	25	50	75
8	06AEL78	Simulation Laboratory	AE	--	03	03	25	50	75
Total				24	06	24	200	700	900

Note: One question has to be set for every 6 to 8 hours of teaching.

ELECTIVE II (GROUP B)

06AE751	Engineering Optimisation	06AE761	Experimental Stress analysis
06AE752	Computational Fluid Dynamics	06AE762	Helicopter Dynamics
06AE753	Aircraft Maintenance, Repair and Overhaul	06AE763	Space Mechanics and Launch Vehicles
06AE754	Statistical Quality Control	06AE764	Smart Materials
06AE755	Theory of plates and shells	06AE765	Agile Manufacturing
06AE756	Nondestructive Testing	06AE766	Robotics
06AE757	Mechatronics and Microprocessor	06AE767	Industrial and Experimental Aerodynamics
06AE758	Total Quality Management	06AE768	Micro and Smart Systems Technology

ELECTIVE II (GROUP C)

* Students shall register for one subject each from Group B and C Electives

SCHEME OF TEACHING AND EXAMINATION
B.E. AERONAUTICAL ENGINEERING

VIII SEMESTER

Sl No	Subject Code	Title	Teaching Dept.	Teaching Hours / week		Examination			
				Th.	Pr.	Dura-tion	I.A Marks	Theory/ Practical	Total Marks
1	06AE81	Flight Vehicle Design	AE	04	--	03	25	100	125
2	06AE82	Avionics	AE	04	--	03	25	100	125
3	06AE83x	**Electives IV (Group D)**	AE	04	--	03	25	100	125
4	06AE84x	**Electives V (Group E)**	AE	04	--	03	25	100	125
5	06AE85	Project Work	AE	--	03	--	100	100	200
6	06AE86	Seminar on Current Topics	AE	03	--	--	50	--	50
Total				19	03	12	250	500	750

Note: One question has to be set for every 6 to 8 hours of teaching.

ELECTIVE IV (GROUP D)

06AE831	Flight Testing	06AE841	Aircraft Safety Rules and Regulations
06AE832	Fracture Mechanics	06AE842	Guidance and Navigation
06AE833	Theory of Aeroelasticity	06AE843	Management Information Systems
06AE834	Hydraulics and Pneumatics	06AE844	Project Management
06AE835	Reliability and Maintenance Engineering	06AE845	Product Design and Manufacturing
06AE836	Boundary Layer Theory	06AE846	Artificial Intelligence
06AE837	Operation Research	06AE847	Computer Integrated Manufacturing
06AE838	Aerospace Quality Assurance	06AE848	Aircraft Systems and Instrumentation

ELECTIVE V (GROUP E)

* Students shall register for one subject each from Group D and E Electives.

V SEMESTER

MANAGEMENT & ENTREPRENEURSHIP

Subject Code	: **06AL51**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

MANAGEMENT

UNIT - 1

MANAGEMENT: Introduction - Meaning - nature and characteristics of Management, Scope and functional areas of Management - Management as a Science, Art or Profession Management & Administration - Roles of Management, Levels of Management, Development of Management Thought-Early Management Approaches-Modern Management Approaches.

7 Hours

UNIT - 2

PLANNING: Nature, importance and purpose of planning process - Objectives - Types of plans (Meaning only) - Decision making - Importance of planning - steps in planning & planning premises - Hierarchy of plans.

6 Hours

UNIT - 3

ORGANISING AND STAFFING: Nature and purpose of organization - Principles of organization - Types of organization - Departmentation - Committees – Centralisation Vs Decentralisation of authority and responsibility - Span of control - MBO and MBE (Meaning only) Nature and importance of Staffing - Process of Selection & Recruitment (in brief).

6 Hours

UNIT - 4

DIRECTING & CONTROLLING: Meaning and nature of directing - Leadership styles, Motivation Theories, Communication - Meaning and importance – Coordination, meaning and importance and Techniques of Co - ordination. Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control.

7 Hours

PART - B

ENTREPRENEURSHIP

UNIT - 5

ENTREPRENEUR: Meaning of Entrepreneur; Evolution of the Concept, Functions of an Entrepreneur, Types of Entrepreneur, Intrapreneur - an

emerging Class. Concept of Entrepreneurship - Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship – its Barriers.

6 Hours

UNIT - 6

SMALL SCALE INDUSTRY: Definition; Characteristics; Need and rationale: Objectives; Scope; role of SSI in Economic Development. Advantages of SSI Steps to start an SSI - Government policy towards SSI; Different Policies of S.S.I.; Government Support for S.S.I. during 5 year plans, Impact of Liberalization, Privatization, Globalization on S.S.I., Effect of WTO/GATT Supporting Agencies of Government for S.S.I Meaning; Nature of Support; Objectives; Functions; Types of Help; Ancillary Industry and Tiny Industry (Definition only).

7 Hours

UNIT - 7

INSTITUTIONAL SUPPORT: Different Schemes; TECKSOK; KIADB; KSSIDC; KSIMC; DIC Single Window Agency: SISI; NSIC; SIDBI; KSFC.

6 Hours

UNIT - 8

PREPARATION OF PROJECT: Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of Business Opportunities - Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study.

7 Hours

TEXT BOOKS:

1. **Principles of Management** - P. C. Tripathi, P. N. Reddy; Tata McGraw Hill.
2. **Dynamics of Entrepreneurial Development & Management** - Vasant Desai Himalaya Publishing House.
3. **Entrepreneurship Development** - Small Business Enterprises - Poornima M Charantimath - Pearson Education – 2006.

REFERENCE BOOKS:

1. **Management Fundamentals** - Concepts, Application, Skill Development Robert Lusier – Thomson.
2. **Entrepreneurship Development** - S S Khanka - S Chand & Co.
3. **Management** - Stephen Robbins - Pearson Education /PHI -17th Edition, 2003.

ELEMENTS OF AERONAUTICS

Subject Code	: **06AE52**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

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

6 Hours

UNIT - 2

AIRCRAFT CONFIGURATIONS: Different types of flight vehicles and classifications. Components of an airplane and their functions. Airfoils, wings and other shapes.

6 Hours

UNIT - 3

PRINCIPLES OF ATMOSPHERIC FLIGHT: Physical properties and structure of the atmosphere, The Standard Atmosphere, Temperature, Pressure and Altitude relationships, Evolution of lift, drag and moment, Airfoils, Mach number, Maneuvers, Concepts of stability and control.

8 Hours

UNIT - 4

INTRODUCTION TO SPACE FLIGHT: Introduction to basic concepts, The upper atmosphere, Differential equations, Lagrange's equation, Orbit equation, Space vehicle trajectories-some basic concepts, Kepler's Laws of planetary motion.

6 Hours

PART - B

UNIT - 5

AIRCRAFT STRUCTURES AND AIRCRAFT MATERIALS: General types of construction, Monocoque, semi-monocoque and geodesic construction, typical wing and fuselage structure. Metallic and non-metallic materials for aircraft application.

6 Hours

UNIT - 6

AIRCRAFT POWER PLANTS: Basic ideas about piston, turboprop and jet engines, Use of propeller and jets for thrust production. Comparative merits;

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

8 Hours

UNIT - 7

AIRCRAFT SYSTEMS: MECHANICAL: Description of different airplane systems and their components: Hydraulics, Pneumatic, Oxygen System, Environmental Control System, Fuel System.

6 Hours

UNIT - 8

AIRCRAFT SYSTEMS: ELECTRICAL: Flight Control System, Aircraft Electrical System, Aircraft Instruments, Navigation System, Communication System.

6 Hours

TEXT BOOKS:

1. **Introduction to Flight,,** Anderson, J.D., McGraw-Hill, 1995.
2. **Fundamentals of Flight Vol. IV Aircraft Systems,** Lalit Gupta and Dr. O. P. Sharma., Himalayan Books, 2006

REFERENCE BOOKS:

1. **Flight without Formulae,** Kermode, A.C., McGraw-Hill, 1997.
2. **Introduction to Aircraft Basic Science**, Kroes, Michael J and Rardon, JamesR", 7th Edition, Macmillan / McGraw Hill, 1993.
3. **Space Vehicle Design, 2nd Edition AIAA Education Series,** Michael D. Griffin, James R. French by Michael D.
4. **Mechanics of Flight, (Revised by RH Bernard & DR Philpott),** Kermode, A.C., LPE, Pearson Education, 2005.

DYNAMICS OF MACHINES

Subject Code	: **06AE53**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

STATIC FORCE ANALYSIS: Static force analysis: Introduction: Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque, Free body diagrams, principle of virtual work. Static force analysis of four bar mechanism and slider-crank mechanism with and without friction.

6 Hours

UNIT - 2

DYNAMIC FORCE ANALYSIS: D'Alembert's principle, Inertia force, inertia torque, Dynamic force analysis of four-bar mechanism and slider crank mechanism. Dynamically equivalent systems. Turning moment diagrams and flywheels, Fluctuation of Energy. Determination of size of flywheels.

8 Hours

UNIT - 3

FRICTION AND BELT DRIVES: Definitions: Types of friction: laws of friction, Friction in pivot and collar bearings. Belt drives: Flat belt drives, ratio of belt tensions, centrifugal tension, power transmitted.

6 Hours

UNIT - 4

BALANCING OF ROTATING MASSES: Static and dynamic balancing, Balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes.

6 Hours

PART - B

UNIT - 5

BALANCING OF RECIPROCATING MASSES: Inertia effect of crank and connecting rod, single cylinder engine, balancing in multi cylinder-inline engine primary & Secondary forces, V-type engine; Radial engine – Direct and reverse crank method.

8 Hours

UNIT - 6

GOVERNORS: Types of governors; force analysis of Porter and Hartnell governors. Controlling force, stability, sensitiveness, isochronism, effort and power.

6 Hours

UNIT - 7

GYROSCOPE: Vectorial representation of angular motion, Gyroscopic couple. Effect of gyroscopic couple on ship, plane disc, aeroplane, stability of two wheelers and four wheelers.

6 Hours

UNIT - 8

ANALYSIS OF CAMS: Analysis of Tangent cam with roller follower and Circular arc cam operating flat faced and roller followers, Undercutting in Cams.

6 Hours

TEXT BOOKS:

1. **Theory of Machines**: Sadhu Singh, Pearson Education, 2nd edition, 2007.
2. **Theory of Machines**: Rattan S.S. Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition, 2006.

REFERENCE BOOKS:

1. **Theory of Machines** by Thomas Bevan, CBS Publication 1984.
2. **Design of Machinery** by Robert L. Norton, McGraw Hill, 2001.
3. **Mechanisms and Dynamics of Machinery** by J. Srinivas, Scitech Publications, Chennai, 2002.
4. **Dynamics of machinery** by J. B. K. Das & P. L. S. Murthy.

AERODYNAMICS - I

Subject Code	: **06AE54**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

REVIEW OF BASIC FLUID MECHANICS: Continuity, momentum and energy equation, units and dimensions, inviscid and viscous flows, compressibility, Mach number regimes.

6 Hours

UNI1 - 2

DESCRIPTION OF FLUID MOTION: Euler and Lagrangian descriptions, control volume approach to continuity and momentum equations, pathlines, streamlines and streaklines, angular velocity, vorticity, circulation, stream function, velocity potential and relationship between them.

6 Hours

UNIT - 3

AIRFOIL CHARACTERISTICS : Fundamental aerodynamic variables, airfoil section geometry and wing planform geometry, aerodynamic forces and moments, centre of pressure, pressure coefficient, calculation of airfoil lift and drag from measured surface pressure distributions, typical airfoil aerodynamic characteristics at low speeds.

6 Hours

UNIT - 4

TWO-DIMENSIONAL INVISCID INCOMPRESSIBLE FLOWS: Bernoulli's equation, pitot-tube measurement of airspeed, condition on velocity for incompressible flow, Eulers equations of motion, Governing equations for irrotational, incompressible flow, Laplace equation and boundary conditions. Two-dimensional source, sink, doublet and vortex flows.

8Hours

PART - B

UNIT - 5

FLOW OVER CIRCULAR CYLINDERS: Non-lifting flow over a two-dimensional circular cylinder, Lifting flow over a two-dimensional circular cylinder, Kutta-Joukowski theorem and generation of lift, D'Alembert's paradox.

6 Hours

UNIT - 6

INCOMPRESSIBLE FLOW OVER AIRFOILS: Kelvin's circulation theorem and the starting vortex, vortex sheet, Kutta condition, Classical thin airfoil theory for symmetric and cambered airfoils.

6 Hours

UNIT - 7

INTRODUCTION TO VISCOUS FLOWS:

Navier-Stokes equations, boundary layer concept, displacement, momentum thickness and wall skin friction, viscous flow over two-dimensional streamlined and bluff bodies and drag characteristics, aspects of boundary layer separation and airfoil stall.

6 Hours

UNIT - 8

INTRODUCTION TO AERODYNAMIC TESTING:

Principles of wind tunnel flow simulation, open and closed circuit wind tunnels, Major features of low speed, transonic and supersonic wind tunnels, smoke and tuft flow visualization techniques, Pressure and Aerodynamic load measurements on a model, total drag determination of two-dimensional bodies using wake survey at low speeds.

8 Hours

TEXT BOOKS:

1. **Fundamentals of Aerodynamics,** Anderson, Jr. J.D. Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2007. (Special Indian Edition).
2. **Aerodynamics for Engineering Students,** Houghton E.L and Carpenter P.W., CBS Publications and Distributors, 1993. (4^{th} Edition).

REFERENCE BOOKS:

1. **Low Speed Wind Tunnel testing,** Pope A. and Harper, J J John Wiley Inc. New York, 1966.
2. **Introduction to Flight,** Anderson, Jr. J.D., Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2007. (Special Indian Edition).
3. **Boundary Layer Theory,** Schlichting, H. Mc Graw Hill, New York, 2004.
4. **Mechanics of Fluids,** Duncan WJ, Thom AS and Young AD., Second Edition, Edward Arnold Printers Ltd, London, 1981.
5. **High Speed Wind Tunnel Testing,** Pope A. and Goin, KL, John Wiley & Sons Inc. New York, 1965.

AIRCRAFT PROPULSION

Subject Code	: **06AE55**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: Review of thermodynamic principles, Principles of aircraft propulsion, Types of power plants, Working principles of internal combustion engine, Two – stroke and four – stroke piston engines, Gas-turbine engines, Cycle analysis of reciprocating engines and jet engines.

6 Hours

UNIT - 2

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.

7 Hours

UNIT - 3

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.

7 Hours

UNIT - 4

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.

6 Hours

PART - B

UNIT - 5

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

7 Hours

UNIT - 6

COMPRESSORS: Principle of operation of centrifugal compressor – Work done and pressure rise – Velocity diagrams – Diffuser vane design considerations – Concept of prewhirl – Rotation stall – Elementary theory of axial flow compressor – Velocity triangles – degree of reaction -Centrifugal and Axial compressor performance characteristics.

7 Hours

UNIT - 7

INTRODUCTION TO TURBINES: Types of turbines – Design considerations – Performance parameters - Basics of blade design principles.

6 Hours

UNIT - 8

RAMJET PROPULSION: Operating principle – Sub critical, critical and supercritical operation – Combustion in ramjet engine – Ramjet performance – Introduction to scramjet – Preliminary concepts in supersonic combustion.

6 Hours

TEXT BOOKS:

1. **Gas Turbine,** V. Ganesan, Tata McGraw Hill Pub. Co. Ltd., 1996.
2. **Mechanics & Thermodynamics of Propulsion,** Hill, P.G. & Peterson, C.R. Addison – Wesley Longman INC, 1999.

REFERENCE BOOKS:

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

AIRCRAFT STRUCTURES – I

Subject Code	: **06AE56**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

LOADS ON AIRCRAFT: Structural nomenclature-types of loads, load factor, aerodynamic loads, symmetric manoeuvre loads and functions of structural components.

6 Hours

UNIT - 2

MATERIALS FOR AIRCRAFT STRUCTURES: Metallic and non-metallic materials, Use of Aluminium alloy, titanium, stainless steel and composite materials. Desirable properties for aircraft application.

6 Hours

UNIT - 3

MECHANICAL PROPERTIES OF MATERIAL: Stress – Strain - Tensile properties – Compression properties – Shear properties – Bearing properties – Creep and Stress properties – Fracture properties –Fatigue properties.

6 Hours

UNIT - 4

STATICALLY DETERMINATE AND INTERDETERMINATE STRUCTURES: Analysis of plane truss – Method of joints – 3 D Truss - Plane frames Composite beam –Clapeyron's Three Moment Equation - Moment Distribution Method**.**

8 Hours

PART - B

UNIT - 5

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

6 Hours

UNIT - 6

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

6 Hours

UNIT - 7

THEORY OF ELASTICITY: Concept of stress and strain, derivation of Equilibrium equations, strain-displacement relation, compatibility conditions and boundary conditions. Plane stress and Plane strain problems in 2-D elasticity and Airy's Stress function.

8 Hours

UNIT - 8

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

6 Hours

TEXT BOOKS:

1. **Aircraft Structures for Engineering Students,** Megson, T.M.G., Edward Arnold, 1995.
2. **Theory of Elasticity,** Timoshenko and Godier Mc Graw Hill Co.

REFERENCE BOOKS:

1. **Analysis of Aircraft Structures – An Introduction,** Donaldson, B.K., McGraw-Hill, 1993.
2. **Strength of Materials,** Timoshenko, S., Vol. I and II, Princeton D. Von Nostrand Co, 1990.

STRUCTURES LABORATORY

Subject Code	: **06AEL57**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 42	Exam Marks	: 50

LIST OF EXPERIMENTS

1. Deflection of a Simply Supported Beam.S
2. Verification of Maxwell's Reciprocal Theorem.
3. Determination of Young's Modulus using strain gages.
4. Poisson Ratio Determination.
5. Buckling Load of Slender Eccentric Columns and Construction of Southwell Plot
6. Shear failure of Bolted and Riveted Joints.
7. Bending Modulus of a Sandwich Beam
8. Verification of the Superposition Theorem.

ENERGY CONVERSION LABORATORY

Subject Code	: **06AEL58**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 42	Exam Marks	: 50

PART - A

(INDIVIDUAL EXPERIMENTS)

1. Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Pensky Martins Apparatus.
2. Determination of Caloric value of solid, liquid and gaseous fuels.
3. Determination of Viscosity of lubricating oil using Redwoods, Saybolts and Torsion Viscometers.
4. Valve, Timing/port opening diagram of an I.C. engine (4 stroke/ 2stroke).
5. Use of planimeter.

