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Total: 21 09 24 200 700 900

*Note: Student opted for subjects with code A in III semester, shall opt for Subjects with Code B in IV semester

Note: One question has to be set for every unit (6 to 8 hours of teaching).
### SCHEME OF TEACHING AND EXAMINATION

(COMMON TO ME/IP/IM/AU/MA/AE)

**IV SEMESTER**

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*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

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

### Subject Code

*Elective I (Group A)*

- 10AE661: Numerical Methods
- 10AE662: Aircraft Materials
- 10AE663: Combustion
- 10AE664: Reliability Engineering
- 10AE665: Industrial Management
- 10AE666: Rockets and Missiles

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

**Note:** One question has to be set for every unit (6 to 8 hours of teaching).
### SCHEME OF TEACHING AND EXAMINATION
#### B.E. AERONAUTICAL ENGINEERING
#### VII SEMESTER

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

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* Students shall register for one subject each from Group B and C Electives
### SCHEME OF TEACHING AND EXAMINATION
**B.E. AERONAUTICAL ENGINEERING**
**VIII SEMESTER**

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

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* Students shall register for one subject each from Group D and E Electives.
## III SEMESTER
ENGINEERING MATHEMATICS-III

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### PART-A

#### Unit-I: FOURIER SERIES
Convergence and divergence of infinite series of positive terms, definition and illustrative examples*
Periodic functions, Dirichlet’s conditions, Fourier series of periodic functions of period $2\pi$ and arbitrary period, half range Fourier series. Complex form of Fourier Series. Practical harmonic analysis.  

* [7 hours]

#### Unit-II: FOURIER TRANSFORMS
Infinite Fourier transform, Fourier Sine and Cosine transforms, properties, Inverse transforms

* [6 hours]

#### Unit-III: APPLICATIONS OF PDE
Various possible solutions of one dimensional wave and heat equations, two dimensional Laplace? equation by the method of separation of variables, Solution of all these equations with specified boundary conditions. D?lembert? solution of one dimensional wave equation.

* [6 hours]

#### Unit-IV: CURVE FITTING AND OPTIMIZATION
Curve fitting by the method of least squares- Fitting of curves of the form $y=ax+b$; $y=ax^2+bx+c$; $y=ae^{bx}$; $y=ax^b$  
Optimization: Linear programming, mathematical formulation of linear programming problem (LPP), Graphical method and simplex method.

* [7 hours]

### PART-B

#### Unit-V: NUMERICAL METHODS - 1

* [6 hours]
Unit-VI: NUMERICAL METHODS 2
Finite differences: Forward and backward differences, Newton’s forward and backward interpolation formulae. Divided differences - Newton’s divided difference formula, Lagrange’s interpolation formula and inverse interpolation formula.
Numerical integration: Simpson’s one-third, three-eighth and Weddle’s rules (All formulae/rules without proof) \[7\text{ hours}\]

Unit-VII: NUMERICAL METHODS 3
Numerical solutions of PDE finite difference approximation to derivatives, Numerical solution of two dimensional Laplace’s equation, one dimensional heat and wave equations \[7\text{ hours}\]

Unit-VIII: DIFFERENCE EQUATIONS AND Z-TRANSFORMS
Difference equations: Basic definition; Z-transforms definition, standard Z-transforms, damping rule, shifting rule, initial value and final value theorems. Inverse Z-transform. Application of Z-transforms to solve difference equations. \[6\text{ hours}\]

Note: * In the case of illustrative examples, questions are not to be set.

TEXT BOOKS:

REFERENCE BOOK:
2 Peter V. O’eil, Engineering Mathematics, CENGAGE Learning India Pvt Ltd. Publishers
MATERIAL SCIENCE AND METALLURGY

PART - A

UNIT - 1
Crystal Structure: BCC, FCC and HCP Structures, coordination number and atomic packing factors, crystal imperfections - point line and surface imperfections. Atomic Diffusion: Phenomenon, Fick’s laws of diffusion, factors affecting diffusion. 06 Hours

UNIT - 2
Mechanical Behaviour: Stress-strain diagram showing ductile and brittle behaviour of materials, linear and non linear elastic behaviour and properties, mechanical properties in plastic range, yield strength offset yield strength, ductility, ultimate tensile strength, toughness. Plastic deformation of single crystal by slip and twinning. 06 Hours

UNIT - 3
Fracture: Type I, Type II and Type III. Creep: Description of the phenomenon with examples. three stages of creep, creep properties, stress relaxation. Fatigue: Types of fatigue loading with examples, Mechanism of fatigue, fatigue properties, fatigue testing and S-N diagram. 07 Hours

UNIT - 4
Solidification: Mechanism of solidification, Homogenous and Heterogeneous nucleation, crystal growth, cast metal structures. Phase Diagram I: Solid solutions Hume Rothary rule substitutional, and interstitial solid solutions, intermediate phases, Gibbs phase rule. 07 Hours

PART - B

UNIT - 5
Phase Diagram II: Construction of equilibrium diagrams involving complete and partial solubility, lever rule. Iron carbon equilibrium diagram description of phases, solidification of steels and cast irons, invariant reactions. 06 Hours

UNIT - 6
Heat treating of metals: TTT curves, continuous cooling curves, annealing and its types. normalizing, hardening, tempering, martempering, austempering,
hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening, age hardening of aluminium-copper alloys.  

UNIT - 7
Ferrous and non ferrous materials: Properties, Composition and uses of
- Grey cast iron, malleable iron, SG iron and steel
- Copper alloys-brasses and bronzes.
  Aluminium alloys-Al-Cu, Al-Si, Al-Zn alloys.

UNIT - 8
Composite Materials: Definition, classification, types of matrix materials & reinforcements, fundamentals of production of FRP sand MMC’s advantages and application of composites.

TEXT BOOKS:

REFERENCE BOOKS:
2. Engineering Materials Science, W.C.Richards, PHI, 1965
3. Physical Metallurgy; Lakhtin, Mir Publications
PART- A

UNIT-1:
Standards of measurement: Definition and Objectives of metrology, Standards of length—International prototype meter, Imperial standard yard, Wave length standard, subdivision of standards, line and end standard, calibration of end bars (Numerical), Slip gauges, Wringing phenomena, Indian Standards (M-81, M-12), Numerical problems on building of slip gauges.  

06 Hours

UNIT-2:
System of Limits, Fits, Tolerance and Gauging: Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly limits of size, Indian standards, concept of limits of size and tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation (IS 919-1963), geometrical tolerance, positional-tolerances, hole basis system, shaft basis system, classification of gauges, brief concept of design of gauges (Taylor’s principles), Wear allowance on gauges, Types of gauges—plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials.

07 Hours

UNIT-3:
Comparators and Angular measurement: Introduction to comparators, characteristics, classification of comparators, mechanical comparators—Johnson Mikrokator, sigma comparators, dial indicator, optical comparators—principles, Zeiss ultra optimeter, electric and electronic comparators—principles, LVDT, pneumatic comparators, back pressure gauges, solex comparators. Angular measurements, bevel protractor, sine principle and use of sine bars, sine centre, use of angle gauges (numericals on building of angles), clinometers.

07 Hours

UNIT-4:
Interferometer and screw thread, gear measurement: Interferometer, interferometry, autocollimator. Optical flats. Terminology of screw threads, measurement of major diameter, minor diameter, pitch, angle and effective diameter of screw threads by 2-wire and 3-wire methods, best size wire. Tool maker’s microscope, gear tooth terminology, use of gear tooth vernier caliper and micrometer.

06 Hours
PART-B

UNIT-5:
Measurements and measurement systems: Definition, significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response-times delay. Errors in measurement, classification of errors. Transducers, transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers, advantages of each type transducers. 07 Hours

UNIT-6:
Intermediate modifying and terminating devices: Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, ballast circuit, electronic amplifiers and telemetry. Terminating devices, mechanical, cathode ray oscilloscope, oscillographs, X-Y plotters. 06 Hours

UNIT-7:
Measurement of force, torque and pressure: Principle, analytical balance, platform balance, proving ring. Torque measurement, Prony brake, hydraulic dynamometer. Pressure measurements, principle, use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge. 06 Hours

UNIT-8:
Temperature and strain measurement: Resistance thermometers, thermocouple, law of thermo couple, materials used for construction, pyrometer, optical pyrometer. Strain measurements, strain gauge, preparation and mounting of strain gauges, gauge factor, methods of strain measurement. 07 Hours

TEXT BOOKS:

REFERENCE BOOKS:
BASIC THERMODYNAMICS

Sub Code : 10ME33 IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART-A

UNIT - 1
Fundamental Concepts & Definitions: Thermodynamics definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, intensive and extensive properties. Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic preesses; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics, Temperature; concepts, scales, fixed points and measurements. 06 Hours

UNIT - 2
Work and Heat: Mechanics, definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. Other types of work. Heat; definition, units and sign convention. 06 Hours

UNIT - 3
First Law of Thermodynamics: Joules expriments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy, pure substance; definition, two-property rule, Specific heat at constant volume, enthalpy , specific heat constant pressure. Extension of the First law to control volume; steady state-steady flow energy equation, important applications, analysis of unsteady processes such as filming and evacuation of vessels with and without heat transfer. 07 Hours

UNIT - 4
Second Law of Thermodynamics: Devices converting heat to work; (a) in a thermodynamic cycle, (b) in a mechanical cycle. Thermal reservoir. Direct heat engine; schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle; reversed heat engine, schematic representation, coefficients of performace. Keivin - Planck statement of the Secend law of Thermodynamics; PMM I and PMM II, Clasius statement of Second law of
Thermodynamics: Equivalence of the two statements; Reversible and irreversible processes; factors that make a process irreversible, reversible heat engines, Carnot cycle, Carnot principles.  

**PART-B**

**UNIT - 5**

Entropy: Clasius inequality; Statement, proof, application to a reversible cycle. Entropy; definition, a property, change of entropy, principle of increase in entropy, entropy as a qualitative test for irreversibility, calculation of entropy using Tds relations, entropy as a coordinate. Available and unavailable energy.  

07 Hours

**UNIT - 6**

Pure Substances: P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams. Steam tables and its use. Throttling calorimeter, separating and throttling calorimeter.  

06 Hours

**UNIT - 7**

Thermodynamic relations: Maxwell relation, Causius Clayperon’s equation. Ideal gas; equation of state, internal energy and enthalpy as functions of temperature only, universal and particular gas constants, specific heats, perfect and semi-perfect gases. Evaluation of heat, work, change in internal energy, enthalpy and entropy in various quasi-static processes.  