21 Hours

PART - B

(GROUP EXPERIMENTS)

1. Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiencies, SFC, FP, heat balance sheet for

   (a) Four stroke Diesel Engine
   (b) Four stroke Petrol Engine
   (c) Multi-cylinder Diesel/Petrol Engine, (Morse test)
   (d) Two stroke Petrol Engine
   (e) Variable Compression Ratio I.C. Engine

21 Hours

VI SEMESTER
INTRODUCTION TO COMPOSITE MATERIALS

Subject Code	: **06AE61**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION TO COMPOSITE MATERIALS: Definition, classification and characteristics of composite materials - fibrous composites, laminated composites, particulate composites. Properties and types of Reinforcement and Matrix materials.

6 Hours

UNIT - 2

FIBER REINFORCED PLASTIC PROCESSING: Lay up and curing, fabricating process - open and closed mould process - hand lay up techniques structural laminate bag molding, production procedures for bag molding.

6 Hours

UNIT - 3

ADVANCED PROCESSING TECHNIQUES AND APPLICATION OF COMPOSITES: Filament winding, pultrusion, pulforming, thermo - forming, injection, injection molding, liquid molding, blow molding, Automobile, Aircrafts, missiles, Space hardware, Electrical and electronics, marine, recreational and Sports equipment, future potential of composites.

8 Hours

UNIT - 4

FABRICATION OF COMPOSITE STRUCTURES: Cutting, machining, drilling, mechanical fasteners and adhesive bonding, joining, computer-aided design and manufacturing, tooling, fabrication equipment.

6 Hours

PART - B

UNIT - 5

MACRO-MECHANICAL BEHAVIOR OF A LAMINA: Stress-strain relation for an orthotropic lamina- Restriction on elastic constants-Strengths of an orthotropic lamina and Failure theories for an orthotropic lamina.

6 Hours

UNIT - 6

MICRO-MECHANICAL BEHAVIOR OF A LAMINA: Determination of elastic constants-Rule of mixtures, transformation of coordinates, micro-mechanics based analysis and experimental determination of material constants.

6 Hours

UNIT - 7

MACRO-MECHANICAL BEHAVIOR OF A LAMINATE: Classical plate theory- Stress and strain variation in a laminate- Resultant forces and moments- A B & D matrices- Strength analysis of a laminate .

6 Hours

UNIT - 8

METAL MATRIX COMPOSITES: Reinforcement materials, types, characteristics and selection of base metals. Application of MMC's.

8 Hours

TEXT BOOKS:

1. **Composites Science and Engineering**, K.K Chawla, Springer Verlag, 1998
2. **Mechanics of Composite Materials,** R M Jones,", McGraw-Hill, New York, 1975

REFERENCE BOOKS:

1. **Composite materials hand book,** Meing Schwaitz,, McGraw Hill Book Company. 1984
2. **Introduction to Composite materials**, Hull and Clyne, Cambridge University Press, 2nd Edition, 1990.
3. **Forming Metal handbook**, 9th edition, ASM handbook, V15. 1988, P327 338.
4. **Mechanics of composites** by Artar Kaw, CRC Press. 2002.

AIRCRAFT STRUCTURES- II

Subject Code	: **06AE62**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION TO AIRCRAFT STRUCTURAL DESIGN: Structural layout of the Airplane and components, Structural design V-n diagram, loads acting on major components such as wing, fuselage, tails, landing gear etc., Concept of allowable stress and margin of safety.

6 Hours

UNIT - 2

UNSYMMETRICAL BENDING: Bending stresses in beams of unsymmetrical sections – Bending of symmetric sections with skew loads.

6 Hours

UNIT - 3

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.

6 Hours

UNIT - 4

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

8 Hours

PART - B

UNIT - 5

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

6 Hours

UNIT - 6

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

8 Hours

UNIT - 7

DESIGN OF AIRCRAFT STRUCTURE: Design criteria – Safety Factor – Design life criteria – Analysis method – Life Assessment procedures – Design Principle – Future Airworthiness Requirements – Two bay crack criteria – Widespread Fatigue damage.

6 Hours

UNIT - 8

JOINTS AND FITTINGS AND INTRODUCTION TO POST BUCLKING: General theory for the design of fittings, Estimation of fitting design loads, design of riveted, bolted and welding joints, post buckling of structures, concept of effective width.

6 Hours

TEXT BOOKS:

1. **"Aircraft Structures for Engineering Students,** Megson, T.M.G.,, Edward Arnold, 1995.
2. **Aircraft Structures,** Peery, D.J., and Azar, J.J., 2nd edition, McGraw–Hill, N.Y., 1993.

REFEENCE BOOKS:

1. **"Analysis and Design of Flight vehicles Structures,** Bruhn. E.H., Tri – state off set company, USA, 1985.
2. **"Theory and Analysis of Flight Structures**, Rivello, R.M., McGraw-Hill, 1993.
3. **An Introduction to the Theory of Aircraft Structures**, D Williams & Edward Arnold.

AERODYNAMICS - II

Subject Code	: **06AE63**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION TO TWO-DIMENSIONAL PANEL METHODS: Non-lifting flows over arbitrary bodies, source panel method, lifting flows over arbitrary bodies, vortex panel method, some examples.

6 Hours

UNIT - 2

INCOMPRESSIBLE FLOWS OVER FINITE WINGS: Downwash, Induced drag, vortex filament, the Biot-Savart Law, Prandtl's lifting line theory and its limitations, Elliptic lift distribution.

8 Hours

UNIT - 3

SUBSONIC LINEARIZED FLOW OVER AIRFOILS: Full velocity potential equation, linearized velocity potential equation and boundary condition, Prandtl-Glauret compressibility correction.

6 Hours

UNIT - 4

EFFECTS OF COMPRESSIBILITY: Critical Mach number; Drag-divergence Mach number, Sound Barrier, Transonic area rule, Introduction to shock-free airfoils.

6 Hours

PART - B

UNIT - 5

APPLICATIONS OF FINITE WING THEORY: Simplified horse-shoe vortex model, formation flight, influence of downwash on tail plane, ground effects.

6 Hours

UNIT - 6

BODIES OF REVOLUTION: Introduction to slender body theory, cylindrical coordinates, boundary conditions, pressure coefficient, Subsonic flow past a axially symmetric body at zero incidence and solution for a slender cone.

6 Hours

UNIT - 7

SWEPT WINGS AND HIGH-LIFT SYSTEMS: Introduction to sweep effects, swept wings, pressure coefficient, typical aerodynamic characteristics, Subsonic and Supersonic leading edges. Introduction to high-lift systems, flaps, leading-edge slats and typical high - lift characteristics.

6 Hours

UNIT - 8

VISCOUS FLOWS: Derivation of Navier-Stokes equation for two-dimensional flows, boundary layer approximations, laminar boundary equations and boundary conditions, Blasius solution, qualitative features of boundary layer flow under pressure gradients, Integral method, aspects of transition to turbulence, turbulent boundary layer properties over a flat plate at low speeds.

8 Hours

TEXT BOOKS:

1. **Fundamentals of Aerodynamics,** Anderson, Jr. J.D, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2007. (Special Indian Edition).
2. **Boundary layer theory,** Schlichting, H,", McGraw Hill, New York 2004

REFERENCE BOOKS:

1. **Aerodynamics for Engineers,** Bertin, John J., Pearson Education Inc., 2002.
2. **Fluid Mechanics,** White, F.M., Mc Graw Hill Inc. New York, 1986
3. **Aerodynamics for Engineering Students,** Houghton E.L and Carpenter P.W., CBS Publications and Distributors,8 1993. (4th Edition).

FINITE ELEMENT ANALYSIS

Subject Code	: **06AE64**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: BASIC CONCEPTS, BACKGROUND REVIEW: Theory of Elasticity, Matrix displacement formulation, Energy concepts, Equilibrium and energy methods for analysing structures. Rayleigh - Ritz Method, Galerkin's Method, Simple applications in structural Analysis.

6 Hours

UNIT - 2

FUNDAMENTALS OF FINITE ELEMENT METHOD: Displacement function and natural coordinates, construction of displacement functions for 2 D truss and beam elements, applications of FEM for the analysis of truss, continuous beam and simple frame problems.

6 Hours

UNIT -3

DISCRETE ELEMENTS: Bar elements, uniform Bar elements, uniform section, mechanical and thermal loading, varying section, truss analysis, Frame element, Beam element, problems for various loadings and boundary conditions, Free vibration, longitudinal and lateral vibration, Use of local and natural coordinates.

8 Hours

UNIT - 4

CONTINUUM ELEMENTS: Plane stress, Plane strain and axisymmetric problems, constant and linear strain, triangular elements, stiffness matrix, axisymmetric load vector.

6 Hours

PART - B

UNIT - 5

ANALYSIS OF 2 D CONTINUUM PROBLEMS: Elements and shape functions, Triangular, rectangular and quadrilateral elements, different types of elements, their characteristics and suitability for application, polynomial shape functions, Lagrange's and Hermitian polynomials, compatibility and convergence requirements of shape functions.

8 Hours

UNIT - 6

THEORY OF ISOPARAMETRIC ELEMENTS: Isoparametric, sub parametric and super-parametric elements, characteristics of Isoparametric quadrilateral, elements, structure of computer program for FEM analysis,

description of different modules, pre and post processing.

6 Hours

UNIT - 7

FIELD PROBLEMS: Heat transfer problems, Steady' state fin problems, Derivation of element matrices for two dimensional problems, Torsion problems.

6 Hours

UNIT - 8

INTRODUCTION TO FINITE ELEMENT METHOD: Construction or discrete models - sub domains and nodes - simple elements for the FEM - Simplex, complex and multiples elements Polynomial selection - illustrative examples.

6 Hours

TEXT BOOKS:

1. **Finite Element analysis - Theory and Programming,** C.S. Krishnamurthy -, Tata McGraw Hill Co. Ltd, New Delhi.
2. Chandrupatla, T R and Belegundu, A.D - Introduction to Finite elements in Engineering", Printice Hall, Newyork, 2002.

REFERENCE BOOKS:

1. **Finite element analysis in engineering design,** Rajasekharan. S - Wheeler Publishers
2. **Finite Element Procedures,** Bathe. KJ , PHI Pvt. Ltd., New Delhi
3. **The Finite Element Method**, Zienkiewicz. O.C., Tata McGraw Hill Co. Ltd, New Delhi.

THEORY OF VIBRATIONS

Subject Code	: **06AE65**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: Types of vibrations, S.H.M, principle of super position applied to Simple Harmonic Motions. Beats, Fourier theorem and simple problems.

6 Hours

UNIT - 2

UNDAMPED FREE VIBRATIONS: Single degree of freedom systems. Undamped free vibration,natural frequency of free vibration, Spring and Mass elements, effect of mass of spring, Compound Pendulum.

7 Hours

UNIT - 3

DAMPED FREE VIBRATIONS: Single degree of freedom systems, different types of damping, concept of critical damping and its importance, study of response of viscous damped systems for cases of under damping, critical and over damping, Logarithmic decrement.

7 Hours

UNIT - 4

FORCED VIBRATION: Single degree of freedom systems, steady state solution with viscous damping due to harmonic force. Solution by Complex algebra, reciprocating and rotating unbalance, vibration isolation, transmissibility ratio. due to harmonic exitation and support motion.

6 Hours

PART - B

UNIT - 5

VIBRATION MEASURING INSTRUMENTS & WHIRLING OF SHAFTS: Vibrometer meter and accelerometer. Whirling of shafts with and without air damping. Discussion of speeds above and below critical speeds.

6 Hours

UNIT - 6

SYSTEMS WITH TWO DEGREES OF FREEDOM: Introduction, principle modes and Normal modes of vibration, co-ordinate coupling, generalized and principal co-ordinates, Free vibration in terms of initial conditions. Geared systems. Forced Oscillations-Harmonic excitation. Applications:

a) Vehicle suspension.
b) Dynamic vibration absorber.
c) Dynamics of reciprocating Engines.

8 Hours

UNIT - 7

CONTINUOUS SYSTEMS: Introduction, vibration of string, longitudinal vibration of rods, Torsional vibration of rods, Euler's equation for beams.

6 Hours

UNIT - 8

NUMERICAL METHODS FOR MULTI-DEGREE FREEDOM SYSTEMS: Introduction, Influence coefficients, Maxwell reciprocal theorem, Dunkerley's equation. Orthogonality of principal modes, Method of matrix iteration-Method of determination of all the natural frequencies using sweeping matrix and Orthogonality principle. Holzer's method, Stodola method.

8 Hours

TEXT BOOKS:

1. **Theory of Vibration with Applications**: W.T. Thomson and Marie Dillon Dahleh, Pearson Education 5th edition, 2007.

2. **Mechanical Vibrations**: V.P. Singh, Dhanpat Rai & Company Pvt. Ltd., 3rd edition, 2006

REFERENCE BOOKS:

1. **Mechanical Vibrations**: S.S. Rao, Pearson Education Inc, 4th Edition, 2003.
2. **Mechanical Vibrations**: S. Graham Kelly, Schaum's Outline Series, Tata McGraw Hill, Special Indian edition, 2007.
3. **Theory & Practice of Mechanical vibrations**: J.S. Rao & K. Gupta, New Age International Publications, New Delhi, 2001.
4. **Elements of Vibrations Analysis**: Leonanrd Meirovitch, Tata McGraw Hill, Special Indian edition, 2007.

ELECTIVE I (GROUP - A)

NUMERICAL METHODS

Subject Code	: **06AE661**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

NUMERICAL COMPUTATION: Motivation and Objectives/ Number Representation/ Machine Precision/ Round-of - Error/ Truncation Error/ Random Number Generation.

6 Hours

UNIT - 2

LINEAR ALGEBRAIC SYSTEMS: Motivation and Objectives/ Gauss-Jordan Elimination/ Gaussian Elimination/ LU Decomposition/ III-Conditioned Systems/ Iterative Methods.

6 Hours

UNIT - 3

INTERPOLATION AND APPROXIMATION: Lagrangian Polynomials - Divided differences Interpolating with a cubic spline - Newton's forward and backward difference formulas.

6 Hours

UNIT - 4

EIGEN VALUES AND EIGENVECTORS: Motivation and Objectives/ The characteristics Polynominal/ Power Methods / Jacobi's Method/ Householder Transformation/ QR Method/ Danilevsky's Method/

Polynominal Roots.

8 Hours

PART - B

UNIT - 5

NUMERICAL DIFFERENTIATION AND INTEGATION: Derivative from difference tables - Divided differences and finite differences - Numerical integration by trapezoidal and Simpson's 1/3 and 3/8 rules - Two and Three point Gaussian quadrature formulas - Double integrals using trapezoidal and Simpson's rules.

8 Hours

UNIT - 6

CURVE FITTING: Motivation and objectives/ Interpolation/ Newton's Difference Formula/ Cubic Splines/ Least Square/ Two-Dimensional Interpolation.

6 Hours

UNIT - 7

ROOT FINDING: Motivation and Objectives/ Bracketing methods/ Contraction Mapping Method/ Se cant Method/ Muller's Method/ Newton's Method/ Polynomial Roots/ Nonlinear Systems of Equations.

6 Hours

UNIT - 8

OPTIMIZATION: Motivation and Objectives/ Local and Global Minima / Line Searches / Steepest Descent Method / Conjugate-Gradient Method / Quasi-Newton Methods / Penalty Functions / Simulated Annealing.

6 Hours

TEXT BOOKS:

1. **Applied Numerical methods for Engineers Using Mat Lab and C**-Robert Schilling and Sandra Harris, Thomson Learning, 2002.
2. **Applied Numerical Analysis** – Gerald and Wheatley, Pearson Education, 2002.

REFERENCE BOOK:

1. **Numerical Recipes in C** – William Press et. Al., 2e, Cambridge University Press.

AIRCRAFT MATERIALS

Subject Code	: **06AE662**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION TO AIRCRAFT MATERIALS: General properties of materials, Definition of terms, Requirements of aircraft materials, Testing of aircraft materials, Inspection methods, Application and trends in usage in aircraft structures and engines, Introduction to smart materials and nano-materials; Selection of materials for use in aircraft.

6 Hours

UNIT - 2

AIRCRAFT METAL ALLOYS AND SUPERALLOYS: Aluminum alloys, Magnesium alloys, Titanium alloys, Plain carbon and Low carbon Steels, Corrosion and Heat resistant steels, Maraging steels, Copper alloys, Producibility and Surface treatments aspects for each of the above; General introduction to superalloys, Nickel based superalloys, Cobalt based superalloys, and Iron based superalloys, manufacturing processes associated with superalloys, Heat treatment and surface treatment of superalloys.

8 Hours

UNIT - 3

COMPOSITE MATERIALS: Definition and comparison of composites with conventional monolithic materials, Reinforcing fibers and Matrix materials, Fabrication of composites and quality control aspects, Carbon - Carbon Composites production, properties and applications, inter metallic matrix composites, ablative composites based on polymers, ceramic matrix, metal matrix composites based on aluminum, magnesium, titanium and nickel based composites for engines.

6 Hours

UNIT - 4

POLYMERS, POLYMERIC MATERIALS & PLASTICS AND CERAMICS & GLASS: Knowledge and identification of physical characteristics of commonly used polymeric material: plastics and its categories, properties and applications; commonly used ceramic, glass and transparent plastics, properties and applications, adhesives and sealants and their applications in aircraft.

6 Hours

PART - B

UNIT - 5

ABLATIVE AND SUPER CONDUCTING MATERIALS: Ablation process, ablative materials and applications in aerospace; Phenomenon of super conduction, super conducting materials and applications in aerospace.

6 Hours

UNIT - 6

AIRCRAFT WOOD, RUBBER, FABRICS & DOPE AND PAINT: Classification and properties of wood, Seasoning of wood, Aircraft woods, their properties and applications, Joining processes for wood, Plywood; Characteristics and definition of terminologies pertaining to aircraft fabrics and their applications, Purpose of doping and commonly used dopes; Purpose of painting, Types of aircraft paints, Aircraft painting process.

7 Hours

UNIT - 7

CORROSION AND ITS PREVENTION: Knowledge of the various methods used for removal of corrosion from common aircraft metals and methods employed to prevent corrosion.

6 Hours

UNIT - 8

HIGH ENERGY MATERIALS: Materials for rockets and missiles. Types of propellants and its general and desirable properties, Insulating materials for cryogenic engines. Types of solid propellants: Mechanical characterization of solid propellants using uni-axial, strip-biaxial and tubular tests.