07 Hours

**UNIT - 8**

Ideal gas mixture: Ideal gas mixture; Dalton’s laws of partial pressures, Amagat’s law of additive volumes, evaluation of properties, Analysis of various process. Real Gases: Introduction. Van-der Waal’s Equation of state, Van-der Waal’s constants in terms of critical properties, Law of corresponding states, compressibility factor; compressibility chart  

06 Hours

**Data Handbooks:**


**TEXT BOOKS:**

REFERENCE BOOKS:
5. B.K Venkanna, Swati B. Wadavadagi “Basic Thermodynamics, PHI, New Delhi, 2010

MECHANICS OF MATERIALS

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PART-A

UNIT 1:
**Simple Stress and Strain:** Introduction, Stress, strain, mechanical properties of materials, Linear elasticity, Hooke’s Law and Poisson’s ratio, Stress-Strain relation - behaviour in tension for Mild steel, cast iron and non ferrous metals. Extension / Shortening of a bar, bars with cross sections varying in steps, bars with continuously varying cross sections (circular and rectangular), Elongation due to self weight, Principle of super position. **07 Hours**

UNIT 2:
**Stress in Composite Section:** Volumetric strain, expression for volumetric strain, elastic constants, simple shear stress, shear strain, temperature stresses (including compound bars). **06 Hours**

UNIT 3:
**Compound Stresses:** Introduction, Plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, Mohr’s circle for plane stress. **07 Hours**

UNIT 4:
**Energy Methods:** Work and strain energy, Strain energy in bar/beams, Castiglianos theorem, Energy methods. **06 Hours**

**Thick and Thin Cylinder** Stresses in thin cylinders, changes in dimensions of cylinder (diameter, length and volume). Thick cylinders Lame’s equation (compound cylinders not included). **06 Hours**
PART-B

UNIT 5:
**Bending Moment and Shear Force in Beams**: Introduction, Types of beams, loads and reactions, shear forces and bending moments, rate of loading, sign conventions, relationship between shear force and bending moments. Shear force and bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load, (UDL) uniformly varying load (UVL) and couple for different types of beams. 07 Hours

UNIT 6:

UNIT 7:
**Deflection of Beams**: Introduction, Differential equation for deflection. Equations for deflection, slope and bending moment. Double integration method for cantilever and simply supported beams for point load, UDL, UVL and Couple. Macaulay’s method 06 Hours

UNIT 8:
**Torsion of Circular Shafts and Elastic Stability of Columns**:
Introduction. Pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts. Power transmitted by solid and hollow circular shafts

**Columns**: Euler’s theory for axially loaded elastic long columns. Derivation of Euler’s load for various end conditions, limitations of Euler’s theory, Rankine’s formula. 06 Hours

**TEXT BOOKS**:
REFERENCE BOOKS:

MANUFACTURING PROCESSES

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PART- A

Unit 1 06 Hrs
Patterns: Definition, functions, Materials used for pattern, various pattern allowances and their importance. Classification of patterns.
Binder: Definition, Types of binder used in moulding sand.
Additives: Need, Types of additives used.

Unit 2 07 Hrs
Sand Moulding: Types of base sand, requirement of base sand. Types of sand moulds.
Sand moulds: Moulding sand mixture ingredients (base sand, binder & additives) for different sand mixtures. Method used for sand moulding.

Unit 3 07 Hrs
Moulding machines: Jolt type; squeeze type, Jolt & Squeeze type and Sand slinger. Special moulding Process: Study of important moulding processes
Green sand, Core sand, Dry sand, Sweep mould, CO₂ mould, Shell mould, Investment mould.

**Metal moulds**: Gravity die-casting, Pressure die-casting, centrifugal casting, Squeeze Casting, Slush casting, Thixocasting and continuous casting processes

**Unit 4**: 06 Hrs

**Welding**

**Welding process**: Definition, Principles, Classification, Application, Advantages & limitations of welding.

**Gas Welding**: Principle, Oxy – Acetylene welding, Reaction in Gas welding, Flame characteristics, Gas torch construction & working. Forward and backward welding.

**Arc Welding**: Principle, Metal Arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG)

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**PART-B**

**Unit 5**: 06 Hrs

**Principles of soldering & brazing**: Parameters involved & Mechanism. Different Types of Soldering & Brazing Methods


**Unit 6**: 07 Hrs

**Theory of metal cutting**: Single point cutting tool nomenclature, geometry of single point cutting tool. Merchant’s circle diagram and analysis, Ernst-Merchant’s solution, Shear angle relationship, Problems on Merchant’s analysis, Tool wear & tool failure, Tool life, Effects of cutting parameters on tool life, Tool’s failure criteria, Taylor’s tool life equation, Problems on tool life evaluation.

**Unit 7**: 07 Hrs


**Unit 8**: 06 Hrs

**Non-Traditional Machining Process**: Principle, need, equipment, operation and applications of LBM, Plasma Arc Machining, Electro chemical machining, Ultrasonic Machining, Abrasive jet machining, Water jet machining
Text Books:

Reference Books:

Scheme of examination:
One Question to be set from each chapter. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

COMPUTER AIDED MACHINE DRAWING

**Introduction:**
Review of graphic interface of the software. Review of basic sketching commands and navigational commands. Starting a new drawing sheet. Sheet sizes. Naming a drawing, Drawing units, grid and snap. **02 Hours**

**PART-A**

**UNIT 1:**
**Sections of Solids:** Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on, axis inclinations, spheres and hollow solids). True shape of sections.

**Orthographic Views:** Conversion of pictorial views into orthographic projections. of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines. **08 Hours**
UNIT 2:
Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw. 08 Hours

UNIT 3:
Keys & Joints:
Parallel key, Taper key, Feather key, Gibhead key and Woodruff key
Riveted Joints: Single and double riveted lap joints, butt joints with single/ double cover straps (Chain and Zigzag, using snap head rivets). cotter joint (socket and spigot), knuckle joint (pin joint) for two rods. 08 Hours

UNIT 4:
Couplings:
Split Muff coupling, Protected type flanged coupling, pin (bush) type flexible coupling, Oldham’s coupling and universal coupling (Hooks’ Joint) 08 Hours

PART - C
Assembly Drawings
(Part drawings should be given)
1. Plummer block (Pedestal Bearing)
2. Rams Bottom Safety Valve
3. I.C. Engine connecting rod
4. Screw jack (Bottle type)
5. Tailstock of lathe
6. Machine vice
7. Tool Head of a shaper 18 Hours

Text Books:
2. ‘Machine Drawing’, N.D.Bhat & V.M.Panchal

Reference Books:
4. ‘Auto CAD 2006, for engineers and designers’, Sham Tickoo. Dream tech 2005

NOTE:
Internal assessment: 25 Marks
All the sheets should be drawn in the class using software. Sheet sizes should be A3/A4. All sheets must be submitted at the end of the class by taking printouts.

Scheme of Examination:
Two questions to be set from each Part-A, Part-B and Part-C
Student has to answer one question each from Part-A and Part-B for 20 marks each. And one question from Part-C for 60 marks.

i.e. PART-A 1 x 20 = 20 Marks
PART-B 1 x 20 = 20 Marks
PART-C 1 x 60 = 60 Marks
Total = 100 Marks

FLUID MECHANICS
Sub Code : 10ME36B/10ME46B IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART – A

UNIT-1
Properties of Fluids: Introduction, Types of fluid, Properties of fluids, viscosity, thermodynamic properties, surface tension, capillarity, vapour pressure and cavitation 06 Hours

UNIT-2
Fluid Statistics: Fluid pressure at a point, Pascal’s law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple manometers and differential manometers. Total pressure and center of pressure on submerged plane surfaces; horizontal, vertical and inclined plane surfaces, curved surface submerged in liquid. 07 Hours
UNIT-3
Buoyancy and Fluid Kinematics:
Buoyancy, center of buoyancy, metacentre and metacentric height, conditions of equilibrium of floating and submerged bodies, determination of Metacentric height experimentally and theoretically.

Kinematics: Types of fluid flow, continuity equation in 2D and 3D (Carversian Co-ordinates only, velocity and acceleration, velocity potential function and stream function. 07 Hours

UNIT-4
Fluid Dynamics: Introduction equation of motion, Euler’s equation of motion, Bernoulli’s equation from first principles and also from Euler’s equation, limitations of Bernoulli’s equation. 06 Hours

PART-B
UNIT-5
Dimensional Analysis: Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh’s method, Buckingham \( \pi \) theorem, dimensionless numbers, similitude, types of similitudes. 07 Hours

UNIT-6
Flow through pipes: Minor losses through pipes. Darey’s and Chezy’s equation for loss of head due to friction in pipes. HGL and TEL. 06 Hours

UNIT-7
Laminar flow and viscous effects: Reynolds’ number, critical Reynolds’ number, laminar flow through circular pipe-Hagen Poiseille’s equation, laminar flow between parallel and stationary plates. 06 Hours

UNIT-8
Flow past immersed bodies: Drag, Lift, expression for lift and drag, boundary layer concept, displacement, momentum and energy thickness.
Introduction to compressible flow: Velocity of sound in a fluid, Mach nuber, Mach cone, propagation of pressure waves in a compressible fluid. 07 Hours

Text Books:
Reference Books:
4. Fluid Mechanics and Fluid Power Engineering, Kumar D.S, Kataria and Sons., 2004

METALLOGRAPHY & MATERIAL TESTING LAB

Sub Code : 10MEL37A/10MEL47A IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART – A
3. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.
4. Non-destructive test experiments like,
   (a). Ultrasonic flaw detection
   (b). Magnetic crack detection
   (c). Dye penetration testing. To study the defects of Cast and Welded specimens

PART – B
1. Tensile, shear and compression tests of metallic and non metallic specimens using Universal Testing Machine
2. Torsion Test
3. Bending Test on metallic and nonmetallic specimens.
6. Fatigue Test.
MECHANICAL MEASUREMENTS AND METROLOGY LABORATORY

Sub Code : 10MEL37B/10MEL47B
Hrs/ Week : 03
Total Hours : 42
IA Marks : 25
Exam Hours : 03
Exam Marks : 50

PART-A: MECHANICAL MEASUREMENTS

1. Calibration of Pressure Gauge
2. Calibration of Thermocouple
3. Calibration of LVDT
4. Calibration of Load cell
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.

PART-B: METROLOGY

1. Measurements using Optical Projector / Toolmaker Microscope.
2. Measurement of angle using Sine Center / Sine bar / bevel protractor
3. Measurement of alignment using Autocollimator / Roller set
4. Measurement of cutting tool forces using
   a) Lathe tool Dynamometer
   b) Drill tool Dynamometer.
5. Measurement of Screw thread Parameters using Two wire or Three-wire method.
6. Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator
7. Measurement of gear tooth profile using gear tooth vernier /Gear tooth micrometer
8. Calibration of Micrometer using slip gauges
9. Measurement using Optical Flats

Scheme of Examination:

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<td>ONE question from part -B:</td>
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Total : 50 Marks
PART – A

1. Testing of Moulding sand and Core sand
Preparation of sand specimens and conduction of the following tests:
2. Permeability test
3. Core hardness & Mould hardness tests.
4. Sieve Analysis to find Grain Finest number of Base Sand
5. Clay content determination in Base Sand

PART – B

2. Foundry Practice
Use of foundry tools and other equipments.
Preparation of moulds using two moulding boxes using patterns or without patterns. (Split pattern, Match plate pattern and Core boxes).
Preparation of one casting (Aluminium or cast iron-Demonstration only)

PART – C

3. Forging Operations:
• Calculation of length of the raw material required to do the model.
• Preparing minimum three forged models involving upsetting, drawing and bending operations.
• Out of these three models, at least one model is to be prepared by using Power Hammer.

Scheme of Examination:
One question is to be set from Part-A: 10 marks
One question is to be set from either Part-B or Part-C: 30 marks
Calculation part in case of forging is made compulsory

| Calculation (Forging) + Foundry Model | 05 + 25 = 30 Marks |
| Calculation (Forging) + Forging Model | 05 + 25 = 30 Marks |

Viva-Voce : 10 marks.
Total : 50 Marks.
MACHINE SHOP

Sub Code : 10MEL38B/10MEL48B       IA Marks : 25
Hrs/ Week : 03                   Exam Hours : 03
Total Hours : 42                  Exam Marks : 50

PART – A
Preparation of three models on lathe involving Plain turning, Taper turning,
Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread
cutting and Eccentric turning.

PART – B
Cutting of V Groove/ dovetail / Rectangular groove using a shaper.
Cutting of Gear Teeth using Milling Machine.

Scheme of Examination:

ONE question from part -A:            30 Marks
ONE question from part -B:              10 Marks
Viva -Voice:                             10 Marks

Total : 50 Marks
IV SEMESTER
ENGINEERING MATHEMATICS-IV

Sub Code : 10MAT41 IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART-A

Unit-I: NUMERICAL METHODS - 1
Numerical solution of ordinary differential equations of first order and first
degree; Picard’s method, Taylor’s series method, modified Euler’s method,
Runge-kutta method of fourth-order. Milne’s and Adams - Bashforth predictor
and corrector methods (No derivations of formulae). [6 hours]

Unit-II: NUMERICAL METHODS – 2
Numerical solution of simultaneous first order ordinary differential equations:
Picard’s method, Runge-Kutta method of fourth-order.
Numerical solution of second order ordinary differential equations: Picard’s
method, Runge-Kutta method and Milne’s method. [6 hours]

Unit-III: Complex variables – 1
Function of a complex variable, Analytic functions-Cauchy-Riemann equations
in cartesian and polar forms. Properties of analytic functions.
Application to flow problems- complex potential, velocity potential, equipotential
lines, stream functions, stream lines. [7 hours]

Unit-IV: Complex variables – 2
Conformal Transformations: Bilinear Transformations. Discussion of
Transformations: \( w=z^2 \), \( w=e^z \), \( w=z + (a^2/z) \). Complex line integrals- Cauchy’s
theorem and Cauchy’s integral formula. [7 hours]

PART-B

Unit-V: SPECIAL FUNCTIONS
Solution of Laplace equation in cylindrical and spherical systems leading Bessel’s
and Legendre’s differential equations, Series solution of Bessel’s differential
equation leading to Bessel function of first kind. Orthogonal property of Bessel
functions. Series solution of Legendre’s differential equation leading to Legendre
polynomials, Rodrigue’s formula. [7 hours]
Unit-VI: PROBABILITY THEORY - 1
Probability of an event, emperical and axiomatic definition, probability associated with set theory, addition law, conditional probability, multiplication law, Baye’s theorem. [6 hours]

Unit-VII: PROBABILITY THEORY- 2
Random variables (discrete and continuous), probability density function, cumulative density function. Probability distributions – Binomial and Poisson distributions; Exponential and normal distributions. [7 hours]

Unit-VIII: SAMPLING THEORY
Sampling, Sampling distributions, standard error, test of hypothesis for means, confidence limits for means, student’s t-distribution. Chi -Square distribution as a test of goodness of fit [6 hours]

Text Books:

Reference Book:

APPLIED THERMODYNAMICS

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PART-A

Unit 1:

Combustion thermodynamics: Theoretical (Stoichiometric) air and excess air for combustion of fuels. Mass balance, actual combustion. Exhaust gas analysis. A./ F ratio, Energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion, Combustion efficiency, adiabatic flow temperature. 07 Hours
Unit 2:
**Gas power cycle:** Air Standard cycles: Carnot, Otto, Diesel, Dual and Stirling cycles, P-V and T-S diagrams, description, efficiencies and mean effective pressures, Comparison of Otto, Diesel and dual cycles.  **06 Hours**

Unit 3:
**I.C. Engine:** Testing of two stroke and four stroke SI and CI engines for performance Related numerical problems, heat balance, Motoring Method, Willian’s line method, swinging field dynamometer, Morse test.  **06 Hours**

Unit 4:
**Vapour Power Cycles:** Carnot vapour power cycles, drawbacks as a reference cycle, Simple Rankine cycle, description, T- S diagram, analysis for performance , comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance. Actual vapour power cycles. Ideal and practical regenerative Rankine cycle, open and closed feed water heaters, Reheat Rankine cycle.  **07 Hours**

**PART-B**

Unit 5:
**Reciprocating Compressors:** Operation of a single stage reciprocating compressors, work input through P-V diagram and steady state steady flow analysis. Effect of clearance and volumetric efficiency. Adiabatic, isothermal and mechanical efficiencies. Multistage compressor, saving in work, optimum intermediate pressure, inter- cooling, minimum work for compression.  **06 Hours**

Unit 6:
**Gas turbine and Jet propulsion:** Classification of Gas turbines, Analysis of open cycle gas turbine cycle. Advantages and disadvantages of closed cycle. Methods to improve thermal efficiency, Jet propulsion and Rocket propulsion.  **07 Hours**

Unit 7
**Refrigeration:** Vapour compression refrigeration system ; description, analysis, refrigerating effect, capacity , power required, units of refrigeration, COP , Refrigerants and their desirable properties. Air cycle refrigeration; reversed Carnot cycle, reversed Brayton cycle, Vapour absorption refrigeration system, steam jet refrigeration.  **06 Hours**

Unit 8
**Psychrometry:** Atmospheric air and psychrometric properties; Dry bulb temperature, wet bulb temperature, dew point temperature; partial pressures,
specific and relative humidities and the relation between the two enthalpy and adiabatic saturation temperature. Construction and use of psychrometric chart. Analysis of various processes; heating, cooling, dehumidifying and humidifying. Adiabatic mixing of moist air. Summer and winter air conditioning.

07 Hours

Data Hand Book:

Text Book
2. Applied Thermodynamics, Rajput, Laxmi Publication
3. Applied Thermodynamics, B.K. Venkahna, Swati B. Wadavadagi, PHI, New Delhi, 2010

Reference Books

KINEMATICS OF MACHINES

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PART - A

UNIT 1:  
**Introduction:** Definitions Link or element, kinematic pairs, Degrees of freedom, Grubler’s criterion (without derivation), Kinematic chain, Mechanism, Structure, Mobility of Mechanism, Inversion, Machine.  
**Kinematic Chains and Inversions:** Inversions of Four bar chain; Single slider crank chain and Double slider crank chain.  

07 Hours

UNIT 2:  
**Mechanisms:** Quick return motion mechanisms-Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism.  
Straight line motion mechanisms Peaucellier’s mechanism and Robert’s
mechanism. Intermittent Motion mechanisms - Geneva wheel mechanism and Ratchet and Pawl mechanism. Toggle mechanism, Pantograph, Ackerman steering gear mechanism.

UNIT 3: Velocity and Acceleration Analysis of Mechanisms (Graphical Methods)
Velocity and acceleration analysis of Four Bar mechanism, slider crank mechanism and Simple Mechanisms by vector polygons: Relative velocity and acceleration of particles in a common link, relative velocity and accelerations of coincident particles on separate links- Coriolis component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing.

UNIT 4: Velocity Analysis by Instantaneous Center Method: Definition, Kennedy’s Theorem, Determination of linear and angular velocity using instantaneous center method
Klein’s Construction: Analysis of velocity and acceleration of single slider crank mechanism.

PART - B

UNIT 5: Velocity and Acceleration Analysis of Mechanisms (Analytical Methods): Analysis of four bar chain and slider crank chain using analytical expressions. (Use of complex algebra and vector algebra)


UNIT 8: Cams: Types of cams, Types of followers. Displacement, Velocity and, Acceleration time curves for cam profiles. Disc cam with reciprocating follower having knife-edge, roller and flat-face follower, Disc cam with oscillating roller follower. Follower motions including SHM. Uniform velocity, uniform acceleration and retardation and Cycloidal motion.
Text Books:

Reference Books:

Graphical Solutions may be obtained either on the Graph Sheets or on the Answer Book itself.

ELEMENTS OF AERONAUTICS

Sub Code : 10AE45 IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART A

Unit 1 06 Hrs
Historical Developments in Aeronautical Activities:
Early air vehicles: Balloons, Biplanes and Monoplanes, Helicopters; Developments in aerodynamics, aircraft materials, aircraft structures and aircraft propulsion over the years. 06 Hrs

Aircraft Configurations:
Different types of flight vehicles and their classifications; Components of fixed wing airplane and their functions; Airfoils, wings and other shapes

Unit 3 08 Hrs
Principles of Atmospheric Flight:

Unit 4 06 Hrs
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
PART B

Unit 5 06 Hrs
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.

Unit 6 08 Hrs
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.

Unit 7 06 Hrs
Aircraft Systems: Mechanical
Description of different airplane systems and their components: Hydraulics, Pneumatic, Oxygen System, Environmental Control System, and Fuel System.

Unit 8 06 Hrs
Aircraft Systems: Electrical

Text Books:

Reference:

Scheme of Examination:
One Question is to be set from each unit. Students have to answer any FIVE FULL QUESTIONS out of EIGHT questions, choosing at least TWO questions from Part A and TWO questions from Part B.
PART – A
MANAGEMENT

UNIT - 1

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

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 (in brief):

7 Hours

PART-B
ENTREPRENEURSHIP

UNIT - 5
ENTREPRENEUR: Meaning of Entrepreneur; Evolution of the Concept; Functions of an Entrepreneur, Types of Entrepreneur, Entrepreneur - an emerging Class. Concept of Entrepreneurship - Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of

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entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship - its Barriers.

UNIT – 6
SMALL SCALE INDUSTRIES: Definition; Characteristics; Need and rationale; Objectives; Scope; role of SSI in Economic Development. Advantages of SSI Steps to start and SSI - Government policy towards SSI; Different Policies of SSI; Government Support for SSI during 5 year plans. Impact of Liberalization, Privatization, Globalization on SSI Effect of WTO/GATT Supporting Agencies of Government for SSI, Meaning, Nature of support; Objectives; Functions; Types of Help; Ancillary Industry and Tiny Industry (Definition Only)

UNIT - 7
INSTITUTIONAL SUPPORT: Different Schemes; TECKSOK; KIADB; KSSIDC; KSIMC; DIC Single Window Agency; SISI; NSIC; SIDBI; KSFC.

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.

Text Books:
2. Dynamics of Entrepreneurial Development & Management Vasant Desai - Himalaya Publishing House

Reference Books:
INTRODUCTION TO COMPOSITE MATERIALS

Sub Code : 10AE52        IA Marks : 25
Hrs/ Week : 04           Exam Hours : 03
Total Hours : 52         Exam Marks : 100

PART A

Unit 1. 06 Hrs
Introduction To Composite Materials:
Definition, classification and characteristics of composite materials – fibrous composites, laminated. Matrix materials

Unit 2. 06 Hrs
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.

Unit 3. 08 Hrs
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.

Unit 4. 06 Hrs
Fabrication Of Composite Structures:
Cutting, machining, drilling, mechanical fasteners and adhesive bonding, joining, computer-aided design and manufacturing, tooling, fabrication equipment.

PART B

Unit 5. 06 Hrs
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.

Unit 6. 06 Hrs
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.
Unit 7. 06 Hrs
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

Unit 8. 08 Hrs
Metal Matrix Composites:
Reinforcement materials, types, characteristics and selection of base metals. Application of MMC’s.

Text Books:

Reference:

DYNAMICS OF MACHINERY

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PART A

Unit 1. 06 Hrs

Unit 2. 06 Hrs
Dynamic Force Analysis: D’Alembert’s principle, Inertia force, inertia torque,

Unit 3. 08 Hrs
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.

Unit 4. 06 Hrs
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.

PART B
Unit 5. 08 Hrs
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.

Unit 6. 06 Hrs
Governors: Types of governors; force analysis of Porter and Hartnell governors. Controlling force, stability, sensitiveness, isochronism, effort and power

Unit 7. 06 Hrs
Gyroscope: Vectorial representation of angular motion, Gyroscopic couple. Effect of gyroscopic couple on ship, plane disc, aeroplane, stability of two wheelers and four wheelers.

Unit 8. 06 Hrs
Analysis of CAMS: Analysis of Tangent cam with roller follower and Circular arc cam operating flat faced and roller followers, Undercutting in Cams.

Text Books:
Reference:

Scheme of examination:
One Question to be set from each unit. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

AERODYNAMICS – I
Sub Code : 10AE54 IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART A

Unit 1. 4 Hrs.
Review of Basic Fluid Mechanics
Continuity, momentum and energy equation, units and dimensions, inviscid and viscous flows, compressibility, Mach number regimes.