7 Hours

TEXT BOOKS:

1. **Handbook of Aircraft materials Interline publishers**, C G Krishnadas Nair, Bangalore, 1993.
2. **Aicraft Material and Processes,** Titterton G F, , English Book Store, New Delhi, 1998

REFERENCE BOOKS:

1. **Advanced Aerospace Material,** H Buhl, Spring Berlin 1992
2. **Aerospace material Vol. 1,2,3 ARDB**, Balram Gupta, S Chand & Co 1996
3. **Materials for Missiles and Space**, Parker E R, John Wiley.
4. **The Materials of Aircraft Construction**, Hill E T, Pitman London.
5. **AIAA Journal of Propulsion and Power**, 2001

COMBUSTION

Subject Code	**06AE663**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

REVIEW OF BASIC CONCEPTS: Laws of thermodynamics, Multi-component mixtures, simple thermo chemical equations and heat of combustion, properties of real gases, transport phenomena, Rankine-Hugoniot curves, ideas of deflagration and detonation.

6 Hours

UNIT - 2

CHEMICAL EQUILIBRIUM AND KINETICS: Concept of chemical equilibrium in multicomponent mixtures, Elements of adiabatic flame temperature calculation, Chemical kinetics – rates and order of reactions, Reaction mechanism and chain reactions.

6 Hours

UNIT - 3

DIFFUSION FLAMES: Differences between premixed and diffusion flames, gas diffusion flames in parallel flow – jet flames and Burke Schumann flames, Liquid droplet combustion.

6 Hours

UNIT - 4

PREMIXED FLAMES: Mechanistic description of premixed flames, Burning velocity and parametric dependences, Experimental methods of measuring burning velocity, Simple one-dimensional thermal theory of flame, concepts of minimum ignition energy, quenching distance, stability limits and flame stabilization.

8 Hours

PART - B

UNIT - 5

COMBUSTION IN PISTON ENGINES: Review of operation of reciprocating engines, Description of the combustion process in piston engines, Combustion efficiency and factors affecting it, detonation in reciprocating engines and preventive methods.

6 Hours

UNIT - 6

COMBUSTION IN GAS-TURBINE ENGINES: Description of different types of combustion chambers in gas-turbine engines, primary requirements

of the combustor, Flow structure, recirculation and flame stabilization in main combustion chamber, afterburners.

7 Hours

UNIT - 7

COMBUSTION IN ROCKET ENGINES: Combustion of carbon particle, boundary layer combustion, basic principles of combustion solid propellants, extension of droplet combustion to liquid propellant rockets.

7 Hours

UNIT - 8

EMISSIONS: Flame radiation, pollutants - unburnt hydrocarbons, oxides of nitrogen and carbon monoxide, methods of reducing pollutants, Principle of exhaust gas analysis.

6 Hours

TEXT BOOKS:

1. **Introduction to Combustion** by Stephen Turns.
2. **Combustion fundamentals** by Roger Strehlow

REFERENCE BOOKS:

1. **Industrial Combustion** by Charles E. Baukal.
2. **Heat Transfer in Industrial Combustion** by CE Baukal Jr
3. **Combustion, Fossil Power Systems** by G. Singer. 4th Ed. 1966 Ed Pub.
4. **Fuels and Combustion**, Sharma, S.P., and Chandra Mohan , Tata Me. Graw Hill Publishing Co., Ltd., New Delhi, 1987.
5. **Gas Turbine, Jet and Rocket Propulsion,** Mathur, M.L., and Sharma, R.P., ,' Standard Publishers and Distributors, Delhi, 1988

RELIABILITY ENGINEERING

Subject Code	: **06AE664**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: Reliability concepts and definitions, probability distribution functions and their application in reliability Evaluation, Reliability Evaluation in Engineering systems using Markov Models.

7 Hours

UNIT - 2

FAILURE ANALYSIS: Causes of failure, concept of hazard failure models, Bath Tub curve, MTTF, MTBF.

7 Hours

UNIT - 3

RELIABILITY MODELING: System reliability for various configurations and combinational aspects, Weibull analysis on reliability.

6 Hours

UNIT - 4

RELIABILITY STUDIES: Reliability improvement, redundancy, reliability-cost trade-off.

6 Hours

PART - B

UNIT - 5

MAINTAINABILITY AND AVAILABILITY CONCEPTS: System Safety analysis.

6 Hours

UNIT - 6

MAINTENANCE CONCEPTS: Types of Maintenance, Modern trends in Maintenance Philosophy like BITE, IRAN, HUM, TPM etc.

7 Hours

UNIT - 7

FAILURE INVESTIGATION PROCESS AND METHODOLOGIES LIKE FTA, FMEA

6 Hours

UNIT - 8

RELIABILITY AND QUALITY IMPROVEMENT techniques like, Bench Marking, JIT, Quality Circles, Quality Audit, TQM, Kaizan etc.

7 Hours

TEXT BOOK:

1. **Introduction to Reliability Engineering**, E.E. Lewis, John Wiley.

REFERENCE BOOKS:

1. **Probability and statistics with Reliability, Queuing and Computer**, K.S. Trivedi,
2. **Science Applications**, PHI.
3. **Reliability Engineering,** E Balagurswamy, Tata McGraw Hill Publications.

INDUSTRIAL MANAGEMENT

Subject Code	: **06AE665**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: Historical perspective, contribution of Taylor, Henry Fayol, Gilbert, Charles Babbage, Henry Gantt to the evolution of management science in the Indian context. Ownership of Industries Proprietorship, partnership, joint stock companies, public and private undertakings, co-operative organizations

6 Hours

UNIT - 2

QUALITY PHILOSOPHY: The Meaning of Quality and Quality Improvement; Brief History of Quality Methodology; Statistical Methods for Quality Control and Improvement; Total Quality Management (quality philosophy, links between quality and productivity, quality costs legal aspects of quality implementing quality improvement). Definitions and aims of standardizations, techniques for standardization (Statistical Principles, Codification system, variety control and value Engineering).

8 Hours

UNIT - 3

STATISTICAL PROCESS CONTROL: Chance and assignable causes, Statistical Basis of the Control Charts -basic principles, choices of control limits, significance of control limits, control limits, analysis of pattern on Variable attribute control charts (no numericals)

6 Hours

UNIT - 4

WORK STUDY, INCENTIVES, HEALTH AND SAFETY: Work study-Motion study and Method time study, principles of motion economy, charts and diagrams, Job evaluation systems, Multi skilling, Wage payment and plans, Incentive schemes, Training and Development, Safety Regulations and safe practices.

6 Hours

PART - B

UNIT - 5

MOTIVATION AND BEHAVIOR: Hawthorns studies and its findings Maslows theory X and Y theory, Immaturity theory motivation hygiene theory, Pretence of needs and satisfaction of needs, goal oriented behavior, integration of organizational goals and needs of employee.

6 Hours

UNIT - 6

MANAGEMENT AND BEHAVIORAL APPROACH: Contribution of Elton Mayo and Skinner to behavior sciences. Skills of a manager at various levels in an organization and inter-related systems, understanding past behavior, predicting future behavior, directing, changing and controlling behavior.

6 Hours

UNIT - 7

PROCESS MANAGEMENT: Definition of process management. Major process decisions-process choice, vertical integration, resource flexibility, customer involvement, capital intensity, relationships between decisions, service operation, economics of scoop and gaining focus. Designing process-process rearranging and process improvement

7 Hours

UNIT - 8

MANAGEMENT OF TECHNOLOGY: Meaning and role of technology-primary areas of technology management, management of technology and its role in improving business performance. Creating and applying technology-R and D stages and technology fusion. Technology strategy. Implementation guidelines.

7 Hours

TEXT BOOKS:

1. **Principles of Management**, Koontz O Donnel,"Mc.Graw Hill Intl.Book Co.
2. **Statistical Quality Control:** E.L. Grant and R.S. Leavenworth, 7th edition, McGraw- Hill publisher

REFERENCE BOOKS:

1. **Essentials of management,** Koontz Weirich,TATA McGraw Hill Intl. Book Co., 7th Edition.
2. **Management of Organizational Behaviour,** Hersey Paul and Kenneth H," PHI.
3. **Operations management-strategy and analysis,**Lee J.Krajewski and Larry P. Ritzman, Fifth Edition Addison-Wiley.
4. **Organizational Behaviour,** Stephen P Robbins, 9th Edition, Pearson Education Publications, ISBN-81-7808-561-5 2002

AERODYNAMICS LABORATORY

Subject Code	: **06AEL67**	IA Marks	: 25
No. of Lecture Hrs/Week	: 03	Exam Hours	: 03
Total no. of Lecture Hrs.	: 42	Exam Marks	: 50

LIST OF 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.

PROPULSION LABORATORY

Subject Code	: **06AEL68**	IA Marks	: 25
No. of Lecture Hrs/Week	: 03	Exam Hours	: 03
Total no. of Lecture Hrs.	: 42	Exam Marks	: 50

(Wind Tunnel is required)

LIST OF EXPERIMENTS

1. Study of an aircraft piston engine. (Includes study of assembly of sub systems, various components, their functions and operating principles)
2. Study of an aircraft jet engine (Includes study of assembly of sub systems, various components, their functions and operating principles)
3. Study of forced convective heat transfer over a flat plate.
4. Cascade testing of a model of axial compressor blade row.
5. Study of performance of a propeller.
6. Determination of heat of combustion of aviation fuel.
7. Study of free jet
8. Measurement of burning velocity of a premixed flame.
9. Fuel-injection characteristics
10. Measurement of nozzle flow.

VII SEMESTER

CONTROL ENGINEERING

Subject Code	: **06AE71**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 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.

6 Hours

UNIT - 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.

6 Hours

UNIT - 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.

7 Hours

UNIT - 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.

7 Hours

PART - B

UNIT - 5

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

7 Hours

UNIT - 6

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

7 Hours

UNIT - 7

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

7 Hours

UNIT - 8

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

5 Hours

TEXT BOOKS:

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

REFERENCE BOOKS:

1. **Feedback Control Systems:** Schaum's series 2001.
2. **Control systems:** I. J. Nagarath & M. Gopal, New age International publishers 2002.
3. **Automatic Control Systems** – B. C. Kuo, F. Golnaraghi, John Wiley & Sons, 2003.

APPLIED GAS DYNAMICS

Subject Code	: **06AE72**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

1. 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.

7 Hours

2. 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.

7 Hours

3. 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.

6 Hours

4. 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.

6 Hours

PART - B

5. DIFFERENTIAL EQUATIONS OF MOTION FOR STEADY COMPRESSIBLE FLOWS

Basic potential equations for compressible flow. Linearisation of potential equation- small perturbation theory. Methods for solution of nonlinear potential equation -Introduction. Boundary conditions. Pressure coefficient expression.

6 Hours

6. 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.

7 Hours

7. FLOW OF REAL FLUIDS

Shock Wave – Boundary layer interaction. Experimental characteristics of airfoils in compressible flow. Nature of pressure distribution.

6 Hours

8. 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.

7 Hours

TEXT BOOKS:

1. Rathakrishnan, E., “Gas Dynamics”, Prentice Hall of India.1995 edition.
2. Yahya, S.M., “Fundamentals of Compressible flow”, Wiley Eastern, 2003.

REFERENCE BOOK:

1. John D Anderson, "Modern Compressible Flow", Mc Graw Hill 1999.

PERFORMANCE, STABILITY AND CONTROL

Subject Code	: **06AE73**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

1. THRUST AND DRAG OF AIRPLANE

Equilibrium conditions. Drag components. Drag polar from low speed to high speeds. Flight boundary. Variation of thrust, power and SFC with velocity and altitudes for air breathing engines. Propeller charts.

6 Hours

2. AIRCRAFT PERFORMANCE IN STEADY FLIGHT

Performance of airplane in level flight. Power available and power required curves. Thrust available and thrust required curves. Generalized power required curves. Generalized thrust required curves. Maximum speed in level flight. Conditions for minimum drag and power required. Range and endurance. Climbing and gliding flight (Maximum rate of climb and steepest angle of climb; minimum rate of sink and shallowest angle of glide).

7 Hours

3. AIRCRAFT PERFORMANCE IN ACCELERATED FLIGHT

Take-off and landing distances. Acceleration in climb. Turning performance (Turning rate, turn radius). Bank angle and load factor. Power required at various angles of bank. Limitations of pull up and push over. Design performance. Generalized design chart.

6 Hours

4. STATIC LONGITUDINAL STABILITY AND CONTROL

Stability criteria. Contribution of airframe components. Trim condition. Power effects. Static margin. Stick free and stick fixed neutral points. Stick force gradient. Airplane stability in accelerated flight. Influence of C.G. location. Hinge moment coefficient. Determination of neutral points and maneuver points from flight test. Trim runaway.

7 Hours

PART - B

5. STATIC DIRECTIONAL STABILITY AND CONTROL

Definition of directional stability. Weather cocking effect. Contribution of airframe components. Directional control. Dorsal fin. One engine inoperative condition. Rudder lock.

6 Hours

6. STATIC LATERAL STABILITY AND CONTROL

Roll stability. Dihedral effect. Lateral control. Effect of wing sweep, flaps, and power-on dihedral effect. Coupling between rolling and yawing moments. Adverse yaw effects. Aileron reversal. Balancing the aileron. Flaprons and elevons.

7 Hours

7. DYNAMIC LONGITUDINAL STABILITY

Dynamic longitudinal stability: types of modes of motion. Equations of longitudinal motion – small disturbance theory. Estimation of longitudinal stability derivatives. Routh's criteria.. Phugoid motion. Factors affecting period and damping of oscillations. Effect of wind shear. Phugoid stabilization. Flying qualities in pitch. Cooper-Harper Scale.

7 Hours

8. DYNAMIC LATERAL AND DIRECTIONAL STABILITY

Response to aileron step-function, side-slip excursion. Dutch roll and Spiral instability. Auto- rotation and spin. Stability derivatives for lateral and directional dynamics. Roll-Pitch-Yaw Inertial coupling.

6 Hours

TEXT BOOKS:

1. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley Son Inc, New York, 1988.
2. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 2007.

REFERENCE BOOKS:

1. Bandu N. Pamadi, `Performance, Stability, Dynamics and Control of Airplanes`, AIAA 2nd Edition Series, 2004.
2. Barnes W. McCormick, `Aerodynamics, Aeronautics, and Flight Mechanics`, John Wiley & Sons, Inc. 1995.
3. Thomas R. Yechout, `An introduction to Aircraft Flight Mechanics`, AIAA educational Series; 2003.

GAS TURBINE TECHNOLOGY

Subject Code	: **06AE74**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

1. TYPES, VARIATION & APPLICATIONS

Types of engines showing arrangement of parts. Operating parameters. Energy distribution of turbojet, turboprop and turbofan engines. Comparison of thrust and specific fuel consumption. Thrust, pressure and velocity diagrams.

6 Hours

2. ENGINE PARTS

Inlet ducts, compressor assembly, types of burners: advantages and disadvantages. Influence of design factors on burner performance. Effect of operating variables on burner performance. Performance requirements of combustion chambers. Construction of nozzles. Impulse turbine and reaction turbine. Exhaust system, sound suppression. Thrust reversal: types, design & systems. Methods of thrust augmentation, afterburner system.

7 Hours

3. MATERIALS AND MANUFACTURING

Criteria for selection of materials. Heat ranges of metals, high temperature strength. Manufacturing techniques, surface finishing. Powder metallurgy. Use of composites and Ceramics.

6 Hours

4. SYSTEMS

Fuel systems and components. Sensors and Controls. FADEC interface with engine. Typical fuel system. Oil system components. Typical oil system. Starting systems. Typical starting characteristics. Various gas turbine starters.

7 Hours

PART - B

5. ENGINE PERFORMANCE

Design & off-design Performance. Surge margin requirements, surge margin stack up. Transient performance. Qualitative characteristics quantities. Transient working lines. Starting process & Wind milling of Engines. Thrust engine start envelope. Starting torque and speed requirements Calculations for design and off-design performance from given test data – (case study for a single shaft Jet Engine). Engine performance monitoring.

6 Hours

6. COMPONENT LEVEL TESTING

Compressor: Compressor MAP. Surge margin, Inlet distortions. Testing and Performance Evaluation. **Combustor:** Combustor MAP, Pressure loss, combustion light up test. Testing and Performance Evaluation. **Turbines:** Turbine MAP. Turbine Testing and Performance Evaluation. **Inlet duct & nozzles:** Ram pressure recovery of inlet duct. Propelling nozzles, after burner, maximum mass flow conditions. Testing and Performance Evaluation.

7 Hours

7. ENGINE TESTING

Proof of Concepts: Design Evaluation tests. Structural Integrity. Environmental Ingestion Capability. Preliminary Flight Rating Test, Qualification Test, Acceptance Test. Reliability figure of merit. Durability and Life Assessment Tests, Reliability Tests. Engine testing with simulated inlet distortions and, surge test. Estimating engine-operating limits. Methods of displacing equilibrium lines.

Types of engine testings: Normally Aspirated Testing, Open Air Test Bed, Ram Air Testing, Altitude Testing, Altitude test facility, Flying Test Bed, Ground Testing of Engine Installed in Aircraft, Flight testing. Jet thrust measurements in flight. Test procedure: Test Schedule Preparation, Test Log Sheets, Test Documents. Type approval.

7 Hours

8. TEST CELLS

Factors for design of engine test beds. Test bed calibration. Steps in test bed cross calibration.

Measurements and Instrumentation. Data Acquisition system, Measurement of Shaft speed, Torque, Thrust, Pressure, Temperature, Vibration, Stress, Temperature of turbine blading etc. Engine performance trends: Mass and CUSUM plots. Accuracy and Uncertainty in Measurements. Uncertainty analysis. Performance Reduction Methodology.

6 Hours

TEXT BOOKS:

1. Irwin E. Treager, `Gas Turbine Engine Technology`, GLENCOE Aviation Technology Series, 7th Edition, Tata McGraw Hill Publishing Co. Ltd. Print 2003.
2. P.P Walsh and P. Peletcher, 'Gas Turbine Performance' Blackwell Science, 1998, ISBN 0632047843.
3. Michael J. Kores, and Thomas W. Wild**,** `Aircraft Power Plant`, GLENCOE Aviation Technology Series, 7th Edition, Tata McGraw Hill Publishing Co. Ltd. 2002.