Unit 2. 6 Hrs.
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.

Unit 3. 6 Hrs.
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.

Unit 4. 10 Hrs
Two-Dimensional Inviscid Incompressible Flows
Bernoulli’s equation, pitot-tube measurement of airspeed, condition on velocity
for incompressible flow, Euler's equations of motion, Governing equations for irrotational, incompressible flow, Laplace equation and boundary conditions. Two-dimensional source, sink and doublet flows, non-lifting flow over a two-dimensional circular cylinder and vortex flow.

PART B

Unit 5. 06 Hrs
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.

Unit 6. 06 Hrs
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.

Unit 7. 06 Hrs
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.

Unit 8. 08 Hrs
Introduction to Aerodynamic Testing
Principles of wind tunnel flow simulation, open and closed circuit wind tunnels, and 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.

Text Books

References:

Scheme of examination:
One Question to be set from each unit. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

AIRCRAFT PROPULSION

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PART A

Unit 1. 06 Hrs
Introduction
Introduction: Review of thermodynamic principles, Principles of aircraft propulsion, Types of power plants, Basics of heat transfer; conduction, convection, radiation, diffusion mass transfer basic concepts and governing equations.

Unit 2. 07 Hrs
Fundamentals of Gas Turbine Engines

Unit 3. 07 Hrs
Subsonic and Supersonic Inlets for Jet Engines
Unit 4. 06 Hrs
Combustion Chambers and Nozzles

PART B
Unit 5. 07 Hrs
Compressors

Unit 6. 07 Hrs
Introduction to Turbines:
Types of turbines-Operating Principle-Design consideration – Velocity triangles – degree of reaction -performance parameters – Basics of blade design principles

Unit 7. 06 Hrs
Ramjet Propulsion:

Unit 8. 06 Hrs
Fundamentals of Rocket Propulsion
Types and Classification of rockets Operating principle – Specific impulse of a rocket – Rocket nozzle classification – Rocket performance considerations

Text Books
References
6. Heat & mass transfer by Domkundwar

Scheme of examination:
One Question to be set from each unit. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

AIRCRAFT STRUCTURES – I

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PART A

Unit 1. Loads On Aircraft 06 Hrs

Unit 2. Materials for Aircraft Structures 06 Hrs
Metallic and non-metallic materials, Use of Aluminium alloy, titanium, stainless steel and composite materials. Desirable properties for aircraft application

Unit 3. Mechanical Properties of Material 06 Hrs
Stress – Strain - Tensile properties – Compression properties – Shear properties – Bearing properties – Creep and Stress properties – Fracture properties – Fatigue properties.
Unit 4 08 Hrs
Statically Determinate And Interdeterminate Structures

PART B
Unit 5. 06 Hrs
Energy Methods
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.

Unit 6. 06 Hrs
Columns
Columns with various end conditions – Euler’s Column curve – Rankine’s formula - Column with initial curvature - Eccentric loading – South well plot – Beam column.

Unit 7. 08 Hrs
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 2D elasticity and Airy’s Stress function

Unit 8. 06 Hrs
Failure Theory
Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum Strain energy theory – Application to aircraft Structural problems.

Text Book
1. Mechanics of Materials, Dr.BC Punmia, Ashoak Kumar Jain, Arun Kumar Jain, Lakshmi Publication

Reference
Scheme of Examination:
One Question to be set from each unit. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least TWO questions from Part A and TWO questions from Part B.

AERODYNAMICS LABORATORY

Sub Code : 10AEL57 IA Marks : 25
Hrs/ Week : 03 Exam Hours : 03
Total Hours : 42 Exam Marks : 50

LIST OF EXPERIMENTS

1. Calibration of a subsonic wind tunnel
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 incidences 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.
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.
ENERGY CONVERSION LABORATORY

Sub Code : 10AEL58 IA Marks : 25
Hrs/ Week : 03 Exam Hours : 03
Total Hours : 42 Exam Marks : 50

PART – A
(Individual Experiments)

21 Hrs

1. Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Pensky Martins Apparatus.
2. Determination of Calorific value of solid, liquid and gaseous fuels
3. Determination of Viscosity of lubricating oil using Redwood, Saybolt Viscometer and Torsion viscometers.
5. Use of planimeter.

PART – B
(Group Experiments)

21 Hrs

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
VI SEMESTER
APPLIED GAS DYNAMICS

Sub Code : 10AE61 IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART A

Unit 1. 07 Hrs
Basics of Compressible Flow
Basics of thermodynamics-definition and basic relation, Energy Equation- For flow and non-flow process, adiabatic energy equation, stagnation pressure, temperature, density, reference velocities, Bernoulli’s equation, Effect of Mach number on Compressibility, Isentropic flow with variable area-Area ratio as a function of Mach number, Impulse function, Mass flow rate, Flow through nozzles and diffusers

Unit 2. 07 Hrs
Normal, Oblique Shocks and Expansion Waves

Unit 3. 06 Hrs
Fanno Flow

Unit 4. 06 Hrs
Rayleigh Flow

PART B

Unit 5. 07 Hrs
Differential Equations of Motion for Steady Compressible Flows
Unit 6. 06 Hrs

Similarity Rules

Unit 7. 06 Hrs

Flow of Real Fluids.

Unit 8. 07 Hrs

Measurements in Compressible Flow
Types of Wind tunnel. Optical methods of flow visualization-shadow technique, Mach zender interferometer, Schileren technique. Wind tunnel Instrumentation and measurements-Pressure, Temperature, Flow rate, Hot-wire anemometer, Velocity measurements.

Text Books:

Reference Books:

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

AIRCRAFT PERFORMANCE

Sub Code : 10AE62 IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART A

Unit 1. 06 Hrs

Introduction:
The evolution of the airplane and the performance- a short history; The standard atmosphere; The Drag polar- source of aerodynamic force-lift, drag and moments; aerodynamic coefficients-Variation of lift, drag and moment coefficient with
angle of attack and Mach number Components of drag; Aerodynamic center; Equilibrium conditions; Variation of thrust, power and SFC with velocity and altitudes for air breathing engines.

Unit 2. 07 Hrs
The Equations of Motion Steady Unaccelerated Flight:
Introduction, Four forces of flight, General equation of motion, Power available and power required curves. Thrust available and thrust required curves. Conditions for power required and thrust required minimum. Thrust available and maximum velocity, Power available and maximum velocity, Altitude effects on power available and power required; thrust available and thrust required.

Unit 3. 07 Hrs
Steady Performance – Level Flight, Climb & Glide:
Equation of motion for steady level flight, Performance of airplane in level flight. Maximum speed in level flight. Climb Performance: Equation of motion for Rate of climb- graphical and analytical approach -Absolute ceiling, Service ceiling, Time to climb – graphical and analytical approach , climb performance graph (hodograph diagram); maximum climb angle and rate of climb Gliding flight, Range during glide, minimum rate of sink and shallowest angle of glide.

Unit 4. 06 Hrs
Fundamental Airplane Performance Parameters:

PART B
Unit 5. 07 Hrs
Range And Endurance:

Unit 6. 06 Hrs
Aircraft Performance In Accelerated Flight
Take-off Performance: Calculation of Ground roll, Calculation of distance while airborne to clear obstacle, Balanced field length
Unit 7.  
**Landing Performance and Accelerated Climb:**
Calculation of approach distance, Calculation of flare distance, Calculation of ground roll, ground effects. Acceleration in climb.

Unit 8.  
**Manoeuvre Performance:**
Turning performance: Level turn, load factor, Constraints on load factor, Minimum turn radius, Maximum turn rate. Pull-up and Pull-down maneuvers: (Turning rate, turn radius). Limiting case for large load factor. The V-n diagram. Limitations of pull up and push over.

**Text Books:**

**References**

**Scheme of Examination:** Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.
Unit 2. 08 Hrs.
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.

Unit 3. 06 Hrs.
Subsonic linearized flow over airfoils
Full velocity potential equation, linearized velocity potential equation and boundary condition, Prandtl-Glauret compressibility correction.

Unit 4. 06 Hrs.
Effects Of Compressibility
Basics of speed of sound, Mach waves, Normal shock waves, Oblique shock waves, Expansion fan, Prandtl – Meyer expansion, Critical Mach number; Drag-divergence Mach number, Sound Barrier, Transonic area rule.

PART B

Unit 5. 06 Hrs.
Applications Of Finite Wing Theory
Simplified horse-shoe vortex model, formation flight, influence of downwash on tail plane, ground effects.

Unit 6. 06 Hrs.
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.

Unit 7. 06 Hrs.
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.

Unit 8. 08 Hrs.
Viscous Flows
Derivation of Navier-Stokes equation for two-dimensional flows, boundary 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.
Text Books:

Reference:

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

FINITE ELEMENT ANALYSIS

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PART A

Unit 1. 08 Hrs.
Introduction: Basic Concepts, Background Review:
Stresses and Equilibrium, Plane stress, Plane strain, Potential energy and Equilibrium. Rayleigh - Ritz Method, Galerkin’s Method, Simple applications in structural Analysis. Construction or discrete models - sub domains and nodes - simple elements for the FEM - Simplex, complex and multiples elements Polynomial selection - illustrative examples

Unit 2 06 Hrs
Fundamentals of Finite Element Method:
Elements and shape functions and natural coordinates, Use of local and natural coordinates, compatibility and convergence requirements of shape functions, Construction of shape functions for bar element and beam element

Unit 3 06 Hrs
Analysis of 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.

Unit 4 06 Hrs
Analysis of Two dimensional Elements:
Shape functions of Triangular, Rectangular and Quadrilateral elements, different types of higher order elements, constant and linear strain triangular elements, stiffness matrix

PART B
Unit 5 06 Hrs
Analysis of Three dimensional elements:
Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 8), Tetrahedral elements, Hexahedral elements: Serendipity family, Hexahedral elements: Lagrange family.

Unit 6 06 Hrs
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.

Unit 7 06 Hrs
Axisymmetric solids subjected to axisymmetric loading:
Axisymmetric formulation, finite element modeling of triangular and quadrilateral element

Unit 8 08 Hrs
Field Problems:
Heat transfer problems, Steady state fin problems, 1D heat conduction governing equation, Derivation of element matrices for two dimensional problems, Dynamic consideration- Formulation-Hamilton’s principle, Element mass matrices.

Text Books:
3. Bhavikatti, Finite element Analysis, New Age International

Reference Books:

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

THEORY OF VIBRATIONS


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PART A

Unit 1 06 Hrs
Introduction

Unit 2 07 Hrs
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.

Unit 3 07 Hrs
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.

Unit 4 06 Hrs
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.

PART B

Unit 5 06 Hrs
Vibration Measuring Instruments & Whirling Of Shafts
Vibration of elastic bodies – Vibration of strings – Longitudinal, lateral and torsional Vibrations
Unit 6 08 Hrs
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.

Unit 7 06 Hrs
Continuous Systems
Introduction, vibration of string, longitudinal vibration of rods, Torsional vibration of rods, Euler’s equation for beams.

Unit 8 06 Hrs
Numerical Methods For Multi-Degree Freedom Systems

Text Books:

Reference Books:

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B
ELECTIVE - I (Group A)
NUMERICAL METHODS

Sub Code : 10AE661     IA Marks : 25
Hrs/ Week : 04         Exam Hours : 03
Total Hours : 52       Exam Marks : 100

PART A

Unit 1 06Hrs
Numerical Computation
Motivation and Objectives/ Number Representation/ Machine Precision/ Round-off Error/ Truncation Error/ Random Number Generation.

Unit 2 06 Hrs
Linear Algebraic Systems

Unit 3 06 Hrs
Interpolation and Approximation
Lagrangian Polynomials - Divided differences Interpolating with a cubic spline - Newton’s forward and backward difference formulas.