REFERENCE BOOKS:

1. Advance Aero-Engine Testing, AGARD-59 Publication
2. MIL –5007 E, `Military Specifications: Engine, Aircraft, Turbo Jet & Turbofan; General Specification for Advance Aero Engine testing`, 15th Oct 1973.
3. J P Holman,` Experimental methods for Engineers`, Tata McGraw – Hill Publishing Co. Ltd, 2007.

MODELING AND ANALYSIS LABORATORY

Subject Code	: **06AEL77**	IA Marks	: 25
No. of Lecture Hrs/Week	: 03	Exam Hours	: 03
Total no. of Lecture Hrs.	: 42	Exam Marks	: 50

LIST OF EXPERIMENTS

PART - A

1. Modeling of Symmetric Aerofoil geometry, and generation of body fitting mesh.
2. Modeling of Cambered Aerofoil geometry, and generation of body fitting mesh.
3. Modeling of 2-D Incompressible and Inviscid flow over an aerofoil. Computations and analysis for velocity vectors and pressures distributions.
4. Modeling of 2-D Incompressible and Viscous flow over an aerofoil. Computations and analysis for velocity vectors and pressures distributions.
5. Geometric modeling and mesh generation of 2-D Convergent-Divergent nozzle and analyses of flow for adiabatic conditions.

21 Hours

PART -B

6. Structural modeling of sandwich beam of rectangular cross-section and analyses for stresses.
7. Structural modeling of a three dimensional wing.
8. Structural modeling and stress analysis of a fuselage bulk head.
9. Structural modeling and stress analysis of a simply supported rectangular plate uniformly compressed in one direction.

10. Structural modeling and stress analysis of a simply supported rectangular plate uniformly compressed in one direction with a cut-out in center.

21 Hours

Note: Students should store the data generated from each experiment.

Scheme for Examination:

Two Questions from Part A - 20 Mks (05 write up +15)
Two Questions from Part B - 20 Mks (05 write up +15)

VIVA VOCE - 10 Mks

SIMULATION LABORATORY

Subject Code	: **06AEL78**	IA Marks	: 25
No. of Lecture Hrs/Week	: 03	Exam Hours	: 03
Total no. of Lecture Hrs.	: 42	Exam Marks	: 50

LIST OF EXPERIMENTS

PART - A

1. Falling sphere with viscous drag – Investigate velocity versus time plot; & simulate the fall.
2. Frequency response for a spring-mass system; simulation of the oscillations.
3. Simulation of simple servo-mechanism feedback system in time domain.
4. Simulation of simple servo-mechanism feedback system in `s` domain.
5. Simulate with transfer functions the experiments (3) and (4) above.

21 Hours

PART - B

6. Digital simulation of Analog Computations.
7. Simulate a bomb drop from an aircraft on a moving tank for pure – pursuit motion.
8. Simulate an Air Speed Indicator to read air speeds for the pressures read from a Pitot-static tube, with compressibility corrections.
9. Simulate a runaway.
10. Simulate a point take-off from a runaway.

21 Hours

Scheme for Examination:

Two Questions from Part A - 20 Mks (05 write up +15)
Two Questions from Part B - 20 Mks (05 write up +15)
VIVA VOCE - 10 Mks

ELECTIVE II (GROUP B)

ENGINEERING OPTIMISATION

Subject Code	: **06AE751**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

1. INTRODUCTION
Non-linear programming. Mathematical fundamentals. Numerical evaluation of gradient.

6 Hours

2. UNCONSTRIANED OPTIMISATION
One dimensional, single variable optimization. Maximum of a function. Unimodal-Fibonacci method. Polynomial based methods.

6 Hours

3. UNCONSTRAINED MINIMISATION
Multivariable functions. Necessary and sufficient conditions for optimality. Convexity. Steepest Descent Method -Convergence Characteristics. Conjugate Gradient Method. Linear programming -Simplex Method.

7 Hours

4. CONSTRAINED MINIMISATION
Non-linear programming. Gradient based methods. Rosens`s gradient, Zoutendijk`s method, Generalised reduced gradient, Sequential quadratic programming. Sufficient condition for optimality.

7 Hours

PART - B

5. DIRECT SEARCH METHODS
Direct search methods for nonlinear optimization. Cyclic coordinate search. Hooke and Jeeves Pattern search method. Generic algorithm.

6 Hours

6. DISCRETE AND DYNAMIC PROGRAMMING

Integer and discrete programming. Branch and bound algorithm for mixed integers. General definition of dynamic programming problem. Problem modeling and computer implementation. Shortest path problem.

6 Hours

7. OPTIMISATION APPLICATION

Transportation problem. Transportation simplex method. Network problems. Maximum flow in net works. General definition of dynamic programming. Problem modeling and computer implementation.

7 Hours

8. FINITE ELEMENT BASED OPTIMISATION

Parameter optimization using gradient methods -Derivative calculation. Shape optimisation. Topology optimisation of continuum structures.

7 Hours

TEXT BOOKS:

1. Ashok D Belegundu and Tirupathi R . Chandrupatla, `Optimisation Concepts and Applications in Engineering`, Pearson Education, In C., 1991.

REFERENCE BOOKS:

1. Fletcher, R., `Practical Methods of Optimisation`, Wiley, New York, 2nd Edition, 1987.
2. Dennis J.E. and Schnabel, R. B., `Numerical Methods for Unconstrained Optimisation and Nonlinear Equations`, Prentice Hall, Engle Wood Cliffs, New Jersey, 1983.
3. S.S. Rao, `Optimisation -Theory and Application`, Wiley Eastern Ltd., 5th Edition.1990.

COMPUTATIONAL FLUID DYNAMICS

Subject Code	: **06AE752**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

1. 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.

6 Hours

2. 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.

7 Hours

3. 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.

6 Hours

4. 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.

7 Hours

PART - B

5. 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.

7 Hours

6. 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 .

6 Hours

7. 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.

6 Hours

8. CFD APPLICATION TO SOME PROBLEMS

Time and space marching. LAX-WENDROFF Technique . Relaxation technique. Point iterative mehod. 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.

7 Hours

TEXT 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 (Editor), "Computational Fluid Dynamics - An Introduction", Springer – Verlag, Berlin; 1992.
2. Charles Hirsch, "Numerical Computation of Internal and External Flows", Vols. I and 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.

AIRCRAFT MAINTENANCE, REPAIR AND OVERHAUL

Subject Code	: **06AE753**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

1. WELDING IN AIRCRAFT STRUCTURAL COMPONENTS

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

7 Hours

2. SHEET METAL REPAIR AND MAINTENANCE

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

6 Hours

3. PLASTICS AND COMPOSITES IN AIRCRAFT

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

7 Hours

4. INSPECTION AND REPAIR OF COMPOSITE COMPONENTS

Inspection and Repair of composite components – Special precautions – Autoclaves.

6 Hours

PART - B

5. AIRCRAFT JACKING, ASSEMBLY AND RIGGING

Airplane jacking and weighing and C.G. Location. Balancing of control surfaces – Inspection maintenance. Helicopter flight controls. Tracking and balancing of main rotor.

7 Hours

6. REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM

Trouble shooting and maintenance practices – Service and inspection. – Inspection and maintenance of landing gear systems. – Inspection and maintenance of air-conditioning and pressurisation system, water and waste system. Installation and maintenance of Instruments – handling – Testing – Inspection.

7 Hours

7. INSPECTION AND MAINTENANCE OF AUXILARY SYSTEMS

Inspection and maintenance of auxiliary systems – Fire protection systems – Ice protection system – Rain removal system – Position and warning system – Auxiliary Power Units (APUs)

6 Hours

8. SAFETY PRACTICES

Hazardous materials storage and handling, Aircraft furnishing practices – Equipments. Troubshooting - Theory and practices.

6 Hours

TEXT BOOK:

1. KROES, WATKINS, DELP, "Aircraft Maintenance and Repair", McGraw-Hill, New York, 1992.
2.

REFERENCE BOOKS:

1. LARRY REITHMEIR, "Aircraft Repair Manual", Palamar Books, Marquette, 1992
2. BRIMM D.J. BOGGES H.E., "Aircraft Maintenance", Pitman Publishing corp. New York, 1940.

STATISTICAL QUALITY CONTROL

Subject Code	: **06AE754**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: The Meaning of Quality and Quality Improvement; Brief History of Quality Methodology; Statistical Methods for Quality Control and Improvement; Total Quality Management (quality philosophy, links between quality and productivity, quality costs, legal aspects of quality implementing, quality improvement).

6 Hours

UNIT - 2

MODELING PROCESS QUALITY: Mean, Median, Mode, Standard deviation, Calculating area, The Deming funnel experiment, Normal distribution tables, Finding the Z score, Central limit theorem.

6 Hours

UNIT - 3

METHODS AND PHILOSOPHY OF STATISTICAL PROCESS CONTROL: Chance and assignable causes, Statistical Basis of the Control Charts (basic principles, choices of control limits, significance of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, Average Run Length**-**ARL)

6 Hours

UNIT - 4

CONTROL CHARTS FOR VARIABLES: Control Charts for X-Bar and R- Charts, Type I and Type II errors, the probability of Type II error. Simple Numerical Problems

8 Hours

PART - B

UNIT - 5

PROCESS CAPABILITY: The foundation of process capability, Natural Tolerance limits, c_p – process capability index, c_{pk}, p_p – process performance index, summary of process measures. Numerical problems

6 Hours

UNIT 6: Control Charts For Attributes: Binomial distribution, Poisson distribution (from the point of view of Quality control) Control Chart for Fraction Nonconforming, Control Chart for number Nonconforming, Control Charts for Nonconformities or Defects, Control Chart for Number of non conformities per unit. Numerical problems

7 Hours

UNIT - 7

LOT-BY-LOT ACCEPTANCE SAMPLING FOR ATTRIBUTES: The acceptance sampling problem, single sampling plan for attributes, Double, Multiple, and Sequential sampling, AOQL, LTPD, OC curves, Military Standard 105E, the Dodge-Romig sampling plans. Numerical problems

7 Hours

UNIT - 8

CUMULATIVE-SUM (CUSUM) & EXPONENTIALLY WEIGHTED MOVING AVERAGE (EWMA) CONTROL CHARTS: CUSUM Control Chart (basic principles of the chart for monitoring the process mean); EWMA control chart (EWMA control chart for monitoring process mean), design of an EWMA control chart.

6 Hours

TEXT BOOKS:

1. **Statistical Quality Control:** E.L. Grant and R.S. Leavenworth, 7th edition, McGraw- Hill publisher.

2. **Statistical Quality Control**: RC Gupta, Khanna Publishers, New Delhi, 2005

REFERENCE BOOKS:

1. **Statistical Process Control and Quality Improvement:** Gerald M. Smith, Pearson Prentice Hall. ISBN 0 – 13-049036-9.
2. **Statistical Quality Control for Manufacturing Managers:** W S Messina, Wiley & Sons, Inc. New York, 1987
3. **Statistical Quality Control:** Montgomery, Douglas, 5th Edition, John Wiley & Sons, Inc. 2005, Hoboken, NJ (ISBN 0-471-65631-3).
4. **Principles of Quality Control:** Jerry Banks, Wiley & Sons, Inc. New York.

THEORY OF PLATES AND SHELLS

Subject Code	: **06AE755**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

1. INTRODUCTION

Plate and Shell Structures in Aerospace Vehicles. Flexural rigidity of plates. Flexural rigidity of shells. Introduction to bending and buckling of plates and shells. Reinforced plates. Eccentrically compressed shells.

6 Hours

2. BENDING OF THIN PLATES –STRESSES

Pure bending of plates. Isotropic and orthotropic flat plates. Flexural rigidity of plate. Bending of plates by distributed lateral load. Combined bending and tension or compression. Bending and twisting moments. Shear stress.

7 Hours

3. BENDING OF THIN PLATES - STRAIN ENERGY

Slopes of deflection of surface. Different edge conditions: - built in edge, simply supported edge and, free edge. Combined bending and tension or compression of plates. Strain energy by: – bending of plates, bending by lateral loads, combined bending and tension or compression of plates.

6 Hours

4. BUCKLING OF THIN PLATES

Method of calculation of critical loads. Buckling of simply supported rectangular plates uniformly compressed in one direction. Buckling of

uniformly compressed rectangular plates simply supported along two opposite sides perpendicular to the direction of compression and having various edge conditions along the other two sides. Critical values of compressive stress.

7 Hours

PART - B

5. BUCKLING OF REINFORCED PLATES

Stability of plates reinforced by ribs. Simply supported rectangular plates with longitudinal ribs. General equation for critical compressive stress. Critical compressive stress for a plate stiffened by one rib. Study of the experimental value of buckling of plates.

7 Hours

6. BENDING OF THIN SHELLS

Deformation of an element of a shell. Expression for components of normal stresses. Flexural rigidity of shell. Case of deformation with presence of shearing stresses.

7 Hours

7. STRAIN ENERGY OF DEFORMATION OF SHELLS

Strain energy of deformation of shell:-bending and stretching of middle surface. Symmetrical deformation of a circular cylindrical shell. Differential equation for bending of strip.

6 Hours

8. BUCKLING OF SHELLS

Symmetrical buckling of cylindrical shell under the action of uniform axial compression :-differential equation , critical stress. Symmetrical buckling of cylindrical shell under the action of uniform axial pressure. Study of the experimental values of cylindrical shells in axial compression. Bent or eccentrically compressed shells.

6 Hours

TEXT BOOKS:

1. Timoshenko, S.P. and Gere, J.M., "Theory of Elastic Stability", McGraw-Hill Book Co. 1986.
2. Timoshenko, S.P. Winowsky. S., and Kreger, "Theory of Plates and Shells", McGraw-Hill Book Co. 1990.

REFERENCE BOOK:

1. Flugge, W. "Stresses in Shells", Springer – Verlag, 1985.

NONDESTRUCTIVE TESTING

Subject Code	: **06AE756**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

1. INTRODUCTION

An Overview. Factors influencing the Reliability of NDE. Defects in materials. Defects in composites. NDT methods used for evaluation of materials and composites.

7 Hours

2. RADIOGRAPHIC INSPECTION

X – ray radiography: Principles of X – ray radiography, equipment. Production of X -rays, absorption, scattering, X-ray film processing; industrial radiographic practice, micro-radiography

Gamma ray radiography: Radioactivity, gamma ray sources, film radiography, application, examples.

General radiographic procedures. Reading and Interpretation of Radiographs. Defects in welding.

7 Hours

3. ULTRASONICS

Principle of wave propagation. Ultrasonic equipment. Variables affecting an ultrasound test. Basic methods and general considerations. Testing of products. Ultrasonic testing of composites.

6 Hours

4. ULTRASONIC INSPECTION

Ultrasonic application for thickness measurement. Types of scanning, types of indication. Welding inspection, tube inspection, test standards, determination of elastic constants.

6 Hours

PART - B

5. LIQUID PENETRANT TEST

Basic concept. Test equipment. Test Parameters & Procedure. Safety precautions.

6 Hours

6. MAGNETIC PARTICLE TEST

Methods of generating magnetic field. Demagnetization of materials. Magnetic particle test: Principles, Test Equipment and Procedure. Interpretation and evaluation.

7 Hours

7. EDDY CURRENT TEST

Principles of eddy current. Factors affecting eddy currents. Test system and test arrangement. Standardization and calibration. Application and effectiveness.

6 Hours

8. SOME OTHER METHODS

Thermal Inspection: Principles, equipment, inspection methods, applications.

Optical Holography: Principles, applications, holographic recording interferometer techniques of inspection

Acoustic Emission Inspection: Principle, comparison with other NDT methods, applicability, acoustic emission waves and propagation. Instrumentation principles.

7 Hours

TEXT BOOK:

1. J Prasad and C G Krishnadas Nair, ` Non-Destructive Test and Evaluation of Materials`, Tata McGraw-Hill Publishing Co. Ltd., 2008.

REFERENCE BOOKS:

1. Metals Hand Book, Vol-17, 9th Edition, Non destructive evaluation & quality control, American society of metals. 2001
2. Baldev Raj, T. Jayakumar, M. Thavasimuthu, `Nondestructive Testing`, Narosa Publishing House, 1997.

MECHATRONICS & MICROPROCESSOR

Subject Code	: **06AE757**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION TO MECHATRONIC SYSTEMS: Measurement and control systems Their elements and functions, Microprocessor based controllers.

6 Hours

UNIT - 2

REVIEW OF TRANSDUCERS AND SENSORS: Definition and classification of transducers. Definition and classification of sensors.

Principle of working and applications of light sensors, proximity sensors and Hall effect sensors.

7 Hours

UNIT 3

ELECTRICAL ACTUATION SYSTEMS: Electrical systems, Mechanical switches, solid-state switches, solenoids, DC & AC motors, Stepper motors and their merits and demerits.

6 Hours

UNIT - 4

SIGNAL CONDITIONING: Introduction to signal conditioning. The operational amplifier, Protection, Filtering, Wheatstone bridge, Digital signals Multiplexers, Data acquisition, Introduction to Digital system processing Pulse-modulation.

7 Hours

PART - B

UNIT - 5

INTRODUCTION TO MICROPROCESSORS: Evolution of Microprocessor, Organization of Microprocessors (Preliminary concepts), basic concepts of programming of microprocessors.

Review of concepts – Boolean algebra, Logic Gates and Gate Networks, Binary & Decimal number systems, memory representation of positive and negative integers, maximum and minimum integers. Conversion of real numbers, floating point notation, representation of floating point numbers, accuracy and range in floating point representation, overflow and underflow, addition of floating point numbers, character representation.

7 Hours

UNIT - 6

LOGIC FUNCTION: Data word representation. Basic elements of control systems 8085A processor architecture terminology such as CPU, memory and address, ALU, assembler data registers, Fetch cycle, write cycle, state, bus, interrupts. Micro Controllers. Difference between microprocessor and micro controllers. Requirements for control and their implementation in microcontrollers. Classification of micro controllers.

7 Hours

UNIT - 7

ORGANIZATION & PROGRAMMING OF MICROPROCESSORS: Introduction to organization of INTEL 8085-Data and Address buses, Instruction set of 8085, programming the 8085, assembly language programming.

6 Hours

UNIT - 8

CENTRAL PROCESSING UNIT OF MICROPROCESSORS: Introduction, timing and control unit basic concepts, Instruction and data

flow, system timing, examples of INTEL 8085 and INTEL 4004 register organization.

6 Hours

TEXT BOOKS:

1. **Mechatronics** – W.Bolton, Longman, 2Ed, Pearson Publications, 2007.
2. **Microprocessor Architecture, Programming And Applications With 8085/8085A** – R.S. Ganokar, Wiley Eastern.

REFERENCE BOOKS:

1. **Mechatronics –** Principles, Concepts and applications – Nitaigour and Premchand Mahilik – Tata McGraw Hill – 2003.
2. **Mechatronics Principles & applications** by Godfrey C. Onwubolu, Elsevier.
3. **Introduction Mechatronics & Measurement systems,** David.G. Aliciatore & Michael.B.Bihistaned, Tata McGraw Hill, 2000.
4. **Intel Microprocessor;** Barry B Bray, Pearson edition

TOTAL QUALITY MANAGEMENT

Subject Code	: **06AE758**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

QUALITY, TOTAL QUALITY, TQM: Introduction-Definition, Basic Approach, TQM framework, Historical Review, Benefits of TQM.

4 Hours

UNIT - 2

EVOLUTION OF TQM: Contribution of Quality Gurus- Edward Deming, 14 points, PDSA cycle, Joseph Juran, Quality trilogy, Crosby & quality treatment, Ishikawa and company wide quality control, Taguchi & his quality loss function.

8 Hours

UNIT - 3

LEADERSHIP AND QUALITY COSTS: Characteristics of quality leaders, Quality statement, strategic planning, Introduction to quality costs, prevention costs, Appraisal costs, failure costs, Management of quality costs, economics total of quality costs and its reduction.

6 Hours

UNIT - 4

CONTINUOUS IMPROVEMENT:

a. Improvement as problem solving process
   W-V Model of CI, process control
b. Reactive Improvement
   Standard steps & 7 tools of quality, seven steps, management diagnosis of seven steps, reactive improvement.
c. Proactive Improvement.
   Introduction, standard steps, 7 management tools, applying proactive improvement, to develop new product- three stages & nine step.

8 Hours

PART - B

UNIT - 5

TOOLS AND TECHNIQUES IN TQM: Kaizen, Re-engineering, Six Sigma, Benchmarking Definition, Process of benchmarking, 5S, 3M, Poka-Yoke.

8 Hours

UNIT - 6

QUALITY FUNCTION DEPLOYMENT AND FAILURE MODES EFFECTS ANALYSIS: Introduction to QFD and QFD process, Quality by design, Rationale for implementation of quality by design, FMEA, Design FMEA and process FMEA.

6 Hours

UNIT - 7

QUALITY MANAGEMENT SYSTEMS: Introduction to different standards Quality management systems, Bureau of Indian standards (BIS), Institute of Standards Engineers (SEI), ISO-9000 series of standards, Overview of ISO-14000, Overview of TS 16959.

6 Hours

UNIT - 8

PRODUCT ACCEPTANCE CONTROL: Product acceptance control through IS 2500 part 1 and part 2.

6 Hours

TEXT BOOKS:

1. **Total Quality Management:** Dale H. Bester field, Publisher - Pearson Education India, ISBN: 8129702606, Edition 03/e Paperback (Special Indian Edition)
2. **Total Quality Management for Engineers:** M. Zairi, ISBN: 1855730243, Publisher: Wood head Publishing

REFERENCE BOOKS:

1. **A New American TQM, four revolutions in management,** Shoji Shiba, Alan Graham, David Walden, Productivity press, Oregon, 1990
2. **100 Methods for Total Quality Management**: Gopal K. Kanji and Mike Asher, ISBN: 0803977476, Publisher: Sage Publications, Inc.; Edition – 1
3. **Organisational Excellence through TQM, H**. Lal, New age pub, 2008

ELECTIVE III (GROUP C)

EXPERIMENTAL STRESS ANALYSIS

Subject Code	: **06AE761**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: Mechanical, Optical, Pneumatic, Acoustic strain gauges. Electrical Resistance Strain Gauges – Gauge factor , types, properties of an ideal gauge material, backing material, adhesive material, protective coating; Method of bonding strain gauges, strain gauges lead wire and connections, semiconductor strain gauges problems.

8 Hours

UNIT - 2

Strain gauge Circuits, Wheatstone's bridge, Error due to input impedance of measuring instrument, temperature compensation, multiple gauge circuits, calibration of strain measuring system, loadcells, problems.

7 Hours

UNIT - 3

STRAIN GAUGE ROSETTES: Necessity, analysis, problems.

5 Hours

UNIT - 4

NATURE OF LIGHT: Harmonic wave, phase, amplitude, polarization. Crystal optics: Passage of light through crystalline media, absolute and relative phase difference, quarter wave plate, half wave plate, production of plane polarized light and circularly polarized light.

6 Hours

PART - B

UNIT - 5

TWO-DIMENSIONAL PHOTO ELASTICITY: Stress optic law, plane polariscope, isochromatics and isoclinics, circular polariscope, dark and bright fields arrangements, Isoclinic and Isochromatic fringe order at a point, methods of compensation separation technique.

8 Hours

UNIT - 6

PHOTO ELASTIC ANALYSIS: Calibration of photo elastic model material, properties of ideal photo elastic material, casting of photo elastic models, machining, stress relieving, scaling model prototype relation, two dimensional application, problems.

6 Hours

UNIT - 7

BIFRINGENT COATING: Theory, photo elastic data for stress analysis, reflection polariscope. Moire techniques: Phenomenon, moiré fringe analysis, geometric approach, displacement approach, moiré techniques for inplane problems, sign and other of fringes, problems of moiré gratings, moiré fringe photograph.

6 Hours

UNIT - 8

Introduction to holography. Introduction to brittle coating technique. Introduction to computer techniques and fringe analysis.

6 Hours

TEXT BOOKS:

1. **Experimental Stress Analysis,** L. S. Srinath, M.R. Raghavan, K. Lingaiah, G. Gargesh, K. Ramachandara & B. Pant, Tata McGraw Hill publication 2000.
2. **Experimental Stress Analysis,** Dally & Riley, Tata McGraw Hill Publication 2001.

REFERENCE BOOKS:

1. **Analysis of Stress and Strain,** A. J. Duraelli, E. A. Phillips and C.H. Trao McGraw Hill, 1958.
2. **Applied Stress Analysis,** A. J. Durelli, prentice hall India, 1970.
3. **Moire Analysis of Strain,** Durelli & parks. 1996.
4. **Hand Book of Experimental Mechanics,** A. S. Kobayassin (Ed.,) SEM/ VCH, 2nd edn. 2000.

HELICOPTER DYNAMICS

Subject Code	: **06AE762**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

1. INTRODUCTION TO HELICOPTER

Definitions. Genealogical tree of aircraft. Comparison between fixed wing aircraft and helicopter. Some helicopter configurations, major parts, and their functions. Civil and Military applications of helicopters. High speed rotorcraft.

6 Hours

2. HOVER AND VERTICAL FLIGHT

Momentum theory and its application. Hovering flight and ground effects. Forces acting during hovering flight. Disc loading and power loading. Thrust and power coefficients. Figure of merit for hover thrust efficiency. Rotor solidity and blade loading coefficient. Forces acting during vertical flight. Cockpit control for vertical flight. Vertical climb and descend - variation in induced velocities. Torque balance and directional control, turning flights.

7 Hours

3. FORWARD FLIGHT

Forces acting on helicopter in forward flight. Method of achieving translatory flight. Controlling cyclic pitch: Swash-plate system. Blade flapping, feathering. Schematics showing flapping, lead/lag and feathering motion of rotor blade. Drag hinges. Lateral tilt - with and without conning. Lateral and longitudinal asymmetry of lift in forward flight. Types of rotors - teetering design, articulated design,, the hinge less design and bearing less design. Cockpit control of rotor system (collective and cyclic pitch).

7 Hours

4. BASIC HELICOPTER PERFORMANCE

Hovering and axial climb and descent performance. Forward flight performance - total power required, effect of gross weight, effect of density altitude, lift – drag ratios, speed for minimum power, speed for maximum range. Factors affecting the maximum attainable forward speed. Autorotation- autorotation in forward flight, autorotation index. Ground effects in hover, transition and near ground, at low speed and high speed flights.

6 Hours

PART - B

5. ROTOR AIRFOIL AERODYNAMICS AND DYNAMIC STALL

Rotor airfoil requirements - Reynolds number and Mach number influence. Airfoil shape criteria. Dynamic stall in rotor environment, flow topology. Effect of sweep angle on dynamic stall. Effect of aerofoil shape on dynamic stall.

6 Hours

6. HELICOPTER STABILTY AND CONTROL

Introductory concepts of stability, control and trim- hover trim and forward flight trim. Static stability of helicopters: longitudinal, lateral – directional and, directional. Dynamic stability aspects. Flight controls and stability augmentation, Main rotor control and tail rotor control.

7 Hours

7. STANDARDS, SPECIFICATIONS AND TESTING ASPECTS

Scope of requirements. General and operational requirements. Military derivatives of civil rotorcraft. Structural strength and design for operations on specified surfaces. Rotorcraft vibration classification. Flight and Ground Handling Qualities – General requirements and definitions. Control characteristics, breakout forces. Levels of handling qualities. Flight Testing - General handling fight test requirements and, the basis of limitations.

7 Hours

8. CONCEPTUAL DESIGN OF HELICOPTERS

Design requirements. Design of main rotor - rotor dia, tip speed, rotor solidity, blade twist and aerofoil selection. Fuselage design - fuselage drag, vertical drag and down loads, side forces. Empennage design.

6 Hours

TEXT BOOKS:

1. John Fay, `The Helicopter, History, Piloting & How it Flies`, Sterling Book House 2007
2. Gordon Leisshman J, `Principles of Helicopter Aerodynamics`, Cambridge University Press, 2002

REFERENCE BOOKS:

1. Bramwell, `Helicopter Dynamics`.
2. Def Stan 00970, Vol. 2 Rotorcraft
3. Saunders, G H, `Dynamics of Helicopter Flight`, John Wiley & Sons, Inc, NY, 1975

SPACE MECHANICS AND LAUNCH VEHICALS

Subject Code	: **06AE763**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

1. INTODUCTION TO SPACE MECHANICS

Space vehicles/ platforms. Inertial and Earth fixed coordinate reference frames. Representation of vector (position, velocity and acceleration) in fixed and moving reference frames, Coordinate transformations, Euler transformations.

7 Hours

2. CENTRAL FORCE MOTION

Two body problem and one body problem. Kepler's laws of motion.

6 Hours

3. ORBITAL MECHANICS

Establishment of orbits, single impulse and two impulse orbital transfers, ballistic trajectory, orbital perturbations – general and special perturbation methods, Sun synchronous and Geo-synchronous orbits.

7 Hours

4. SATELLITE DYNAMICS

Geosynchronous and geostationary satellites life time - satellite perturbations - Hohmann orbits - calculation of orbit parameters - Determination of satellite rectangular coordinates from orbital elements

6 Hours

PART - B

5. INTRODUCTION TO LAUNCH VEHICLES

Introduction to launch vehicles.. Introduction to Solid, Liquid and Cryogenic rocket engines. Performance parameters. Comparison of liquid propellant, solid Propellant and hybrid rockets.

6 Hours

6. PRINCIPLES OF OPERATION AND TYPES OF ROCKET ENGINES

One dimensional and two dimensional rocket motions in free space and homogeneous gravitational fields. Description of vertical, inclined and gravity turn trajectories. Simple approximations to burnout velocity –

7 Hours

7. ROCKET PERFORMANCE AND STAGING

Launch vehicle trajectories, two body problem and orbital elements. Staging of rockets

6 Hours

8. SPACECRAFT

Preliminary concepts of space, spacecraft. Introduction to manned and unmanned space missions. Spacecraft power generation. Life support system for manned space missions.

Materials for spacecraft. Selections of materials for spacecraft - special requirements of materials to perform under adverse conditions - ablative materials. . Life time estimation for a satellite.

7 Hours

TEXT BOOKS:

1. M. H. Kaplan: Modern Spacecraft Dynamics and Control, John Wiley and Sons, 1976.
2. W. T. Thomson: Introduction to Space Dynamics, Dover Publications, 1986
3. G P Sutton, Rocket Propulsion Elements John Wiley and Sons, 1993

REFERENCE BOOK:

1. H. S. Siefert (Ed.), "Space Mechanics", John Wiley & Sons, 1969.

SMART MATERIALS

Subject Code	: **06AE764**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: Characteristics of composites and ceramics materials, Dynamics and controls, concepts, Electro-magnetic materials and shape memory alloys-processing and characteristics

6 Hours

UNIT - 2

SENSING AND ACTUATION: Principals of electromagnetic, acoustics, chemical and mechanical sensing and actuation, Types of sensors and their applications, their compatibility writer conventional and advanced materials, signal processing, principals and characterization.

7 Hours

UNIT - 3

CONTROL DESIGN: Design of shape memory alloys, Types of MR fluids, Characteristics and application, principals of MR fluid value designs, Magnetic circuit design, MR Dumpers, Design issues.

6 Hours

UNIT - 4

OPTICS AND ELECTROMAGNETIC: Principals of optical fiber technology, characteristics of active and adaptive optical system and components, design and manufacturing principles.

7 Hours

PART - B

UNIT - 5

STRUCTURES: Principles of drag and turbulence control through smart skins, applications in environment such as aerospace and transportation vehicles, manufacturing, repair and maintainability aspects.

7 Hours

UNIT - 6

Controls: Principles of structural acoustic control, distributed, amalog and digital feed back controls, Dimensional implications for structural control.

6 Hours

UNIT - 7

PRINCIPLES OF VIBRATION AND MODAL ANALYSIS: PZT Actuators, MEMS, Magnetic shape Memory Alloys, Characteristics and Applications.

7 Hours

UNIT - 8

INFORMATION PROCESSING: Neural Network, Data Processing, Data Visualisation and Reliability – Principals and Application domains.

6 Hours

TEST BOOKS:

1. **Analysis and Design',** A. V. Srinivasan, 'Smart Structures – Cambridge University Press, New York, 2001, (ISBN : 0521650267)
2. **'Smart Materials and Structures',** M V Gandhi and B S Thompson Chapmen & Hall, London, 1992 (ISBN : 0412370107)

REFERENCE BOOKS:

1. **'Smart Materials and Structures',** Banks HT, RC Smith, Y Wang, Massow S A, Paris 1996
2. **G P Gibss'Adaptive Structres',** Clark R L, W R Saunolers, Jhon Wiles and Sons, New York, 1998
3. **An introduction for scientists and Engineers',** Esic Udd, Optic Sensors : Jhon Wiley & Sons, New York, 1991 (ISBN : 0471830070)

AGILE MANUFACTURING

Subject Code	: **06AE765**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

AGILE MANUFACTURING: Definition, business need, conceptual frame work, characteristics, generic features.

6 Hours

UNIT - 2

DEVELOPING AGILE MANUFACTURING: Enterprise, Strategies, integration of organization, workforce and technology, reference models, examples.

7 Hours

UNIT - 3

INTEGRATION OF PRODUCT /PROCESS DEVELOPMENT: Principles, Robust design approach, Approaches to enhance ability in manufacturing, Role of QFD, Managing people in Agile orgnisation, Approaches.

6 Hours

UNIT - 4

APPLICATION OF IT/IS CONCEPTS IN AGILE MANUFACTURING: Strategies, Management of complexities and information. flow, approaches, applications of multimedia to improve agility in manufacturing, system concepts.

7 Hours

PART - B

UNIT - 5

AGILE SUPPLY CHAIN MANAGEMENT: Principles, IT/IS concepts in supply chain management, enterprise integration and management in agile manufacturing, concepts, Agility, Adaptability and learners – comparison of concepts.

7 Hours

UNIT - 6

COMPUTER CONTROL OF AGILE MANUFACTURING: CAPP for Agile Manufacturing, Aggregate capacity planning and production line design / redesign in Agile manufacturing, Cellular manufacturing, concepts, examples.

7 Hours

UNIT - 7

CORPORATE KNOWLEDGE MANAGEMENT IN AGILE MANUFACTURING: Strategies, strategic options in Agile manufacturing, Role of standards.

6 Hours

UNIT - 8

DESIGN OF SKILL & KNOWLEDGE: Enhancing technology for Machine tool system, Resumption of design requirement geometry, definition, methods, decision support for selection of cutting parameters, design enhancements, parametric approach only.

6 Hours

TEXT BOOKS:

1. **'Agile Manufacturing**- Forging Mew Frontiers', **Poul T Kidd,** Amagow Co. UK, ISBN-0-201-63163-6, 1994
2. **''Agile Manufacturing",** A Gunasekharan, the 21st Century Competitive strategy, ISBN -13 978-0-08-04 3567-1, Elsevier Press, India

REFERENCE BOOKS:

1. **O Levine Transitions to Agile Manufacturing,** Joseph C Moutigomery and Lawrurence – Staying Flexible for competitive advantage, ASQC quality press, Milwaukee. Wisconsiw, USA 1996
2. **Agile Development for Mass Customization,** David M Andeson and B Joseph Pine, Irwin Professional Publishing, Chicogo USa 1997

ROBOTICS

Subject Code	: **06AE766**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION AND MATHEMATICAL REPRESENTATION OF ROBOTS: History of Robots, Types of Robots, Notation, Position and Orientation of a Rigid Body, Some Properties of Rotation Matrices, Successive Rotations, Euler Angles For fixed frames X-Y-Z and moving frame ZYZ. Transformation between coordinate system, Homogeneous coordinates, Properties of ${}^{A}_{B}T$, Types of Joints: Rotary, Prismatic joint, Cylindrical joint, Spherical joint, Representation of Links using Denvit-Hartenberg Parameters: Link parameters for intermediate, first and last links, Link transformation matrices, Transformation matrices of 3R manipulator, PUMA560 manipulator, SCARA manipulator

7 Hours

UNIT - 2

KINEMATICS OF SERIAL MANIPULATORS: Direct kinematics of 2R, 3R, RRP, RPR manipulator, puma560 manipulator, SCARA manipulator, Stanford arm, Inverse kinematics of 2R, 3R manipulator, puma560 manipulator.

6 Hours

UNIT - 3

VELOCITY AND STATICS OF MANIPULATORS: Differential relationships, Jacobian, Differential motions of a frame (translation and rotation), Linear and angular velocity of a rigid body, Linear and angular velocities of links in serial manipulators, 2R, 3R manipulators, Jacobian of serial manipulator, Velocity ellipse of 2R manipulator, Singularities of 2R maipulators, Statics of serial manipulators, Static force and torque analysis of 3R manipulator, Singularity in force domain.