Unit 4 08 Hrs
Eigen Values and Eigen vectors
Motivation and Objectives/ The characteristics Polynominal/ Power Methods / Jacobi’s Method/ Householder Transformation/ QR Method/ Danilevsky’s Method/ Polynominal Roots.

PART B

Unit 5 08 Hrs
Numerical Differentiation and Integration
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.

Unit 6 06 Hrs
Curve Fitting
Motivation and objectives/ Interpolation/ Newton’s Difference Formula/ Cubic Splines/ Least Square/ Two-Dimensional Interpolation.
Unit 7 06 Hrs
Root Finding
Motivation and Objectives/ Bracketing methods/ Contraction Mapping Method/ Secant Method/ Muller’s Method/ Newton’s Method/ Polynomial Roots/ Nonlinear Systems of Equations.

Unit 8 06 Hrs
Optimization
Motivation and Objectives/ Local and Global Minima/ Line Searches/ Steepest Descent Method/ Conjugate-Gradient Method/ Quasi-Newton Methods/ Penalty Functions/ Simulated Annealing.

Text Book:

Reference Books:

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

AIRCRAFT MATERIALS

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<th>Sub Code</th>
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PART A 06 Hrs
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 nanomaterials; Selection of materials for use in aircraft.
Unit – 2 08 Hrs
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.

Unit – 3 06 Hrs
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.

Unit – 4 06 Hrs
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.

PART B

Unit – 5 06 Hrs
Ablative and Super Conducting Materials:
Ablation process, ablative materials and applications in aerospace; Phenomenon of super conduction, super conducting materials and applications in aerospace.

Unit – 6 07 Hrs
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.

Unit – 7 06 Hrs
Corrosion and Its Prevention:
Knowledge of the various methods used for removal of corrosion from common aircraft metals and methods employed to prevent corrosion.
Unit – 8 07 Hrs

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.

Text Books:

Reference:
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,

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

COMBUSTION

Sub Code : 10AE663 IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART A

Unit – 1 06 Hrs

Review of Basic Concepts:
Laws of thermodynamics, simple thermo chemical equations, and heat of combustion, properties of real gases, Rankine-Hugoniot curves, ideas of deflagration and detonation.

Unit – 2 06 Hrs

Chemical Equilibrium And Kinetics:
Concept of chemical equilibrium, Elements of adiabatic flame temperature calculation, Chemical kinetics – rates and order of reactions, Reaction mechanism and chain reactions.
Unit – 3 08 Hrs
Premixed Flames:
Mechanistic description of premixed flames, Burning velocity and parametric dependences, Experimental methods of measuring burning velocity, One dimensional Conservation Equations, Simple one-dimensional thermal theory of flame, concepts of minimum ignition energy, quenching distance, stability limits and flame stabilization.

Unit – 4 06 Hrs
Diffusion Flames:
Differences between premixed and diffusion flames, gas diffusion flames in parallel flow – jet flames and Burke Schumann flames, Liquid droplet combustion.

PART B

Unit – 5 06 Hrs
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.

Unit – 6 07 Hrs
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.

Unit – 7 07 Hrs
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.

Unit – 8 06 Hrs
Emissions:

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

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B

RELIABILITY ENGINEERING

Sub Code : 10AE664 IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART A

Unit 1 07 Hrs
Introduction
Reliability concepts and definitions, probability distribution functions and their application in reliability Evaluation, Reliability Evaluation in Engineering systems using Markov Models

Unit 2 07 Hrs
Failure analysis
Causes of failure, concept of hazard failure models, Bath Tub curve, MTTF, MTBF

Unit 3 06 Hrs
Reliability Modeling
System reliability for various configurations and combinational aspects, Weibull analysis on reliability

Unit 4 06 Hrs
Reliability Studies:
Reliability improvement, redundancy, reliability-cost trade-off

PART B

Unit 5 06 Hrs
Maintainability and Availability concepts
System Safety analysis
Unit 6 07 Hrs
Maintenance concepts
Types of Maintenance, Modern trends in Maintenance Philosophy like BITE, IRAN, HUM, TPM etc.

Unit 7 06 Hrs
Failure Investigation Process and Methodologies like FTA, FMEA

Unit 8 07 Hrs
Reliability and Quality Improvement techniques like, Bench Marking, JIT, Quality Circles, Quality Audit, TQM, Kaizan etc.

Text Book:
1. Introduction to Reliability Engineering, E.E. Lewis, John Wiley.

Reference Books:
1. Probability and statistics with Reliability, Queueuing and Computer, K.S. Trivedi,
2. Science Applications, PHI.

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

INDUSTRIAL MANAGEMENT

Sub Code : 10AE665 IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART - A

Unit – 1 06 Hrs
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

Unit – 2 08 Hrs
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).

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)

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.

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.

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.

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

Unit – 8
Management Of Technology: Meaning and role of technology-primary areas of technology management, management of technology and its role in improving

Text Books:

Reference Books:

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

### ROCKETS AND MISSILES

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**PART-A**

**Unit-1** 06 Hrs
Rockets Classification and Definitions, Rocket propulsion, nuclear rocket engine, electric rocket propulsion, other rocket propulsion concepts. Application of rocket propulsion. Total impulse, exhaust velocity, energy and efficiency, acceleration in multiple of earth gravity or thrust to vehicle weight ratio.

**Unit-2** 06 Hrs
Nozzle Theory and Flight Performance, Ideal rocket thrust and thrust coefficient, characteristics velocity and specific impulse. Principal losses in real nozzles. Nozzle alignment, Gravity free, drag free space flight, forces acting on a vehicle in atmospheric space flight.
Unit-3 06 Hrs

Unit-4 08 Hrs

PART-B
Unit-5 08 Hrs

Unit-6 06 Hrs
Missile Aerodynamic Control; Types of Controls-Conventions. Change in Missile Attitude due to Impulsive Pitch Control. Altitude effects. Equations of motion for missile pitch control. All moving control for Cruciform Controls.

Unit-7 06 Hrs
Thrust Vector Control: Thrust Vector Control Mechanism-advantages and disadvantages. TVC with multiple thrust chamber or nozzle. Testing, Integration with Vehicle.

Unit-8 06 Hrs
Rocket Testing Different types of tests, Test facility and safe guards. Instrumentation and data management Flight testing & post accident procedure.

Text Books:

Reference Books:
1. S S Chin, ‘Missile Configuration Design”
**Scheme of Examination:**
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

**STRUCTURES LABORATORY**

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**List of Experiments**
1. Deflection of a Simply Supported Beam.
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 sandwich Beam
8. Verification of Superposition Theorem
9. Determination of fundamental frequency of a cantilever beam and harmonics.
10. Frequency spectrum analysis for a cantilever beam.

**PROPULSION LABORATORY**

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**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.
7. Study of free jet
9. Fuel-injection characteristics
VII SEMESTER
CONTROL ENGINEERING

Sub Code : 10AE71        IA Marks : 25
Hrs/ Week : 04           Exam Hours : 03
Total Hours : 52         Exam Marks : 100

PART- A

UNIT - 1
Introduction: Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system, Types of controllers- Proportional, Integral Proportional Integral, Proportional Integral Differential controllers. 07 Hrs

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. 06 Hrs

UNIT - 3
Block Diagrams and Signal Flow Graphs: Transfer Functions definition, function, block representation of systems elements, reduction of block diagrams, Signal flow graphs: Mason’s gain formula. 07 Hrs

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. 06 Hrs

PART- B

UNIT - 5
Frequency Response Analysis: Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin, M&N circles. 06 Hrs

UNIT - 6
Frequency Response Analysis Using Bode Plots: Bode attenuation diagrams, Stability analysis using Bode plots, Simplified Bode Diagrams. 07 Hrs
UNIT - 7

**Root Locus Plots:** Definition of root loci, General rules for constructing root loci, Analysis using root locus plots. \[06 \text{ Hrs}\]

UNIT 8

**System Compensation and State Variable Characteristics of Linear Systems:**
Series and feedback compensation, Introduction to state concepts, state equation of linear continuous data system. Matrix representation of state equations, controllability and observability, Kalman and Gilberts test. \[07 \text{ Hrs}\]

Text Books:

Reference Books:

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**AIRCRAFT STRUCTURES - II**

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**PART A**

**Unit 1.** \[06 \text{ Hrs}\]**

**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.

**Unit 2.** \[06 \text{ Hrs}\]**

**Unsymmetrical Bending:**
Bending stresses in beams of unsymmetrical sections – Bending of symmetric sections with skew loads.
Unit 3. Shear Flow in Open Sections: 06 Hrs
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.

Unit 4. Shear Flow in Closed Sections: 08 Hrs
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.

PART B

Unit 5. Buckling of Plates: 06 Hrs
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.

Unit 6. Stress Analysis in Wing And Fuselage: 08 Hrs
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).

Unit 7. Design of Aircraft Structure: 06 Hrs

Unit 8. Joints and Fittings And Introduction to Post Buckling: 06 Hrs
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.

Text Books:

Reference:
3. D Williams & Edward Arnold, An Introduction to the Theory of Aircraft
Structures.

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students
have to answer any FIVE full questions out of EIGHT questions, choosing at
least 2 questions from part A and 2 questions from part B.

**AIRCRAFT STABILITY AND CONTROL**

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**PART A**

Unit 1. **Static Longitudinal Stability**: 06 Hrs
Historical perspective, Aerodynamic Nomenclature, Equilibrium conditions,
Definition of static stability, Definition of longitudinal static stability, stability
criteria, Contribution of airframe components: Wing contribution, Tail
contribution, Fuselage contribution, Power effects- Propeller airplane and Jet
airplane

Unit 2. **Static Longitudinal Stability and Control-Stick Fixed** 07 Hrs
Introduction, Trim condition. Static margin. stick fixed neutral points.
Longitudinal control, Elevator power, Elevator angle versus equilibrium lift
coefficient, Elevator required for landing, Restriction on forward C.G. range,

Unit 3. **Static Longitudinal Stability and Control-Stick Free** 07 Hrs
Introduction, Hinge moment parameters, Control surface floating characteristics
and aerodynamic balance, Estimation of hinge moment parameters, The trim tabs, Stick-free Neutral point, Stick force gradient in unaccelerated flight, Restriction on aft C.G.

Unit 4. 06 Hrs
Static Directional Stability and Control
Introduction, Definition of directional stability, Static directional stability rudder fixed, Contribution of airframe components, Directional control. Rudder power, Stick-free directional stability, Requirements for directional control, Rudder lock, Dorsal fin. One engine inoperative condition. Weather cocking effect.

PART B

Unit 5. 06 Hrs
Static Lateral Stability And Control

Unit 6. 07 Hrs
Dynamic Longitudinal Stability

Unit 7. 07 Hrs
Estimation of Dynamic Derivatives:
Aerodynamic force and moment representation, Derivatives due to change in forward speed. Derivatives due to the pitching velocity, Derivatives due to the time rate of change of angle of attack, Derivatives due to rolling rate, Derivatives due to yawing rate

Unit 8. 06 Hrs
Dynamic Lateral and Directional Stability
Text Books:

References

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

GAS TURBINE TECHNOLOGY

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PART-A

Unit 1. 06 Hrs
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.

Unit 2. 07 Hrs
Engine Parts
Unit 3. 06 Hrs
Materials and Manufacturing

Unit 4. 07 Hrs
Systems

PART – B
Unit 5. 06 Hrs
Engine Performance

Unit 6. 07 Hrs
Component Level Testing

Unit 7. 07 Hrs
Engine Testing
flight. Test procedure: Test Schedule Preparation, Test Log Sheets, Test Documents. Type approval.