7 Hours

UNIT - 4

DYNAMICS OF MANIPULATORS: Kinetic energy, Potential energy, Equation of motion using Lagrangian, Equation of motions of one and two degree freedom spring mass damper systems using Lagrangian formulation, Inertia of a link, Recursive formulation of Dynamics using Newton Euler equation, Equation of motion of 2R manipulator using Lagrangian, Newton-Euler formulation.

6 Hours

PART - B

UNIT - 5

TRAJECTORY PLANNING: Joint space schemes, cubic trajectory, Joint space schemes with via points, Cubic trajectory with a via point, Third order polynomial trajectory planning, Linear segments with parabolic blends, Cartesian space schemes, Cartesian straight line and circular motion planning

7 Hours

UNIT - 6

CONTROL: Feedback control of a single link manipulator- first order, second order system, PID control, PID control of multi link manipulator, Force control of manipulator, force control of single mass,Partitioning a task for force and position control- lever, peg in hole Hybrid force and position controller

8 Hours

UNIT - 7

ACTUATORS: Types, Characteristics of actuating system: weight, power-to-weight ratio, operating pressure, stiffness vs. compliance, Use of reduction gears, comparision of hydraulic, electric, pneumatic actuators, Hydraulic actuators, proportional feedback control, Electric motors: DC motors, Reversible AC motors, Brushles DC motors, Stepper motors- structure and principle of operation, stepper motor speed-torque characteristics

6 Hours

UNIT - 8

SENSORS: Sensor characteristics, Position sensors- potentiometers, Encoders, LVDT, Resolvers, Displacement sensor, Velocity sensor-encoders, tachometers, Acceleration sensors, Force and Pressure sensors – piezoelectric, force sensing resistor, Torque sensors, Touch and tactile sensor, Proximity sensors-magnetic, optical, ultrasonic, inductive, capacitive, eddy-current proximity sensors.

5 Hours

TEXT BOOKS:

1. **Fundamental Concepts and Analysis,** Ghosal A., Robotics, Oxford,2006
2. **Introduction to Robotics Analysis, Systems, Applications,** Niku, S. B., Pearso Education, 2008

REFERENCE BOOKS:

1. **Introduction to Robotics: Mechanica and Control,** Craig, J. J., 2nd Edition, Addison-Welsey, 1989.
2. Fundamentals of Robotics, Analysis and Control, Schilling R. J., PHI, 2006

INDUSTRIAL AND EXPERIMENTAL AERODYNAMICS

Subject Code	: **06AE767**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

1. WIND ENERGY COLLECTORS

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

6 Hours

2. VEHICLE AERODYNAMICS

Power requirements and drag coefficients of automobiles. Effects of cut back angle. Aerodynamics of Trains and Hovercraft.

7 Hours

3. BUILDING AERODYNAMICS

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

6 Hours

4. FLOW INDUCED VIBRATIONS

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

7 Hours

PART - B

5. MODEL MEASUREMENTS

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

7 Hours

6. WIND TUNNEL BOUNDARY CORRECTIONS AND SCALE EFFECTS

Effects of lateral boundaries. Method of images. Wall corrections. Effects of Buoyancy, Solid Blocking, Wake Blocking. General downwash correction.

Lift interference correction. Corrections for reflection plane models. Scale effects on aerodynamic characteristics and stability derivatives.

6 Hours

7. NEARSONIC AND TRANSONIC TESTING

Near sonic tunnel design. Calibration of test section. Model support system. Tare and interference evaluation. Near transonic testing.

7 Hours

8. SUPERSONIC WIND TUNNEL TESTING

Types of supersonic tunnels: - continuous, intermittent (indraft ,and blowdown). Pressure-vacuum tunnels. Supersonic tunnel design features. Calibration of test section. Optical systems- Schlieren set-up. Starting loads. Hypersonic wind tunnels - General introduction.

6 Hours

TEXT BOOKS:

1. Jewel B. Barlow, William H RAE, Jr. and Alan Pope**,** ` Low speed Wind Tunnel Testing`, John Wiley & Sons; 1999.
2. M.Sovran (Ed), "Aerodynamics and drag mechanisms of bluff bodies and road Vehicles", Plenum press, New York, 1978.
3. P. Sachs, "Winds forces in engineering", Pergamon Press, 1978.

REFERENCE BOOKS:

1 R. D. Blevins, "Flow induced vibrations", Van Nostrand, 1990.

2 N. G. Calvent, "Wind Power Principles", Charles Griffin & Co.,London,1979

MICRO AND SMART SYSTEMS TECHNOLOGY

Subject Code	: **06AE768**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION TO MICRO AND SMART SYSTEMS:

a) What are smart-material systems? Evolution of smart materials, structures and systems. Components of a smart system. Application areas. Commercial products.

b) What are microsystems? Feynman's vision. Micromachined transducers. Evolution of micro-manufacturing. Multi-disciplinary aspects. Applications areas. Commercial products.

5 Hours

UNIT - 2

MICRO AND SMART DEVICES AND SYSTEMS: PRINCIPLES AND MATERIALS:

a) Definitions and salient features of sensors, actuators, and systems.

b) Sensors: silicon capacitive accelerometer, piezo-resistive pressure sensor, blood analyzer, conductometric gas sensor, fiber-optic gyroscope and surface-acoustic-wave based wireless strain sensor.

c) Actuators: silicon micro-mirror arrays, piezo-electric based inkjet print-head, electrostatic comb-drive and micromotor, magnetic micro relay, shape-memory-alloy based actuator, electro-thermal actuator

d) Systems: micro gas turbine, portable clinical analyzer, active noise control in a helicopter cabin

8 Hours

UNIT - 3

MICROMANUFACTURING AND MATERIAL PROCESSING:

a) Silicon wafer processing, lithography, thin-film deposition, etching (wet and dry), wafer-bonding, and metallization.

b) Silicon micromachining: surface, bulk, moulding, bonding based process flows.

c) Thick-film processing:

d) Smart material processing:

e) Processing of other materials: ceramics, polymers and metals

f) Emerging trends

7 Hours

UNIT - 4

MODELING:

a) Scaling issues.

b) Elastic deformation and stress analysis of beams and plates. Residual stresses and stress gradients. Thermal loading. Heat transfer issues. Basic fluids issues.

c) Electrostatics. Coupled electromechanics. Electromagnetic actuation. Capillary electro-phoresis. Piezoresistive modeling. Piezoelectric modeling. Magnetostrictive actuators.

6 Hours

PART - B

UNIT - 5

COMPUTER-AIDED SIMULATION AND DESIGN:

Background to the finite element element method. Coupled-domain simulations using Matlab. Commercial software.

8 Hours

UNIT - 6

ELECTRONICS, CIRCUITS AND CONTROL:

Carrier concentrations, semiconductor diodes, transistors, MOSFET amplifiers, operational amplifiers. Basic Op-Amp circuits. Charge-measuring circuits. Examples from microsystems. Transfer function, state-space modeling, stability, PID controllers, and model order reduction. Examples from smart systems and micromachined accelerometer or a thermal cycler.

8 Hours

UNIT - 7

INTEGRATION AND PACKAGING OF MICROELECTRO MECHANICAL SYSTEMS:

Integration of microelectronics and micro devices at wafer and chip levels. Microelectronic packaging: wire and ball bonding, flip-chip. Low-temperature-cofired-ceramic (LTCC) multi-chip-module technology. Microsystem packaging examples.

6 Hours

UNIT - 8

CASE STUDIES:

BEL pressure sensor, thermal cycler for DNA amplification, and active vibration control of a beam.

4 Hours

PART - C

UNIT - 9

Mini-projects and class-demonstrations (not for Examination)

a) CAD lab (coupled field simulation of electrostatic-elastic actuation with fluid effect)

b) BEL pressure sensor

c) Thermal-cycler for PCR

d) Active control of a cantilever beam

9 Hours

TEXT BOOKS AND A CD-SUPPLEMENT:

1. A course-pack with matter taken from the following books including some newly written material. (This is until the textbook is ready. Chapter-wise resource material is indicated below.)
2. **MEMS & Microsystems: Design and Manufacture,** Tai-Ran Tsu, Tata Mc-Graw-Hill.

REFERENCE BOOKS:

1. Animations of working principles, process flows and processing techniques, A CD-supplement with Matlab codes, photographs and movie clips of processing machinery and working devices.

2. **Laboratory hardware kits for** (i) BEL pressure sensor, (ii) thermal-cycler and (iii) active control of a cantilever beam.
3. **Microsystems Design,** S. D. Senturia, 2001, Kluwer Academic Publishers, Boston, USA. ISBN 0-7923-7246-8.
4. **Analysis and Design Principles of MEMS Devices,** Minhang Bao, Elsevier, Amsterdam, The Netherlands, ISBN 0-444-51616-6.
5. **Design and Development Methodologies,** Smart Material Systems and MEMS: V. Varadan, K. J. Vinoy, S. Gopalakrishnan, Wiley.
6. **MEMS-** Nitaigour Premchand Mahalik, TMH 2007

VIII SEMESTER
FLIGHT VEHICLE DESIGN

Subject Code	: **06AE81**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART – A

1. CONCEPTUAL AIRCRAFT DESIGN

Operational specifications-mission requirements. Government standards and regulations (MIL Specs, JAR-23 and JAR-25). Design process, flow chart, survey of various types of airplanes, over-view of design process. Airplane configuration description. Take-off weight-Preliminary Estimate-Spread sheet approach.

6 Hours

2. PRELIMINARY AERODYNAMIC DESIGN

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

6 Hours

3. DESIGN OF STRUCTURAL COMPONENTS WING, FUSELAGE AND TAIL

Mainplane: Airfoil cross-section shape, taper ratio selection, sweep angle selection, wing drag estimation. Spread sheet for wing design. Fuselage: Volume consideration, quantitative shapes, air inlets, wing attachments. Aerodynamic considerations and drag estimation. Spread sheets. Tail arrangements: Horizontal and vertical tail sizing. Tail planform shapes. Airfoil selection type. Tail placement. Spread sheets for tail design.

7 Hours

4. POWER FOR FLIGHT

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

7 Hours

PART - B

5. PERFORMANCE ESTIMATION

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

7 Hours

6. STATIC STABILITY

Longitudinal stability, static margin and stabilization. Control surface sizing. Effect of static margin on performance. Lateral and directional static stability-contribution of airframe components. Aileron sizing, rudder area sizing. Longitudinal maneuverability.

7 Hours

7. DESIGN ASPECTS OF SUB-SYSTEMS

Air-conditioning and pressurisation, ice protection systems. Electric power system. Hydraulic systems, fuel system. Landing gear.

6 Hours

8. DESIGN ASPECTS AVIONICS, CONTROLS AND WEAPON SYSTEMS

Communication system, Navigation system, Radar, Flight control system, Weapon systems, and weapon system interface.

6 Hours

TEXT BOOKS:

1. Tomas C Corke., "Design of Aircraft," Person Education, LPE, 2003.
2. John P Fielding, Introduction to Aircraft Design Cambridge University Press, 1999

REFERENCE BOOKS:

1. Darrol Stinton D.," The Design of the Aeroplane", Black Well Science, 2nd Edition, 2001
2. Daniel P. Raymer, "Aircraft Design: A Conceptual approach", AIAA Education Services, 1992.

AVIONICS

Subject Code	: **06AE82**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

1. POWER DISTRIBUTION SYTEM

Bus Bar, split bus bar system, special purpose cables. Electrical diagram and identification scheme. Circuit controlling devices. Power utilisation-typical application to avionics. Need for Avionics in civil and military aircraft.

7 Hours

2. INERTIAL NAVIGATION SYSTEM

Gyroscopic versus Inertial platform. Structure of stable platform. Inertial Navigation units. Inertial alignment. Inertial interface system. Importance of Compass swing.

6 Hours

3. ELECTRONIC FLIGHT CONTROL SYSTEM

Fly-by-wire system: - basic concept and features. Pitch and Roll rate: - command and response. Control Laws. Frequency response of a typical FBW actuator. Cooper Harper scale. Redundancy and failure survival. Common mode of failures and effects analysis.

7 Hours

4. ELECTRONIC FLIGHT INSTRUMENT SYSTEMS

Display -units, presentation, failure, and annunciation. Display of air data.

6 Hours

PART - B

5. INTRODUCTION TO AVIONICS SUB SYSTEMS AND ELECTRONIC CIRCUITS

Typical avionics subsystems. Amplifier, oscillator, aircraft communication system, transmitter, receiver, antenna.

7 Hours

6. PRINCIPLES OF DIGITAL SYSTEMS

Digital Computers – Microprocessors – Memories

6 Hours

7. FLIGHT DECK AND COCKPITS

Control and display technologies CRT, LED, LCD, EL and plasma panel - Touch screen - Direct voice input (DVI) - Civil cockpit and military cockpit : MFDS, HUD, MFK, HOTAS

6 Hours

8. AVIONICS SYSTEMS INTEGRATION

Avionics equipment fit. Electrical data bus system. Communication Systems, Navigation systems, Flight control systems, Radar , Electronic Warfare, and fire control system. Avionics system architecture–Data buses MIL–STD 1553 B.

7 Hours

TEXT BOOKS:

1. R P G Collinson, `Introduction to Avionics Systems,` Kulwar Academic Publishers`, 2003
2. E H J Pallett, `Aircraft Electrical System,`. Pitman Publishers, 1976.

REFERENCE BOOKS:

1. Middleton, D.H., Ed., `Avionics Systems`, Longman Scientific and Technical Longman Group UK Ltd., England, 1989.
2. Spitzer, C.R., `Digital Avionic Systems`, Prentice Hall, Englewood Cliffs, N.J., USA, 1987.

3. R.B. Underdown & Tony Palmer, `Navigation~, Black Well Publishing 2001.

ELECTIVE IV (GROUP D)

FLIGHT TESTING

Subject Code	: **06AE831**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

1. INTRODUCTION

Purpose and scope of flight testing, basic definition, types of flight tests, sequence of flight testing, planning the test program, governing regulations. Aircraft weight and center of gravity, flight testing tolerances. Method of reducing data uncertainty in flight test data -sources and magnitudes of error, avoiding and minimizing errors.

6 Hours

2. FLIGHT TEST INSTRUMENTATION

Planning flight test instrumentation, sensing and transuding techniques. Measurement of linear and angular displacements, velocities and accelerations, vibration, force, temperature - onboard and ground based data acquisition system. Radio telemetry.

7 Hours

3. PERFORMANCE FLIGHT TESTING - RANGE, ENDURANCE AND CLIMB

Airspeed – in flight calibration. Level flight performance for propeller driven aircraft and for Jet aircraft - Techniques and data reduction. Range and endurance estimation of propeller and jet aircraft. Climb performance methods.

7 Hours

4. PERFORMANCE FLIGHT TESTING -TAKE-OFF, LANDING, TURNING FLIGHT

Turning performance limitations. Drag estimation. Take-off and landing - methods, procedures and data reduction.

6 Hours

PART - B

5. STABILITY AND CONTROL - LONGITUDAL AND MANOEUVRING

Flight test Methods :-Static longitudinal stability ; Dynamic longitudinal stability. Data reduction. Maneuvering stability methods & data reduction.

7 Hours

6. STABILITY AND CONTROL - LATERAL & DIRECTIONAL

Flight Test methods: - Lateral and directional static stability; Lateral and directional dynamic stability. Regulations and data reduction.

7 Hours

7. FLYING QUALITIES

MIL and FAR regulations. Cooper-Harper scale. Pilot Rating . Flight test procedures.

6 Hours

8. HARARDOUS FLIGHT TESTING

Stall and spin- regulations, test and recovery techniques. Dive testing for flutter, vibration and buffeting.

6 Hours

TEXT BOOK:

1. Ralph D Kimberlin, `Flight Testing of Fixed Wing Aircraft`, AIAA educational Series, 2003.

REFERENCE BOOK:

1. ADARD, Flight Test Manual Vol. I to IV

FRACTURE MECHANICS

Subject Code	: **06AE832**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

FRACTURE MECHANICS PRINCIPLES: Introduction, Mechanisms of Fracture, a crack in structure, the Griffith's criterion, modern design – strengths, stiffness and toughness. Stress intensity approach

6 Hours

UNIT - 2

STRESS ANALYSIS FOR MEMBERS WITH CRACKS: Linear elastic fracture mechanics, Crack tip stress and deformations, Relation between stress intensity factor and fracture toughness, Stress intensity based solutions. Crack tip plastic zone estimation, Plane stress and plane strain concepts. The Dugdale approach, the thickness effect.

7 Hours

UNIT - 3

ELASTIC – PLASTIC FRACTURE MECHANICS: Introduction, Elasto–plastic factor criteria, crack resistance curve, J-integral, Crack opening displacement, crack tip opening displacement. Importance of R-curve in fracture mechanics, experimental determination of J-integral, COD and CTOD.

7 Hours

UNIT - 4

DYNAMIC AND CRACK ARREST: Introduction, the dynamic stress intensity and elastic energy release rate, crack branching, the principles of crack arrest, the dynamic fracture toughness.

6 Hours

PART - B

UNIT - 5

FATIGUE AND FATIGUE CRACK GROWTH RATE: Fatigue loading, various stages of crack propagation, the load spectrum, approximation of the stress spectrum, the crack growth integration, fatigue crack growth laws.

7 Hours

UNIT - 6

FRACTURE RESISTANCE OF MATERIALS: Fracture criteria, fatigue cracking criteria, effect of alloying and second phase particles, effect of processing and anisotropy, effect of temperature, closure.

6 Hours

UNIT - 7

COMPUTATIONAL FRACTURE MECHANICS: Overview of numerical methods, traditional methods in computational fracture mechanics – stress and displacement marching, elemental crack advance, virtual crack extension, the energy domain integral, finite element implementation. Limitations of numerical fracture analysis.

7 Hours

UNIT - 8

FRACTURE TOUGHNESS TESTING OF METALS: Specimen size requirements, various test procedures, effects of temperature, loading rate and plate thickness on fracture toughness. Fracture testing in shear modes, fatigue testing, NDT methods.

6 Hours

TEXT BOOKS:

1. **Introduction to Fracture Mechanics**, Karen Hellan McGraw Hill Pub.2000
2. **Fracture of Engineering Brittle Materials,** Jayatilake, Applied Science, London. 2001.

REFERENCE BOOKS:

1. **Fracture Mechanics – Fundamentals and Application,** T.L. Anderson, CRC press 1998
2. **Elementary Engineering Fracture Mechanics**, David Broek, Artinus Nijhoff, London 1999.
3. **Fracture and Fatigue Control in Structures**, Rolfe and Barsom, Printice Hall 2000.
4. **Fundamentals of Fracture Mechanics**, Knott, Bureworth 2000.

THEORY OF AEROELASTICITY

Subject Code	: **06AE833**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

1. INTRODUCTION

Aeroelasticity - definition and problems. Influence of aeroelastic phenomenon on design :- flutter, buffeting, dynamic loads problems, load distribution, divergence, control effectiveness & reversal. Critical flutter speeds versus wing sweep back. Effect of speed on control effectiveness.

6 Hours

2. DEFORMATION OF AIRPLANE STRUCTURES UNDER STATIC LOADS

Deformation due to several forces. Influence coefficients. Properties of influence coefficients. Deformation under distributed forces. Influence functions. Properties of influence functions. Simplified elastic airplane. Deformation of airplane wing. Force and torque applied to wing. Integration by weighting matrices. Bending, torsional and shear stiffness curves.

7 Hours

3. STATIC AEROELASTIC PHENOMENA

Load distribution and divergence-wing torsional divergence (two-dimensional case, & finite wing case). Swept wing divergence. Prevention of aeroelastic instabilities.

6 Hours

4. CONTROL EFFECTIVENESS AND REVERSAL

Aileron effectiveness and reversal -2 dimensional case, and finite wing case. Strip theory. Aileron effectiveness in terms of wing -tip helix angle. Critical aileron reversal speed. Rate of change of local pitching moment coefficient with aileron angle.

7 Hours

PART - B

5. DEFORMATION OF AIRPLANE STRUCTURES UNDER DYNAMIC LOADS

Differential and Integral forms of equations of motions of vibrations. Natural modes and frequencies of complex airplane structures - introduction. Dynamic response phenomenon -equations of disturbed motion of an elastic airplane.

6 Hours

6. DYNAMIC PROBLEMS OF AEROELASTICITY

Flutter. Single-degree-of- freedom system. Determination of critical flutter speed. Aeroelastic modes. Wing bending and torsion flutter. Coupling of bending and torsion oscillations and destabilizing effects of geometric

incidences. Stall flutter, Supersonic panel flutter, Buffeting and, Aileron buzz. Flutter prevention and control.

7 Hours

7. TEST MODEL SIMILARITES

Dimensional concepts. Vibration model similarity laws. Dimensionless form of equation of motion. Mode shapes and natural frequencies in dimensionless forms. Model scale factors. Flutter model similarity law. Scale factors. Structural simulation:-shape, mass and stiffness.

7 Hours

8. TESTING TECHNIQUES

Measurement of structural flexibility. Measurements of natural frequencies and mode shapes. Polar plot of the damped response. Identification and measurement of normal modes. Steady state aeroelastic model testing. Dynamic aeroelastic model testing. Flight flutter testing.

6 Hours

TEXT BOOKS:

1. Dowell, E. H., Crawley, E. F., Curtiss Jr., H. C., Peters, D. A., Scanlan, R. H., and Sisto, F., A Modern Course in Aeroelasticity, Kluwer Academic Publishers, 3rd Edition, 1995. (TL574.A37.M62)
2. Bisplinghoff, R., Ashley, H., and Halfman, R. L., Aeroelasticity, Dover, 1955. (TL570.B622)

REFERENCE BOOKS:

1. Fung, Y. C., An Introduction to the Theory of Aeroelasticity, 1955 (Dover, 1969).
2. Megson THG, `Aircraft structures for Engineering students`, Edward Arnold.
3. Bisplinghoff, R. and Ashley, H., Principles of Aeroelasticity, Dover, 1962. (TL570.B623)

HYDRAULICS AND PNEUMATICS

Subject Code	: **06AE834**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION TO HYDRAULIC POWER: Pascal's law and problems on Pascal's Law, continuity equations, introduction to conversion of units. Structure of Hydraulic Control System. The Source of Hydraulic Power: Pumps Pumping theory, pump classification, gear pumps, vane pumps, piston pumps, pump performance, pump selection. Variable displacement pumps. **8 Hours**

UNIT - 2

HYDRAULIC ACTUATORS AND MOTORS: Linear Hydraulic Actuators [cylinders], Mechanics of Hydraulic Cylinder loading, Hydraulic Rotary Actuators, Gear motors, vane motors, piston motors, Hydraulic motor theoretical torque, power and flow rate, hydraulic motor performance.

6 Hours

UNIT - 3

CONTROL COMPONENTS IN HYDRAULIC SYSTEMS: Directional Control Valves – Symbolic representation, Constructional features, pressure control valves – direct and pilot operated types, flow control valves.

5 Hours

UNIT - 4

HYDRAULIC CIRCUIT DESIGN AND ANALYSIS: Control of single and double – acting Hydraulic Cylinder, regenerative circuit, pump unloading circuit, Double pump Hydraulic system, Counter Balance Valve application, Hydraulic cylinder sequencing circuits. Locked cylinder using pilot check valve, cylinder synchronizing circuits, speed control of hydraulic cylinder, speed control of hydraulic motors, accumulators and accumulator circuits.

7 Hours

PART - B

UNIT - 5

MAINTENANCE OF HYDRAULIC SYSTEMS: Hydraulic oils; Desirable properties, general type of fluids, sealing devices, reservoir system, filters and strainers, problem caused by gases in hydraulic fluids, wear of moving parts due to solid particle contamination, temperature control, trouble shooting.

6 Hours

UNIT - 6

INTRODUCTION TO PNEUMATIC CONTROL: Choice of working medium, characteristics of compressed air. Structure of Pneumatic control system. Pneumatic Actuators: Linear cylinders – Types, conventional type of cylinder working, end position cushioning, seals, mounting arrangements applications. Rod–less cylinders, types, working advantages. Rotary cylinder types construction and application. Design parameters, selection.

6 Hours

UNIT - 7

DIRECTIONAL CONTROL VALVES: Symbolic representation as per ISO 1219 and ISO 5599. Design and constructional aspects, poppet valves, slide valves spool valve, suspended seat type slide valve. Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, use of memory valve. Flow control valves and speed control of cylinders supply air throttling and exhaust air throttling use of quick exhaust valve. Signal processing elements: Use of Logic gates – OR and AND gates pneumatic applications.

Practical examples involving the sue of logic gates. Pressure dependent controls types construction–practical applications. Time dependent controls – Principle, construction, practical applications.

7 Hours

UNIT - 8

MULTI-CYLINDER APPLICATIONS: Coordinated and sequential motion control. Motion and control diagrams – Signal elimination methods. Cascading method – principle. Practical application examples (up to two cylinders) using cascading method (using reversing valves). Electro-Pneumatic control: Principles-signal input and out put pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple single cylinder applications. Compressed air: Production of compressed air – compressors, preparation of compressed air- Driers, Filters, Regulators, Lubricators, Distribution of compressed air- Piping layout.

7 Hours

TEXT BOOKS:

1. **Fluid Power with applications,** Anthony Esposito, Fifth edition pearson education, Inc. 2000.
2. **Pneumatics and Hydraulics,** Andrew Parr. Jaico Publishing Co. 2000.

REFERENCE BOOKS:

1. **Oil Hydraulic Systems - Principles and Maintenance,** S.R. Majumdar, Tata Mc Graw Hill publishing company Ltd. 2001.
2. **Pneumatic Systems,** S.R. Majumdar, Tata Mc Graw Hill publishing Co., 1995.
3. **Industrial Hydraulics,** Pippenger, Hicks, McGraw Hill, New York.

RELIABILITY AND MAINTENANCE ENGINEERING

Subject Code	: **06AE835**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

1. INTRODUCTION

Definition. Performance, cost and reliability. Quality, reliability and safety. Probability and sampling. Probability concept. Discrete random variables. Binomial distribution. Multiple sampling methods. Continuous random variables.

6 Hours

2. QUALITY & ITS MEASURES

Quality & reliability. Taguchi methodology. Quality measure. The six Sigma

Methodology.

7 Hours

3. DATA & DISTRIBUTIONS

Non parametric methods. Histograms. Probability Plotting. Point and interval estimates. Normal and Lognormal Parameters.

6 Hours

4. RELAIBILTY & RATES OF FAILURE

Reliability characterisation. Bath tub curve. MTBF concept. Constant failure rate model. Time dependent failure rates. Component failures and failure modes.

7 Hours

PART - B

5. RELIABILTY TESTING

Reliability enhancement procedures. Reliability growth testing, Environmental stress testing. Nonparametric methods. Ungrouped data. Accelerated life testing.

6 Hours

6. REDUNDANCY

Introduction: Active and standby redundancy. Constant failure rate models. Redundancy limitations. Multiply redundant system. Case studies.

7 Hours

7. MAINTAINED SYSTEMS

Types of maintenance. Preventive maintenance, Idealised maintenance, Imperfect maintenance. Redundant components. Corrective maintenance. Maintainability. Repair: revealed failures. Testing & repair: unrevealed failures. Prediction of maintenance schedules. Modern trends in maintenance Philosophy like BITE, IRAN, HUM, TPM etc.

7 Hours

8. SYSTEM SAFETY ANALYSIS

Product and equipment hazards. Human errors. Methods of analysis. Failure Modes and Effects Analysis. Fault tree construction. Direct evaluation of fault tree.

6 Hours

TEXT BOOK:

1. E.E. Lewis, `Introduction to Reliability Engineering`, John Wiley., 1994

REFERENCE BOOKS:

1. K.S. Trivedi, `Probability and statistics with Reliability`, Queuing and Computer Science Applications, PHI.
2. E Balagurswamy, `Reliability Engineering,` Tata McGraw Hill Publications.

BOUNDARY LAYER THEORY

Subject Code	: **06AE836**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

1. PRELIMINARY CONCEPTS

Some examples of viscous flow phenomena: - aerofoil, cylinder, circular pipe. Boundary conditions for viscous flow problems. The kinematics properties of viscous flow.

6 Hours

2. FUNDAMENTAL EQUATIONS OF VISCOUS FLOW

Conservation of mass, momentum and energy equations. Mathematical characterisation of basic equations. Dimensionless parameters in viscous flow.

7 Hours

3. SOLUTIONS OF VICOUS FLOW EQUATIONS

Classification of solutions. Couette flow, stability of Couette flow. Poiseuille steady flow through duct. Unsteady duct flow between plates with bottom injection and top suction. Plane stagnation flow- differential equation free of parameters.

6 Hours

4. INTRODUCTION TO LAMINAR BOUNDARY LAYER

Laminar boundary layer equations. Flat plate Integral analysis. Displacement thickness, Momentum and Energy thicknesses for two dimensional flows; Shape factor. Some insight into boundary layer approximations. Discussion of Navier Stokes equations. Concept of thermal boundary layer.

7 Hours

PART - B

5. LAMINAR BOUNDARY LAYER EQUATIONS

Dimensionless variables. Laminar boundary layer equations. Similarity solutions for steady two-dimensional flow. Blasius solution for flat- plate flow, wall shear stress. Flat plate heat transfer for constant wall temperature. Some examples of Falkner-Skan potential flows. Reynolds analogy as a function of pressure gradient.

6 Hours

6. TRANSITION TO TURBULENCE

Stability of laminar flows - concept of small disturbance stability. Temporal instability and Spatial instability. Stability of Blasius and Falkner-Skan profiles. Effect of wall temperature. Transition to turbulence. Affecting

parameters.

6 Hours

7. INCOMPRESSIBLE TURBULENT MEAN FLOW

Physical and mathematical description of turbulence. Fluctuations and time averging. Turbulent flow in pipes and channels. Free turbulence: - jets, wakes and mixing layers.

7 Hours

8. INSTRUMENTATION AND MEASUREMENTS

Hot wire and Hot film anemometer for turbulence measurements. Schlieren methods for flow visualization. Pressure probes, Interferometer and Smoke method.

7 Hours

TEXT BOOKS:

1. H. Schlichting, `Boundary Layer Theory`, McGraw- Hill, New York, 1979.
2. Frank White, `Viscous Fluid flow` - McGraw Hill, 1991.
3. J. P. Hollman and W.J. Gajda, Jr. 'Experimental methods for Engineers', 5th Edition McGraw- Hill , 1989

REFERENCE BOOKS:

1. Ronald L., Panton, `Incompressible fluid flow`, John Wiley & Sons, 1984.
2. Boundary Layer by T.R.Oke

OPERATION RESEARCH

Subject Code	: **06AE837**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: Linear programming, Definition, scope of Operations Research (O.R) approach and limitations of OR Models, Characteristics and phases of OR Mathematical formulation of L.P. Problems. Graphical solution methods.

6 Hours

UNIT - 2

LINEAR PROGRAMMING PROBLEMS: The simplex method - slack, surplus and artificial variables. Concept of duality, two phase method, dual simplex method, degeneracy, and procedure for resolving degenerate cases.

7 Hours

UNIT - 3

TRANSPORTATION PROBLEM: Formulation of transportation model,

Basic feasible solution using different methods, Optimality Methods, Unbalanced transportation problem, Degeneracy in transportation problems, Applications of Transportation problems. Assignment Problem: Formulation, unbalanced assignment problem, Traveling salesman problem.

7 Hours

UNIT - 4

SEQUENCING: Johnsons algorithm, n - jobs to 2 machines, n jobs 3machines, n jobs m machines without passing sequence. 2 jobs n machines with passing. Graphical solutions priority rules.

6 Hours

PART - B

UNIT - 5

QUEUING THEORY: Queuing system and their characteristics. The M/M/1 Queuing system, Steady state performance analysing of M/M/ 1 and M/M/C queuing model.

6 Hours

UNIT - 6

PERT-CPM TECHNIQUES: Network construction, determining critical path, floats, scheduling by network, project duration, variance under probabilistic models, prediction of date of completion, crashing of simple networks.

7 Hours

UNIT - 7

GAME THEORY: Formulation of games, Two person-Zero sum game, games with and without saddle point, Graphical solution (2x n, m x 2 game), dominance property.

7 Hours

UNIT - 8

INTEGER PROGRAMMING: Gommory's technique, branch and bound lgorithm for integer programming problems, zero one algorithm

6 Hours

TEXT BOOKS:

1. **Operations Research and Introduction,** Taha H. A. – Pearson Education edition
2. **Operations Research**, S. D. Sharma –Kedarnath Ramnath & Co 2002.

REFERENCE BOOKS:

1. **"Operation Research"** AM Natarajan, P. Balasubramani, A Tamilaravari Pearson 2005
2. **Introduction to operation research,** Hiller and liberman, Mc Graw Hill. 5th edition 2001.
3. **Operations Research:** Principles and practice: Ravindran, Phillips

& Solberg, Wiley India lts, 2nd Edition 2007
4. **Operations Research,** Prem Kumar Gupta, D S Hira, S Chand Pub, New Delhi, 2007

AEROSPACE QUALITY ASSURANCE

Subject Code	: **06AE838**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

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

6 Hours

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

7 Hours

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

6 Hours

4. 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.

7 Hours

PART - B

5. 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.

6 Hours

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

7 Hours

7. INSPECTION, TEST & MEASUREMENTS

Sampling risk. Analysis of some rule to thumb. Sampling plot. Evaluation of parameters affecting field performance. Acceptance sampling plan. Feed back . Field data.

7 Hours

8. QUALITY 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.

6 Hours

TEXT BOOK:

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`, Parga man Publishers.
3. S C Keshu and K K Ganapathi, `Aircraft production technology and Management,` Interline Publishers,1993

ELECTIVE V (GROUP E)

AIRCRAFT SAFETY RULES AND REGULATIONS

Subject Code	: **06AE841**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

1. C.A.R. SERIES 'A' – PROCEDURE FOR CIVIL AIR WORTHINESS REQUIREMENTS AND RESPONSIBILITY OPERATORS Vis-à-vis AIR WORTHINESS DIRECTORATE Responsibilities of operators / owners- Procedure of CAR issue, amendments etc., Objectives and targets of airworthiness directorate; Airworthiness regulations and safety oversight of engineering activities of operators.

6 Hours

2. C.A.R. SERIES 'B' – ISSUE APPROVAL OF COCKPIT CHECK LIST, MEL, CDL: Deficiency list (MEL & CDL); Preparation and use of cockpit checklist and emergency list.

6 Hours

3. C.A.R. SERIES 'C' – DEFECT RECORDING, MONITORING, INVESTIGATION AND REPORTING

Defect recording, reporting, investigation, rectification and analysis; Flight report; Reporting and rectification of defects observed on aircraft; Analytical study of in-flight readings & recordings; Maintenance control by reliability Method.

7 Hours

4. C.A.R. SERIES 'D' – AND AIRCRAFT MAINTENANCE PROGRAMMES

Reliability Programmes (Engines); Aircraft maintenance programme & their approval; On condition maintenance of reciprocating engines; TBO – Revision programme; Maintenance of fuel and oil uplift and consumption records – Light aircraft engines; Fixing routine maintenance periods and component TBOs – Initial & revisions.

7 Hours

PART - B

5. C.A.R. SERIES 'E' – APPROVAL OF ORGANISATIONS

Approval of organizations in categories A, B, C, D, E, F, & G - Requirements of infrastructure at stations other than parent base.

6 Hours

6. C.A.R. SERIES 'F' – AIR WORTHINESS AND CONTINUED AIR WORTHINESS

Procedure relating to registration of aircraft; Procedure for issue / revalidation of Type Certificate of aircraft and its engines / propeller; Issue / revalidation of Certificate of Airworthiness; Requirements for renewal of Certificate of Airworthiness.

7 Hours

7. C.A.R. SERIES 'L'&'M'

Issue of AME Licence, its classification and experience requirements, Mandatory Modifications / Inspections.

6 Hours

8. C.A.R. SERIES 'T'&'X'

Flight testing of (Series) aircraft for issue of C of A; Flight testing of aircraft for which C of A had been previously issued.

Registration Markings of aircraft; Weight and balance control of an aircraft; Provision of first aid kits & Physician's kit in an aircraft; Use furnishing materials in an aircraft; Concessions; Aircraft log books; Document to be carried on board on Indian registered aircraft; Procedure for issue of tax permit; Procedure for issue of type approval of aircraft components and equipment including instruments.

7 Hours

TEXT BOOK:

1. "Civil Aviation Requirements with latest Amendment (Section 2 Airworthiness)" – Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi 2000.

REFERENCE BOOK:

1. "Aircraft Manual (India) Volume" – Latest Edition, The English Book Store, 17-1, Connaught Circus, New Delhi.