**Unit 8. 06 Hrs**

**Test Cells**


**Text Books:**


**Reference Books:**

1. Advance Aero-Engine Testing, AGARD-59 Publication

**Scheme of Examination:**

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B
ELECTIVE - II (Group B)
OPTIMISATION TECHNIQUES

Sub Code : 10AE751 IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART A

Unit 1. 06 Hrs
Introduction

Unit 2. 06 Hrs
Unconstrained Optimisation

Unit 3. 07 Hrs
Unconstrained Minimisation

Unit 4. 07 Hrs
Constrained Minimisation

PART B

Unit 5. 06 Hrs
Direct Search Methods

Unit 6. 06 Hrs
Discrete And Dynamic Programming
Unit 7. 07 Hrs
Optimisation Application

Unit 8. 07 Hrs
Finite Element Based Optimisation

Text Books:

Reference Books:

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

COMPUTATIONAL FLUID DYNAMICS

Sub Code : 10AE752 IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART A 06 Hrs
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.
Unit 2. 07 Hrs
Governing Equations

Unit 3. 06 Hrs
Mathematical Behavior of Partial Differential Equations:
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 inviscid flow; steady boundary layer flow; and unsteady thermal conduction.

Unit 4. 07 Hrs
Discretization

PART B

Unit 5. 07 Hrs
Grid Generation

Unit 6. 06 Hrs
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.
Unit 7. 06 Hrs

Finite Volume Techniques

Unit 8. 07 Hrs

CFD Application to Some Problems

Text Books:

References:

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.
AIRCRAFT MAINTENANCE, REPAIR AND OVERHAUL

Sub Code : 10AE753 IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART A

Unit 1. 07 Hrs
Welding In Aircraft Structural Components
Equipments used in welding shop and their maintenance – Ensuring quality welds – Welding jigs and fixtures – Soldering and brazing.

Unit 2. 06 Hrs
Sheet Metal Repair And Maintenance

Unit 3. 07 Hrs
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.

Unit 4. 06 Hrs
Inspection And Repair Of Composite Components:
Inspection and Repair of composite components – Special precautions – Autoclaves.

PART B

Unit 5. 07 Hrs
Aircraft Jacking, Assembly And Rigging

Unit 6. 07 Hrs
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.
Unit 7. 06 Hrs
Inspection And Maintenance Of Auxiliary Systems:
Inspection and maintenance of auxiliary systems – Fire protection systems – Ice protection system – Rain removal system – Position and warning system – Auxiliary Power Units (APUs)

Unit 8. 06 Hrs
Safety Practices

Text Book

References

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

STATISTICAL QUALITY CONTROL

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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). 06 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.  

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)  

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  

PART - B
UNIT - 5
Process Capability: The foundation of process capability, Natural Tolerance limits, $c_p$, process capability index, $c_pp$, process performance index, summary of process measures. Numerical problems  

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  

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  

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.  

06 Hours

06 Hours

08 Hours

06 Hours

06 Hours

07 Hours

07 Hours

06 Hours
Text Books:
2. Statistical Quality Control, RC Gupta, Khanna Publishers, New Delhi, 2005

Reference Books:

THEORY OF PLATES AND SHELLS

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PART A

Unit 1. 06 Hrs
Introduction

Unit 2. 07 Hrs
Bending of Thin Plates - Stresses

Unit 3. 06 Hrs
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.
Unit 4. 07 Hrs
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.

PART B

Unit 5. 07 Hrs
Buckling of Reinforced Plates

Unit 6. 07 Hrs
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.

Unit 7. 06 Hrs
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.

Unit 8. 06 Hrs
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.

Text Books:
References:

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

NON DESTRUCTIVE TESTING

Sub Code : 10AE756  IA Marks : 25
Hrs/ Week : 04  Exam Hours : 03
Total Hours : 52  Exam Marks : 100

PART A

Unit 1  07 Hrs
Introduction

Unit 2  07 Hrs
Radiographic Inspection
Gamma ray radiography: Radioactivity, gamma ray sources, film radiography, application, examples. General radiographic procedures. Reading and Interpretation of Radiographs. Defects in welding.

Unit 3  06 Hrs
Ultrasonics

Unit 4.  06 Hrs
Ultrasonic Inspection
Ultrasonic application for thickness measurement. Types of scanning, types of indication. Welding inspection, tube inspection, test standards, determination of elastic constants.
PART -B

Unit 5. 06 Hrs
Liquid Penetrant Test
Basic concept. Test equipment. Test Parameters & Procedure. Safety precautions.

Unit 6. 07 Hrs
Magnetic Particle Test

Unit 7. 06 Hrs
Eddy Current Test

Unit 8. 07 Hrs
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.

Text Book:

Reference Books:

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.
MECHATRONICS AND MICROPROCESSOR

Sub Code : 10AE757 IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART - A

UNIT - 1
Introduction to Mechatronic Systems: Measurement and control systems. Their elements and functions, Microprocessor based controllers. 06 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. 07 Hours

UNIT 3
Electrical Actuation Systems: Electrical systems, Mechanical switches, solid-state switches, solenoids, DC & AC motors, Stepper motors and their merits and demerits. 06 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. 07 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. 07 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. 07 Hours

UNIT - 7
Organization & Programming of Microprocessors: Introduction to organization of INTEL 808S-Data and Address buses, Instruction set of 8085, programming the 8085, assembly language programming. 06 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. 06 Hours

Text Books:

Reference Books:

TOTAL QUALITY MANAGEMENT

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PART - A

UNIT - 1
Principles and Practice: Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM. 06 Hours
UNIT - 2
Leadership: Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making. 06 Hours

UNIT - 3
Customer Satisfaction and Customer Involvement:
Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention. Case studies.
Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies. 07 Hours

UNIT - 4
Continuous Process Improvement: process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies.
Tools and Techniques: Benchmarking, information technology, quality management systems, environmental management system, quality function deployment, quality by design, failure mode and effect analysis, product liability, total productive maintenance. 07 Hours

PART - B
UNIT - 5
Quality Management Tools: Why Why, forced filed analysis, nominal group technique, affinity diagram, interrelationship digraph, tree diagram, matrix diagram, prioritization matrices, process decision program chart, activity network diagram. 07 hours

UNIT - 6
Statistical Process Control: Pareto diagram, process flow diagram, cause-and-effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies. 06 Hours

UNIT - 7
Building and Sustaining Performance Excellence in Organizations: Making the commitment to total quality, organizational culture and total quality, change management, sustaining the quality organization, self-assessment processes, implementing ISO 9000, Bald ridge, and six sigma, a view toward the future. 07 Hours
UNIT - 8

**Design for Six Sigma:** Tools for concept development, tools for design development, tools for design optimization, tools for design verification, problems.  

06 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:


ELECTIVE III (GROUP C)

**EXPERIMENTAL STRESS ANALYSIS**

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PART - A

UNIT-1

**Electrical Resistance Strain Gages:** Strain sensitivity in metallic alloys, Gage construction, Adhesives and mounting techniques, Gage sensitivity and gage factor, Performance Characteristics, Environmental effects, Strain Gage circuits, Potentiometer, Wheatstone’s bridges, Constant current circuits.

06 Hours

UNIT-2

**Strain Analysis Methods:** Two element, three element rectangular and delta rosettes, Correction for transverse strain effects, Stress gage, Plane shear gage, Stress intensity factor gage.

06 Hours
UNIT-3
**Photo-elasticity:** Nature of light, Wave theory of light - optical interference, Stress optic law – effect of stressed model in plane and circular polariscopes, Isoclinics & Isochromatics, Fringe order determination Fringe multiplication techniques, Calibration photoelastic model materials **08 Hours**

UNIT-4
**Two Dimensional Photo-elasticity:** Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling. Properties of 2D photo-elastic model materials, Materials for 2D photo-elasticity **06 Hours**

**PART -B**

UNIT-5
**Three Dimensional Photo elasticity:** Stress freezing method, Scattered light photo-elasticity, Scattered light as an interior analyzer and polarizer, Scattered light polariscope and stress data Analyses. **06 Hours**

UNIT-6
**Photoelastic (Birefringent) Coatings :** Birefringence coating stresses, Effects of coating thickness: Reinforcing effects, Poisson’s, Stress separation techniques: Oblique incidence, Strip coatings. **08 Hours**

UNIT-7
**Brittle Coatings:** Coatings stresses, Crack patterns, Refrigeration techniques, Load relaxation techniques, Crack detection methods, Types of brittle coatings, Calibration of coating. Advantages and brittle coating applications. **06 Hours**

UNIT-8
**Moire Methods:** Moire fringes produced by mechanical interference. Geometrical approach, Displacement field approach to Moire fringe analysis, Out of plane displacement measurements, Out of plane slope measurements. Applications and advantages **06 Hours**

Text Books:
HELIICOPTER DYNAMICS

Sub Code : 10AE762  IA Marks : 25
Hrs/ Week : 04  Exam Hours : 03
Total Hours : 52  Exam Marks : 100

PART- A

Unit 1.  06 Hrs
Introduction to Helicopter

Unit 2.  07 Hrs
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.

Unit 3.  07 Hrs
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).
Unit 4. 06 Hrs

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.

PART B

Unit 5. 06 Hrs

Rotor Airfoil Aerodynamics And Dynamic Stall

Unit 6. 07 Hrs

Helicopter Stabilty And Control

Unit 7. 07 Hrs

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.

Unit 8. 06 Hrs

Conceptual Design Of Helicopters
Text Books:

Reference Books:
2. Def Stan 00970, Vol. 2 Rotorcraft

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

SPACE MECHANICS AND LAUNCH VEHICLALS

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PART A

Unit 1. 07 Hrs
Introduction 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.

Unit 2. 06 Hrs
Central Force Motion
Two body problem and one body problem. Kepler’s laws of motion.

Unit 3. 07 Hrs
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.
Unit 4. 06 Hrs
Satellite Dynamics
Geosynchronous and geostationary satellites life time - satellite perturbations - Hohmann orbits - calculation of orbit parameters - Determination of satellite rectangular coordinates from orbital elements

PART B

Unit 5. 06 Hrs
Introduction to Launch Vehicles

Unit 6. 07 Hrs
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.

Unit 7. 06 Hrs
Rocket Performance and Staging
Launch vehicle trajectories, two body problem and orbital elements. Staging of rockets.

Unit 8. 07 Hrs
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.

Text Books:

Reference Books:
**Scheme of Examination:**
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

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**SMART MATERIALS**

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**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  

**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.

**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 Dampers, Design issues.

**UNIT - 4**

*Optics And Electromagnetic:* Principals of optical fiber technology, characteristics of active and adaptive optical system and components, design and manufacturing principles.

**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.
UNIT - 6
Controls: Principles of structural acoustic control, distributed, analog and digital feedback controls, Dimensional implications for structural control. 
06 Hours

UNIT - 7
07 Hours

UNIT - 8
Information Processing: Neural Network, Data Processing, Data Visualisation and Reliability – Principals and Application domains. 
06 Hours

Text Books:

Reference Books:

AGILE MANUFACTURING

Sub Code : 10AE765 IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART - A

UNIT - 1
Agile Manufacturing: Definition, business need, conceptual frame work, characteristics, generic features. 
06 Hours

UNIT - 2
07 Hours

96
UNIT - 3
Integration Of Product /Process Development: Principles, Robust design approach, Approaches to enhance ability in manufacturing, Role of QFD, Managing people in Agile organisation, Approaches.  
06 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. 
07 Hours

PART - B

UNIT - 5
07 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.  
07 Hours

UNIT - 7
Corporate Knowledge Management In Agile Manufacturing: Strategies, strategic options in Agile manufacturing, Role of standards.  
06 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.  
06 Hours

Text Books:

Reference Books:
1. O Levine Transitions to Agile Manufacturing, Joseph C

97
Moutgorney and Lawrurence – Staying Flexible for competitive advantage, ASQC quality press, Milwaukee, Wisconsin, USA 1996


ROBOTICS

Sub Code : 10AE766 IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART - A

UNIT - 1

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. 06 Hours

UNIT - 3
Velocity and Static’s 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 manipulators, Statics of serial manipulators, Static force and torque analysis of 3R manipulator, Singularity in force domain. 07 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.  