GUIDANCE AND NAVIGATION

Subject Code	: **06AE842**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

1. INTRODUCTION

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

6 Hours

2. 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)

7 Hours

3. TRACKING WITH RADAR

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

6 Hours

4. OTHER GUIDANCE SYSTEMS

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

7 Hours

PART - B

5. TRANSFER FUNCTIONS

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

6 Hours

6. 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.

7 Hours

7. MISSILE GUIDANCE

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

6 Hours

8. 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

7 Hours

TEXT BOOKS:

1. Merrilh I. Skolnik,` Introduction to Radar Systems`, 3rd edition, Tata Mc Graw Hill , 2001.
2. John H Blakelock,` Automatic control of Aircraft & Missiles`, Wile –Inter Science Publication, 2nd edition, May 1990.

REFERENCE BOOK:

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

MANAGEMENT INFORMATION SYSTEMS

Subject Code	: **06AE843**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

FOUNDATION CONCEPTS: Foundations of Information Systems in Business Information System and Technologies, Business applications, developments and management, competing with Information Technology using Information Technology for strategic advantage.

7 Hours

UNIT - 2

REVIEW OF INFORMATION TECHNOLOGIES: Computer Hardware – computer systems, end user and enterprise computing, computer peripherals, input, output, and storage technologies, Computer Software-application software, end user application, system software, computer system management.

6 Hours

UNIT - 3

DATA RESOURCE MANAGEMENT: Managing Data Resources, Technical foundations of Database Management, Telecommunication and Networks – overview of telecommunications and networks, technical telecommunications alternatives.

6 Hours

UNIT - 4

BUSINESS APPLICATIONS: The Internet worked E. business Enterprise The Internet, Intranets and Extranets in Business, Enterprises Communication and Collaboration, Electronic Business Systems, Cross Functional E-Business systems, Functional E-Business systems, Electronic Commerce systems, Electronics commerce fundamentals, commerce applications and Issues.

7 Hours

PART - B

UNIT - 5

BUSINESS DECISION: E –Business Decision Supports Systems for decision support, executive support systems, group decision support system, Artificial Intelligence Technologies in Business

6 Hours

UNIT - 6

DEVELOPMENT PROCESSES: Developing E-Business strategies, E-Business planning fundamentals, implementing E-Business strategies, Developing E-Business solutions – Developing E-Business systems, Implementing E-Business systems.

7 Hours

UNIT - 7

MANAGEMENT CHALLENGES: Security and Ethical challenges of E-Business – Security, Ethical and Societal challenges of E-Business, security management of E –Business, Enterprise and Global management of E-Business Technology – Managing E-Business Technologies, Global E-Business, Technology Management.

7 Hours

UNIT - 8

MANAGING GLOBAL SYSTEMS: Growth of International Information Systems, Organizing International Information Systems, Managing Global systems, Off/Outsourcing, Global Value chain, Case Studies

6 Hours

TEXT BOOKS:

2. **Management Information Systems,** Managing information Technology in the Internet Worked Enterprise, Jams, A O'Braien - McGraw Hillpublishing company Ltd., 2002. 5th edition ISBN 0-07048637-9
3. **Managing information systems,** W.S.Jawadekar,Tata McGraw Hillpulbishing Co. Ltd., New Delhi 1998. ISBN 0-07-463197-9

REFERENCE BOOKS:

1. **Mangement Information Systems,** Laudon & Laudon, PHI 1998 Ed. ISBN 81-203-1282-1
2. **Managaement Information systems,** S.Sadagopan, Prentice Hall of India, 1998 Ed. ISBN 81-203-1180-9
3. **Information sytems for Modern managaement** G.R.Murdick PHI 2002.

PROJECT MANAGEMENT

Subject Code	: **06AE844**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

CONCEPTS OF PROJECT MANAGEMENT: Concepts of a Project, Categories of projects, Phases of project life cycle, Roles and responsibilities of project leader, tools and techniques for project management.

5 Hours

UNIT - 2

PROJECT PLANNING AND ESTIMATING: Feasibility report, phased Planning, Project planning steps, Objectives and goals of the project, preparation of cost estimation, evaluation of the project profitability.

7 Hours

UNIT - 3

ORGANIZING AND STAFFING: The Project Team: Skills / abilities required for project manager, Authorities and responsibilities of project manager, Project organization and types, Accountability in project execution, controls, tendering and selection of contractors

7 Hours

UNIT - 4

PROJECT SCHEDULING: Project implementation scheduling, different scheduling techniques-bar (GANTT) charts, Bar charts for combined activities. Project Evaluation and Review Techniques (PERT) planning. Simple Numerical Problems.

7 Hours

PART - B

UNIT - 5

CO-ORDINATION AND CONTROL: Project direction co-ordination; and communication in a project, Role of MIS in project control, performance control, schedule control, cost Control Examples.

7 Hours

UNIT - 6

PERFORMANCE MEASURES IN PROJECT MANAGEMENT:

Performance indicators, Performance improvement for the CM & DM companies for better project management.

7 Hours

UNIT - 7

CLOSING OF PROJECT: Types of project termination, strategic implications, project in trouble, termination strategies, evaluation of termination possibilities

6 Hours

UNIT - 8

PROJECT INVENTORY MANAGEMENT: Nature of project inventory, supply and transportation of materials.

6 Hours

TEXT BOOKS:

1. **Project Management A System approach to Planning Scheduling & Controlling,** Harold Kerzner, CBS Publishers and Distributors.2002
2. **Project Management:** Beningston Lawrence- Mc-Graw hill 1970

REFERENCE BOOKS:

1. **Project Management with PERT and CPM,** Moder Joseph and Phillips Cerel R., 2nd edition, New York V-AN Nostrand, Reinhold-1976.
2. **Project planning, Scheduling & control,** James P. Lewis, Meo Publishing company. 2001
3. **Project Management,** Bhavesh M Patel, Vikas Publishing House, ISBN 81-259-0777-7 2002

PRODUCT DESIGN AND MANUFACTURING

Subject Code	: **06AE845**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION TO PRODUCT DESIGN: Asimow's model: Definition of product design, Design by Evolution, Design by Innovation, Essential Factors of Product design, Production-Consumption Cycle, Flow and Value Addition in the Production-Consumption Cycle, The Morphology of Design (The seven phases), Primary Design Phases and Flowcharting, Role of Allowance, Process Capability and Tolerance in Detailed Design & Assembly.

6 Hours

UNIT - 2

PRODUCT DESIGN PRACTICE AND INDUSTRY: Introduction, Product Strategies, Time to Market, Analysis of the Product, The S's Standardization, Renard Series, Simplification, Role of Aesthetics in Product Design, Functional Design Practice.

6 Hours

UNIT - 3

REVIEW OF STRENGTH, STIFFNESS AND RIGIDITY CONSIDERATIONS IN PRODUCT DESIGN: Principal Stress Trajectories (Force-Flow Lines), Balanced Design, Criteria and Objectives of Design, Material Toughness: Resilience Designing for Uniform Strength, Tension vis-a-vis Compression. Review of Production Process: Introduction, Primary Processes, Machining Process, Non-traditional Machining Processes.

7 Hours

UNIT - 4

DESIGN FOR PRODUCTION – METAL PARTS: Producibility requirements in the Design of machine Components, Forging Design, Pressed components Design, Casting Design, and Design for Machining Ease, The Role of Process Engineer, Ease of Location Casting and Special Casting. Designing with Plastic, rubber, ceramics and wood: Approach to design with plastics, plastic bush bearings, gears in plastics, rubber parts, design recommendations for rubber parts, ceramic and glass parts.

7 Hours

PART - B

UNIT - 5

OPTIMIZATION IN DESIGN: Introduction, Siddal's Classification of Design Approaches, Optimization by Differential Calculus, Lagrange Multipliers, Linear Programming (Simplex Method), Geometric Programming, Johnson's Method of Optimum Design.

6 Hours

UNIT - 6

ECONOMIC FACTOR INFLUENCING DESIGN: Product Value, Design for Safety, Reliability and Environmental Considerations, Manufacturing Operations in relation to Design, Economic Analysis, Profit and Competitiveness, Break – even Analysis, Economic of a New Product Design.

6 Hours

UNIT - 7

HUMAN ENGINEERING CONSIDERATIONS IN PRODUCT DESIGN: Introduction, Human being as Applicator of Forces, Anthropometry; Man as occupant of Space, The Design of Controls, of controls, the Design of Displays, Man/Machine Information Exchange.

6 Hours

UNIT - 8

VALUE ENGINEERING AND PRODUCT DESIGN: Introduction, Historical Perspective, What is Value? Nature and Measurement of Value, Normal Degree of Value, Importance of Value, The Value analysis Job Plan, Creativity, Steps to Problems-solving and Value Analysis, Value Analysis Test, Value Engineering Idea Generation Check-list Cost Reduction through value engineering case study on Tap Switch Control Assembly, Material and Process Selection in Value Engineering

Modern Approaches to Product Design: Concurrent Design and Quality Function Deployment (QFD).

8 Hours

TEXT BOOKS:

1. **Product Design and Manufacturing,** A.C. Chitale and R.C. Gupta, PHI 4th edition 2007.
2. **Product Design & Development,** Karl T. Ulrich & Steven D, Epinger, Tata Mc. Graw Hill, 3rd Edition, 2003

REFERENCE BOOKS:

1. **New Product Development,** Tim Jones, Butterworh Heinmann, Oxford, mc 1997.
2. **New Product Development:** Design & Analysis by Roland Engene Kinetovicz, John Wiley and Sosn Inc., N.Y. 1990.

ARTIFICIAL INTELLIGENCE

Subject Code	: **06AE846**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

ARTIFICIAL INTELLIGENCE: Introduction, definition, underlying assumption, importance f A1, AI and related fields.

6 Hours

UNIT - 2

SPACE REPRESENTATION: Defining a problem. Production systems and its characteristics, Search and Control strategies – Generate and Test, Hill Climbing, Best – first Search, Problem reduction, Constraint Satisfaction, Means – Ends Analysis.

7 Hours

UNIT - 3

KNOWLEDGE REPRESENTATION ISSUES: Representations and Mappings, Types of knowledge – Procedural Vs Declarative, Logic programming. Forward Vs Backward reasoning, Matching.

7 Hours

UNIT - 4

USE OF PREDICATE LOGIC: Representing simple facts, Instance and Isa relationships, Syntax and Semantics for Prepositional logic, FQPL and properties of Wffs, Conversion to Clausal form, Resolution, Natural deduction.

6 Hours

PART - B

UNIT - 5

STATISTICAL AND PROBABILISTIC REASONING: Symbolic reasoning under uncertainty, Probability and Bayes' theorem, Certainity factors and Rule based systems, Bayesian Networks, Shafer Theory, Fuzzy Logic.

7 Hours

UNIT - 6

EXPERT SYSTEMS: Structure and uses, Representing and using domain knowledge, Expert System Shells. Pattern recognition Learning classification patterns, recognizing and understanding speech. Introduction to knowledge Acquisition, Types of Learning.

7 Hours

UNIT - 7

TYPICAL EXPERT SYSTEMS: MYCIN, Variants of MYCIN, PROSPECTOR, DENDRAL, PUFF, ETC.

6 Hours

UNIT - 8

INTRODUCTION TO MACHINE LEARNING: Perceptrons, Checker Playing Examples, Learning Automata, Genetic Algorithms, Intelligent Editors.

6 Hours

TEXT BOOKS:

1. **Artificial Intelligence,** Elaine Rich & Kevin Knight, M/H 1983.
2. **Introduction to AI & ES,** Dan W. Patterson, Prentice Hall of India, 1999.

REFERENCE BOOKS:

1. **Principles of Artificial Intelligence**, Springer Verlag, Berlin, 1981.
2. **Artificial Intelligence in business, Science & Industry**, Wendy B. Ranch
3. **A guide to expert systems,** Waterman, D.A., Addison – Wesley inc. 1986

4. **Building expert systems,** Hayes, Roth, Waterman, D.A. Addison – Wesley, 1983

COMPUTER INTEGRATED MANUFACTURING

Subject Code	: **06AE847**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

UNIT - 1

COMPUTER INTEGRATED MANUFACTURING SYSTEMS: Introduction, Automation definition, Types of automation, CIM, processing in manufacturing, Production concepts, Mathematical Models-Manufacturing lead time, production rate, components of operation time, capacity, Utilization and availability, Work-in-process, WIP ratio, TIP ratio, Problems using mathematical model equations.

8 Hours

UNIT - 2

HIGH VOLUME PRODUCTION SYSTEM: Introduction Automated flow line-symbols, objectives, Work part transport-continuous, Intermittent, synchronous, Pallet fixtures, Transfer Mechanism-Linear-Walking beam, roller chain drive, Rotary-rack and pinion, Rachet & Pawl, Geneva wheel, Buffer storage, control functions-sequence, safety, Quality, Automation for machining operation.

6 Hours

UNIT - 3

ANALYSIS OF AUTOMATED FLOW LINE & LINE BALANCING: General terminology and analyisis, Analysis of Tranfer Line without storage-upper bound approach, lower bound approach and problems, Analysis of Transfer lines with storage buffer, Effect of storage, buffer capacity with simple problem, Partial automation-with numerical problems, flow lines with more than two stages, Manual Assembly lines, line balancing problem.

6 Hours

UNIT - 4

MINIMUM RATIONAL WORK ELEMENT: Work station process time, Cycle time, precedence constraints. Precedence diagram, Balance delay methods of line balancing-largest Candidate rule, Kilbridge and Westers method, Ranked positional weight method, Numerical problems covering above methods and computerized line balancing.

6 Hours

PART - B

UNIT - 5

AUTOMATED ASSEMBLY SYSTEMS: Design for automated assembly systems, types of automated assembly system, Parts feeding devices-elements of parts delivery system-hopper, part feeder, Selectors, feed back, escapement and placement analysis of Multistation Assembly Machine analysis of single station assembly.

Automated Guided Vehicle System: Introduction, Vehicle guidance and routing, System management, Quantitative analysis of AGV's with numerical problems and application.

8 Hours

UNIT - 6

COMPUTERIZED MANUFACTURING PLANNING SYSTEM: Introduction, Computer Aided Process Planning, Retrieval types of process planning, Generative type of process planning, Material requirement planning, Fundamental concepts of MRP inputs to MRP, Capacity planning.

6 Hours

UNIT - 7

CNC MACHINING CENTERS: Introduction to CNC, elements of CNC, CNC machining centers, part programming, fundamental steps involved in development of part programming for milling and turning.

6 Hours

UNIT - 8

ROBOTICS: Introduction to Robot configuration, Robot motion, programming of Robots end effectors, Robot sensors and Robot applications. [This is required for CIM automation lab 06MEL77]

6 Hours

TEXT BOOKS:

1. **Automation, Production system & Computer Integrated manufacturing,** M. P. Groover" Person India, 2007 2nd edition.
2. **Principles of Computer Integrated Manufacturing,** S. Kant Vajpayee, Prentice Hall India.

REFERENCE BOOKS:

1. **Computer Integrated Manufacturing,** J. A. Rehg & Henry. W. Kraebber.
2. **CAD/CAM by Zeid,** Tata McGraw Hill.

AIRCRAFT SYSTEMS AND INSTRUMENTATION

Subject Code	: **06AE848**	IA Marks	: 25
No. of Lecture Hrs/Week	: 04	Exam Hours	: 03
Total no. of Lecture Hrs.	: 52	Exam Marks	: 100

PART - A

1. FLIGHT CONTROL SYSTEMS

Primary and secondary flight controls. Flight control linkage system. Conventional Systems, Power assisted and fully powered flight controls. Power control unit – Mechanical, Electro-hydraulic. Advanced actuation concepts.

6 Hours

2. MECHANICAL SYSTEMS

Hydraulic fluid. Hydraulic system and components. Study of typical workable system. Power packs. Hydraulic actuators.

Pneumatic system and components. Use of bleed air. Emergency lowering of landing gear and braking. Shock absorbers - Retraction mechanism.

7 Hours

3. AIRCRAFT FUEL AND ENGINE SYSTEMS

Characteristics of aircraft fuel system. Gravity feed and pressure feed. A generalized fuel system. Fuel pumps-classification. Fuel control unit. Engine starting sequence. Starting and Ignition systems.

Engine oils and a typical lubricating system.

7 Hours

4. ENVIRONMENTAL CONTROL AND EMERGENCY SYSTEMS

Air-conditioning system, vapour cycle system, deicing and anti-icing system. Fire detection- warning and suppression. Crew escape aids.

6 Hours

PART - B

5. AIRCRAFT INSTRUMENTS

Instruments displays, panels & layouts. Instrumentation grouping. Navigation instruments, Radio instruments . Hydraulic and Engine instruments

6 Hours

6. AIR DATA INSTRUMENTS

Basic air data system and probes. Mach meter, Air speed indicator, Vertical speed indicator. Barometric pressure sensing. Altimeter. Air data alerting system- angle of attack sensing, stall warning, Mach warning, altitude alerting system.

7 Hours

7. GYROSCOPIC FLIGHT INSTRUMENTS

The gyroscope and its properties. Limitations of a free gyroscope. Drift. Gyroscopic flight. Instruments -Pneumatic, and Electric. Direction indicator, Turn and Bank Indicator.

7 Hours

8. ENGINE INSTRUMENTS

Study of various types of engine instruments- RPM, Pressure, Temperature, Fuel flow, Fuel quantity, and vibrations.

6 Hours

TEXT BOOKS:

1. Ian Moir and Allan Seabridge,` Aircraft Systems: Mechanical, Electrical and Avionics-Subsystem Integration`, AIAA Educational Series, 2001.
2. Pallet, E.H.J., "Aircraft Instruments and Integrated Systems", Longman Scientific and Technical, Indian reprint 1996.
3. William A Neese, `Aircraft Hydraulic Systems`, Himalayan Books; 2007.

REFERENCE BOOKS:

1. Lalit Gupta and O P Sharma, `Aircraft Systems (Fundamentals of Flight Vol. IV)`, Himalayan Books; 2006.
2. Treager, S., "Gas Turbine Technology", McGraw-Hill, 1997.
3. R. W. Sloley and W. H. Coulthard,` The aircraft Engineers Handbook, No4, INSTRUMENTS', Sterling Book House, 6th Edition, 2005.
4. S R Majumdar,` Pneumatic Systems`, Tata McGraw Hill Publishing Co.; 1995.