06 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  

07 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.  

08 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, Brushes DC motors, Stepper motors- structure and principle of operation, stepper motor speed-torque characteristics  

06 Hours

UNIT - 8

05 Hours

Text Books:

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**PART A**

**Unit 1. 06 Hrs**

**Wind Energy Collectors**
Horizontal axis and vertical axis machines. Power coefficient. Betz coefficient by momentum theory.

**Unit 2. 07 Hrs**

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

**Unit 3. 06 Hrs**

**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.

**Unit 4. 07 Hrs**

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

**PART B**

**Unit 5. 07 Hrs**

**Model Measurements**

**Unit 6. 06 Hrs**

**Wind Tunnel Boundary Corrections and Scale Effects**
Unit 7. 07 Hrs
Near sonic And Transonic Testing
sonic tunnel design, Calibration of test section, Model support system, Tare and interference evaluation, Near transonic testing.

Unit 8. 06 Hrs
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.

Text Books:

REFERENCE BOOKS:

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

MICRO AND SMART SYSTEMS TECHNOLOGY

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PART - A
UNIT - 1
Introduction To Micro And Smart Systems:
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

08 Hours

UNIT - 3
Micro-Manufacturing 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

07 Hours

UNIT - 4
Modeling:

a) Scaling issues.

06 Hours

PART - B

UNIT - 5
Computer-Aided Simulation And Design:

08 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.  

UNIT - 7

UNIT - 8
Case Studies: BEL pressure sensor, thermal cycler for DNA amplification, and active vibration control of a beam.  

PART - C
UNIT - 9
Mini-projects and class-demonstrations (not for Examination)

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.
6. MEMS- Nitaigour Premchand Mahalik, TMH 2007
DESIGN, MODELING AND ANALYSIS LABORATORY

Sub Code : 10AEL77  IA Marks : 25
Hrs/ Week : 03  Exam Hours : 03
Total Hours : 42  Exam Marks : 50

List of Experiments

Part-A 21 Hrs

Part-B 21 Hrs
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.

Scheme of Examination

ONE question From Part-A 20 Marks
ONE question From Part-B 20 Marks
VIVA Voce 10 Marks
Total 50 Marks
SIMULATION LABORATORY

Sub Code : 10AEL78 IA Marks : 25
Hrs/ Week : 03 Exam Hours : 03
Total Hours : 42 Exam Marks : 50

List of Experiments

Part-A 21 Hrs

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.

PART B 21 Hrs

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.

Scheme of Examination

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105
PART-A

Unit 1. 06 Hrs
Conceptual Aircraft Design

Unit 2. 06 Hrs
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.

Unit 3. 07 Hrs
Design Of Structural Components: Wing, Fuselage And Tail

Unit 4. 07 Hrs
Power for Flight
PART-B

Unit 5. Performance Estimation 07 Hrs

Unit 6. Static Stability 07 Hrs

Unit 7. Design Aspects of Sub-Systems 06 Hrs

Unit 8. Design Aspects: Avionics, Controls and Weapon Systems 06 Hrs
Communication system, Navigation system, Radar, Flight control system, Weapon systems, and weapon system interface.

Text Books:

Reference:

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.
AVIONICS

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PART A

Unit 1. 07 Hrs
**Power Distribution System**

Unit 2. 06 Hrs
**Inertial Navigation System**

Unit 3. 07 Hrs
**Electronic Flight Control System**

Unit 4. 06 Hrs
**Electronic Flight Instrument Systems**
Display -units, presentation, failure, and annunciation. Display of air data.

PART-B

Unit 5. 07 Hrs
**Introduction to Avionics Sub Systems and Electronic Circuits**
Typical avionics subsystems. Amplifier, oscillator, aircraft communication system, transmitter, receiver, antenna.

Unit 6. 06 Hrs
**Principles of Digital Systems**
Digital Computers – Microprocessors – Memories
Unit 7. 06 Hrs
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

Unit 8. 07 Hrs
Avionics Systems Integration

Text Books

References

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

ELECTIVE IV (GROUP D)
FLIGHT TESTING

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PART A
Unit 1. 06 Hrs
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.

**Unit 2. 07 Hrs**
**Flight Test Instrumentation**
Planning flight test instrumentation, sensing and transducing techniques. Measurement of linear and angular displacements, velocities and accelerations, vibration, force, temperature - onboard and ground based data acquisition system. Radio telemetry.

**Unit 3. 07 Hrs**
**Performance Flight Testing - Range, Endurance And Climb**

**Unit 4. 06 Hrs**
**Performance Flight Testing - Take-Off, Landing, Turning Flight**

**PART B**

**Unit 5. 07 Hrs**
**Stability And Control - Longitudal And Manoeuvring**

**Unit 6. 07 Hrs**
**Stability And Control - Lateral & Directional**

**Unit 7. 06 Hrs**
**Flying Qualities**

**Unit 8. 06 Hrs**
**Hazardous Flight Testing**
Stall and spin- regulations, test and recovery techniques. Dive testing for flutter, vibration and buffeting.
Text Books:

Reference Books:

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

FRACUTRE MECHANICS

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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 06 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. 07 Hours

UNIT - 3

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. 06 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.  
07 Hours

UNIT - 6
06 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.  
07 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.  
06 Hours

Text Books:

Reference Books:
THEORY OF AEROELASTICITY

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PART A

Unit 1. 06 Hrs
Introduction

Unit 2. 07 Hrs
Deformation of Airplane Structures Under Static Loads

Unit 3. 06 Hrs
Static Aeroelastic Phenomena

Unit 4. 07 Hrs
Control Effectiveness and Reversal

PART B

Unit 5. 06 Hrs
Deformation Of Airplane Structures Under Dynamic Loads
Unit 6. 07 Hrs

Dynamic Problems of Aeroelasticity

Unit 7. 07 Hrs

Test Model Similarities

Unit 8. Testing Techniques 06 Hrs

Text Books:

Reference Books:
2. Megson THG,' Aircraft structures for Engineering students', Edward Arnold.

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.
PART - A

UNIT - 1
Introduction to Hydraulic Power: Definition of hydraulic system, advantages, limitations, applications, Pascal’s law, structure of hydraulic control system, problems on Pascal’s law.
The source of Hydraulic Power: Pumps Classification pumps, Pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump Selection factors, problems on pumps. 07 Hours

UNIT - 2
Hydraulic Actuators and Motors: Classification cylinder and hydraulic motors, Linear Hydraulic Actuators [cylinders], single and double acting cylinder, Mechanics of Hydraulic Cylinder Loading, mounting arrangements, cushioning, special types of cylinders, problems on cylinders, construction and working of rotary actuators such as gear, vane, piston motors, Hydraulic Motor Theoretical Torque, Power and Flow Rate, Hydraulic Motor Performance, problems, symbolic representation of hydraulic actuators (cylinders and motors). 06 Hours

UNIT - 3
Control Components in Hydraulic Systems: Classification of control valves, Directional Control Valves- Symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, check valves, Pressure control valves - types, direct operated types and pilot operated types. Flow Control Valves - compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation. 07 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, Automatic cylinder reciprocating system, Locked Cylinder using Pilot check Valve, Cylinder synchronizing circuit using different methods, factors affecting synchronization, Hydraulic circuit for force multiplication, Speed Control of Hydraulic Cylinder, Speed Control of Hydraulic Motors, Safety circuit, Accumulators, types, construction and applications with circuits. 06 Hours
PART – B

UNIT - 5
Maintenance of Hydraulic System: Hydraulic Oils - Desirable properties, general type of Fluids, Sealing Devices, Reservoir System, Filters and Strainers, wear of Moving Parts due to solid -particle Contamination, temperature control (heat exchangers), Pressure switches, trouble shooting. 06 Hours

UNIT - 6
Introduction to Pneumatic Control: Definition of pneumatic system, advantages, limitations, applications, Choice of working medium. Characteristic of compressed air. Structure of Pneumatic control System, fluid conditioners and FRL unit.
Pneumatic Actuators: Linear cylinder - Types, Conventional type of cylinder-working, End position cushioning, seals, mounting arrangements- Applications. Rod - Less cylinders types, working, advantages, Rotary cylinders- types construction and application, symbols. 07 Hours

UNIT-7
Pneumatic Control Valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols. 3Hrs Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and Exhaust air throttling.
Signal Processing Elements: Use of Logic gates - OR and AND gates in pneumatic applications. Practical Examples involving the use of logic gates, Pressure dependant controls- types - construction - practical applications, Time dependent controls principle. Construction, practical applications. 07 Hours

UNIT-8
Multi- Cylinder Application: 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 signal cylinder application.
Compressed Air: Production of compressed air- Compressors Preparation of compressed air-Driers, Filters, Regulators, Lubricators, Distribution of compressed air Piping layout. 06 Hours
Text Books:
2. ‘Pneumatics and Hydraulics’, Andrew Parr, Jaico Publishing Co

Reference Books:
3. ‘Hydraulic & Pneumatic Power for Production’, Harry L. Stewart

RELIABILITY AND MAINTENANCE ENGINEERING

Sub Code : 10AE835 IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART A

Unit 1. 06 Hrs
Introduction

Unit 2. 07 Hrs
Quality & Its Measures
Quality & reliability. Taguchi methodology. Quality measure. The six Sigma Methodology.

Unit 3. 06 Hrs
Data & Distributions

Unit 4. 07 Hrs
Reliability & Rates of Failure
PART-B

Unit 5. 06 Hrs
Reliability Testing

Unit 6. 07 Hrs
Redundancy

Unit 7. 07 Hrs
Maintained Systems

Unit 8. 06 Hrs
System Safety Analysis

Text Book:

Reference Books:

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.
PART A

Unit 1. Preliminary Concepts

Unit 2. Fundamental Equations of Viscous Flow
Conservation of mass, momentum and energy equations. Mathematical characterisation of basic equations. Dimensionless parameters in viscous flow.

Unit 3. Solutions of Viscous Flow Equations

Unit 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.

PART B

Unit 5. Laminar Boundary Layer Equations
Unit 6. 06 Hrs
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.

Unit 7. 07 Hrs
Incompressible Turbulent Mean Flow
Physical and mathematical description of turbulence. Fluctuations and time
averaging. Turbulent flow in pipes and channels. Free turbulence: - jets, wakes
and mixing layers.

Unit 8. 07 Hrs
Instrumentation and Measurements:
Hot wire and Hot film anemometer for turbulence measurements. Schlieren
methods for flow visualization. Pressure probes, Interferometer and Smoke
method.

Text Books:
3. J.P.Hollman and W.J. Gajda, Jr. ‘Experimental methods for Engineers’,

Reference Books:
3. Boundary Layer by T.R.Oke

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students
have to answer any FIVE full questions out of EIGHT questions, choosing at
least 2 questions from part A and 2 questions from part B.
OPERATION RESEARCH

Sub Code : 10AE837 IA Marks : 25 
Hrs/ Week : 04 Exam Hours : 03 
Total Hours : 52 Exam Marks : 100 

PART- A

UNIT -1
Introduction: Evolution of OR, definition of OR, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, linear programming (LP) problem-formulation and solution by graphical method. 04 Hours

UNIT -2
Solution Of Linear Programming Problems: The simplex method-canonical and standard form of an LP problem, slack, surplus and artificial variables, big M method and concept of duality, dual simplex method. 08 Hours

UNIT -3
Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using different methods, optimal solution by MODI method, degeneracy in transportation problems, application of transportation problem concept for maximization cases. Assignment Problem-formulation, types, application to maximization cases and travelling salesman problem. 08 Hours

UNIT -4
Integer Programming: Pure and mixed integer programming problems, solution of Integer programming problems-Gomory’s all integer cutting plane method and mixed integer method, branch and bound method, Zero-One programming. 06 Hours

PART- B

UNIT -5
Pert-CPM Techniques: Introduction, network construction - rules, Fulkerson’s rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects. 08 Hours

UNIT -6
Queuing Theory: Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), empirical queuing models – M/M/1 and M/M/C models and their steady state performance analysis. 06 Hours
UNIT -7
Game Theory: Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games. 06 Hours

UNIT -8
Sequencing: Basic assumptions, sequencing ‘n’ jobs on single machine using priority rules, sequencing using Johnson’s rule-‘n’ jobs on 2 machines, ‘n’ jobs on 3 machines, ‘n’ jobs on ‘m’ machines. Sequencing 2 jobs on ‘m’ machines using graphical method. 06 Hours

Text Books

Reference Books
2. Operations Research, Paneerselvan, PHI

AEROSPACE QUALITY ASSURANCE

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PART A

Unit 1. 06 Hrs
Quality Concepts
Concepts and definition, design specifications, manufacture in conformance with design applications, role of quality assurance during usage of aircraft.

Unit 2. 07 Hrs
Quality Assurance during Overhaul
Quality assurance during overall/repair of aircraft and its aggregates, concession and deviations. Production permits.
Unit 3. 06 Hrs
Quality Control

Unit 4. 07 Hrs
Probability Concepts

PART B

Unit 5. 06 Hrs
Designing For Quality

Unit 6. 07 Hrs
Manufacture & Reliability Prediction

Unit 7. 07 Hrs
Inspection, Test & Measurements

Unit 8. 06 Hrs
Quality Assurance

Text Books:
Reference Books:

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

ELECTIVE V (GROUP E)
AIRCRAFT SAFETY RULES AND REGULATIONS

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PART A

Unit 1. 06 Hrs
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.

Unit 2. 06 Hrs
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.

Unit 3. 07 Hrs
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.
Unit 4. 07 Hrs
C.A.R. Series ‘D’ – 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.

PART B

Unit 5. 06 Hrs
C.A.R. Series ‘E’ – Approval of Organizations
Approval of organizations in categories A, B, C, D, E, F, & G - Requirements of infrastructure at stations other than parent base.

Unit 6. 07 Hrs
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.

Unit 7. 06 Hrs
C.A.R. Series ‘L’ & ‘M’
Issue of AME Licence, its classification and experience requirements, Mandatory Modifications / Inspections.

Unit 8. 07 Hrs
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.

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

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

GUIDANCE AND NAVIGATION

Sub Code : 10AE842 IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART A
Unit 1. 06 Hrs
Introduction
Concepts of navigation, guidance and control. Introduction to basic principles. Air data information.

Unit 2. 07 Hrs
Radar Systems

Unit 3. 06 Hrs
Tracking With Radar
Mono pulse tracking. Conical scan and sequential lobbing. Automatic tracking with surveillance radar (ADT)

Unit 4. 07 Hrs
Other Guidance Systems

PART B
Unit 5. 06 Hrs
Transfer Functions
Unit 6. 07 Hrs
Missile Control System

Unit 7. 06 Hrs
Missile Guidance
Proportional navigation guidance; command guidance. Comparison of guidance system performance. Bank to turn missile guidance

Unit 8. 07 Hrs
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

Text Books:

Reference Books:

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

MANAGEMENT INFORMATION SYSTEMS

Sub Code : 10AE843
Hrs/ Week : 04
Total Hours : 52
IA Marks : 25
Exam Hours : 03
Exam Marks : 100

PART - A

UNIT - 1
The Information Age: An Overview: The purpose, data, information, and information systems and their types, ethical and societal issues, information systems in business functions, web empowered enterprises. 05 Hours
UNIT - 2
**Strategic Uses of Information Systems:** Strategies and Strategic moves, Achieving a competitive advantage, creating and maintaining strategic information systems, Business Functions and Supply Chains – effectiveness and efficiency, accounting, finance, engineering, supply chain management, Human resource management, Enterprise resource planning.  
**05 Hours**

UNIT - 3
**Information Technology:** Business Hardware – components, classification of computers, output devices, storage media, and purchasing, Business Software – programming languages and software development tools, language translation, compilers and interpreters, system software, open source software, software licensing, ethical issues,  
**08 Hours**

UNIT - 4
**Business Networks and Telecommunication:** Telecommunication in Business and Daily Use, Bandwidths and Media, networks, protocols, internet networking services, Telecommuting – pros and cons, Future of Networking Technologies.  
**08 Hours**

PART - B

UNIT - 5
**Web Enabled Commerce:** Web enabled enterprises – web business and technologies, web enabled business, Challenges of Global Information Systems – multinational organizations, international commerce, ethical issues.  
**07 hours**

UNIT - 6
**Decision Support and Business intelligence:** Decision support and expert systems – decision support and decision making process, structured and unstructured problems, decision support systems, expert systems, geographical systems, Business Intelligence and Knowledge Management – Data Mining and online analysis, knowledge management,  
**06 Hours**

UNIT - 7
**Planning, Acquisition, and Control:** Systems Planning and Development – Planning Information systems, systems development life cycle, agile methods, systems integration, ethical issues – IS professionals certification.  
**07 Hours**

UNIT - 8
**Choices in Systems Acquisition:** Options and Priorities, outsourcing, licensing applications, software as a service, user application development, ethical issues - computer use policies for employees.  
**06 Hours**

128
Text Book


Reference Books:

PROJECT MANAGEMENT

Sub Code : 10AE844 IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART - A

UNIT 1
Introduction: Definition of project, characteristics of projects, understand projects, types of projects, scalability of project tools, project roles. **04 Hours**

UNIT 2
Project Selection And Prioritization – Strategic planning process, Strategic analysis, strategic objectives, portfolio alignment – identifying potential projects, methods of selecting projects, financial mode / scoring models to select projects, prioritizing projects, securing and negotiating projects. **05 Hours**

UNIT 3
Planning Projects: Introduction, developing the project management plan, understanding stake holders, communication planning, project meeting management, communication needs of global and virtual project teams, communication technologies, Constructing Work Breakdown Structures – scope planning, scope definition, work breakdown structures (WBS), Using Microsoft project for work breakdown structures. **08 Hours**
UNIT 4
Scheduling Projects: purpose of a project schedule, historical development, how project schedules are limited and created, develop project schedules, uncertainty in project schedules, Gantt Chart, Using Microsoft Project for critical path schedules. 08 Hours

PART - B
UNIT 5
Resourcing Projects: Abilities needed when resourcing projects, estimate resource needs, creating staffing management plant, project ream composition issues, assign resource to each activity, resource overloads, critical chain project management (CCPM), compress the project schedule, Using Microsoft Project for resource allocation.
Budgeting Projects: Cost planning, cost estimating, cost budgeting, establishing cost control, using Microsoft Project for Project Budgets, 08 hours

UNIT 6
Project Risk Planning: Risk Management Planning, risk identification, risk analysis, risk response planning, Project Quality Planning and Project Kickoff: Development of quality concepts, project quality management plan, project quality tools, kickoff project, baseline and communicate project management plan, using Microsoft Project for project baselines. 06 Hours

UNIT 7
Performing Projects: Project supply chain management: - Plan purchasing and acquisitions, plan contracting, contact types, project partnering and collaborations, project supply chain management, Leading and Managing Project Teams – Acquiring, developing, managing and leading the project team, managing stakeholders, managing project conflicts. 07 Hours

UNIT 8
Determining Project Progress and Results: Project Balanced Scorecard Approach, Internal project, customer, financial issues, Using Microsoft Project to monitor and control projects. Finishing the project: Terminate project early, finish projects on time, secure customer feedback and approval, knowledge management, perform administrative and contract closure, celebrate success and reward participant, provide ongoing support. 06 Hours

Text Book:
2. Project Management, A systems approach to planning scheduling and controlling by Harold kerzner, CBS publication.
PRODUCT DESIGN AND MANUFACTURING

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PART –A

UNIT-1 6 Hours
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.

UNIT-2 6 Hours
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.

UNIT-3 7 Hours
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-à-vis compression. Review of production process: Introduction, primary processes, machining process, non-traditional machining processes.

UNIT-4 7 Hours
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 bush
bearings, gears in plastics, rubber parts, design recommendations for rubber parts, ceramic and glass parts.

PART –B

UNIT – 5 6 Hours

UNIT – 6 6 Hours

UNIT – 7 6 Hours
HUMAN ENGINEERING CONSIDERATIONS IN PRODUCT DESIGN: Introduction, Human being as Applicator of forces, Anthropometry, Man as occupant of space, The Design of Controls, the design of displays, Man/Machine information exchange.

UNIT – 8 8 Hours
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)

Text Books:

Reference Books:
ARTIFICIAL INTELLIGENCE

Sub Code : 10AE846  IA Marks : 25
Hrs/ Week : 04  Exam Hours : 03
Total Hours : 52  Exam Marks : 100

PART - A

UNIT - 1
Artificial Intelligence: Introduction, definition, underlying assumption, importance of AI, AI and related fields. 06 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. 07 Hours

UNIT - 3
Knowledge Representation Issues: Representations and Mappings, Types of knowledge – Procedural Vs Declarative, Logic programming. Forward Vs Backward reasoning, Matching. 07 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. 06 Hours

PART - B

UNIT - 5
Statistical And Probabilistic Reasoning: Symbolic reasoning under uncertainty, Probability and Bayes’ theorem, Certainty factors and Rule based systems, Bayesian Networks, Shafer Theory, Fuzzy Logic. 07 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. 07 Hours

UNIT - 7
Typical Expert Systems: MYCIN, Variants of MYCIN, PROSPECTOR, DENDRAL, PUFF, ETC. 06 Hours
UNIT - 8
Introduction To Machine Learning: Perceptrons, Checker Playing Examples, Learning Automata, Genetic Algorithms, Intelligent Editors. 06 Hours

Text Books:
2. Introduction to AI & ES, Dan W. Patterson, Prentice Hall of India, 1999.

Reference Books:

COMPUTER INTEGRATED MANUFACTURING

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PART-A

UNIT - 1

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 analysis, 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.  

UNIT - 4


6 Hours

PART-B

UNIT - 5


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.  

6 Hours

Text Books:


Reference Books:
2. CADICAM by Zeid, Tata McGraw Hill.

AIRCRAFT SYSTEMS AND INSTRUMENTATION

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PART A

Unit 1. 06 Hrs
Flight Control Systems

Unit 2. 07 Hrs
Mechanical Systems

Unit 3. 07 Hrs
Aircraft Fuel and Engine Systems

Unit 4. 06 Hrs
Environmental Control and Emergency Systems
Air-conditioning system, vapour cycle system, deicing and anti-icing system. Fire detection- warning and suppression. Crew escape aids.
PART B

Unit 5. 06 Hrs
Aircraft Instruments

Unit 6. 07 Hrs
Air Data Instruments

Unit 7. 07 Hrs
Gyroscopic Flight Instruments

Unit 8. 06 Hrs
Engine Instruments
Study of various types of engine instruments- RPM, Pressure, Temperature, Fuel flow, Fuel quantity, and vibrations.

Text Books

References

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.
Surge Components. Sem. Epoxy coated, inductive, film capacitors, radial leads.