Syllabus

for

B. Tech. Mechanical Engineering

Third Year

(Effective from the Session: 2018-19)
### STUDY AND EVALUATION SCHEME

**B-Tech. Mechanical Engineering**

**YEAR: 3rd / SEMESTER-V**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Department</th>
<th>L-T-P</th>
<th>Theory / Lab Marks</th>
<th>SESSIONAL</th>
<th>Total</th>
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<td>Heat &amp; Mass Transfer</td>
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**DEPTT ELECTIVE COURSE-1**

1. RME-051 IC Engines and Compressors
2. RME-052 Mechatronics and Microprocessor
3. RME-053 Finite Element Methods
4. RME-054 Engineering Optimization
### STUDY AND EVALUATION SCHEME

**B-Tech. Mechanical Engineering**

**YEAR: 3rd / SEMESTER-VI**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Subject Code</th>
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<th>Department</th>
<th>L-T-P</th>
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**DEPTT ELECTIVE COURSE-2**

1. RME061 Refrigeration & Air-conditioning
2. RME062 Production Planning and Control
3. RME063 Mechanical Vibration
4. RME064 Reliability Engineering
MACHINE DESIGN-I

<table>
<thead>
<tr>
<th>UNIT I</th>
<th>Introduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition, Design requirements of machine elements, Design procedure, Standards in design, Selection of preferred sizes, Indian Standards designation of carbon &amp; alloy steels, Selection of materials for static and fatigue loads.</td>
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<table>
<thead>
<tr>
<th>Design for Static Load</th>
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<tbody>
<tr>
<td>Modes of failure, Factor of safety, Principal stresses, Stresses due to bending and torsion, Theory of failure.</td>
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</table>

<table>
<thead>
<tr>
<th>UNIT II</th>
<th>Design for Fluctuating Loads</th>
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<tbody>
<tr>
<td>Cyclic stresses, Fatigue and endurance limit, Stress concentration factor, Stress concentration factor for various machine parts, Notch sensitivity, Design for finite and infinite life, Soderberg, Goodman &amp; Gerber criteria.</td>
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</table>

<table>
<thead>
<tr>
<th>Riveted Joints</th>
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<tbody>
<tr>
<td>Riveting methods, materials, Types of rivet heads, Types of riveted joints, Caulking and Fullering, Failure of riveted joint, Efficiency of riveted joint, Design of boiler joints, Eccentric loaded riveted joint.</td>
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</table>

<table>
<thead>
<tr>
<th>UNIT III</th>
<th>Shafts</th>
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</thead>
<tbody>
<tr>
<td>Cause of failure in shafts, Materials for shaft, Stresses in shafts, Design of shafts subjected to twisting moment, bending moment and combined twisting and bending moments, Shafts subjected to fatigue loads, Design for rigidity.</td>
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</table>

<table>
<thead>
<tr>
<th>UNIT IV</th>
<th>Mechanical Springs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types, Material for helical springs, End connections for compression and tension helical springs, Stresses and deflection of helical springs of circular wire, Design of helical springs subjected to static and fatigue loading.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UNIT V</th>
<th>Keys and Couplings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types of keys, splines, Selection of square &amp; flat keys, Strength of sunk key, Couplings, Design of rigid and flexible couplings.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Power Screws</th>
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</thead>
<tbody>
<tr>
<td>Forms of threads, multiple threads, Efficiency of square threads, Trapezoidal threads, Stresses in screws, Design of screw jack</td>
</tr>
</tbody>
</table>

Note: Design data book is allowed in the examination

Books and References:
HEAT & MASS TRANSFER

UNIT-1

Introduction to Heat Transfer:

Conduction:
General differential heat conduction equation in the rectangular, cylindrical and spherical coordinate systems. Initial and boundary conditions.

Steady State one-dimensional Heat conduction:
Simple and Composite Systems in rectangular, cylindrical and spherical coordinates with and without energy generation; Concept of thermal resistance. Analogy between heat and electricity flow; Thermal contact resistance and over all heat transfer coefficient; Critical radius of insulation.

UNIT-2 Fins:
Heat transfer from extended surfaces, Fins of uniform cross-sectional area; Errors of measurement of temperature in thermometer wells.

Transient Conduction:
Transient heat conduction; Lumped capacitance method; Time constant; Unsteady state heat conduction in one dimension only, Heisler charts.

UNIT-3

Forced Convection:
Basic concepts; Hydrodynamic boundary layer; Thermal boundary layer; Approximate integral boundary layer analysis; Analogy between momentum and heat transfer in turbulent flow over a flat surface; Mixed boundary layer; Flow over a flat plate; Flow across a single cylinder and a sphere; Flow inside ducts; Thermal entrance region, Empirical heat transfer relations; Relation between fluid friction and heat transfer; Liquid metal heat transfer.

Natural Convection:
Physical mechanism of natural convection; Buoyant force; Empirical heat transfer relations for natural convection over vertical planes and cylinders, horizontal plates and cylinders, and sphere, Combined free and forced convection.
UNIT-4

Thermal Radiation:
Basic radiation concepts; Radiation properties of surfaces; Black body radiation Planck’s law, Wein’s displacement law, Stefan Boltzmann law, Kirchoff’s law; ; Gray body; Shape factor; Black-body radiation; Radiation exchange between diffuse non black bodies in an enclosure; Radiation shields; Radiation combined with conduction and convection; Absorption and emission in gaseous medium; Solar radiation; Green house effect.

UNIT-5

Heat Exchanger:
Types of heat exchangers; Fouling factors; Overall heat transfer coefficient; Logarithmic mean temperature difference (LMTD) method; Effectiveness-NTU method; Compact heat exchangers.

Condensation and Boiling:
Introduction to condensation phenomena; Heat transfer relations for laminar film condensation on vertical surfaces and on outside & inside of a horizontal tube; Effect of non-condensable gases; Dropwise condensation; Heat pipes; Boiling modes, pool boiling; Hysteresis in boiling curve; Forced convection boiling.

Introduction to Mass Transfer:
Introduction; Fick’s law of diffusion; Steady state equimolar counter diffusion; Steady state diffusion though a stagnant gas film.

Books:
1. Fundamentals of Heat and Mass Transfer, by Incroperra& DeWitt, John Wiley and Sons
3. Heat Transfer by J.P. Holman, McGraw-Hill
4. Heat and Mass Transfer by Rudramoorthy and Mayilsamy, Pearson Education
5. Heat Transfer by Ghoshdastidar, Oxford University Press
7. Heat Transfer by Venkateshan, Ane Books Pvt Ltd
MANUFACTURING SCIENCE & TECHNOLOGY-II

Unit I
**Metal Cutting**

Unit-II
**Machine Tools**
(i) Lathe: Principle, construction, types, operations, Turret/capstan, semi/Automatic, Tool layout
(ii) Shaper, slotter, planer: Construction, operations & drives.

Unit-III
**Grinding & Super finishing**
(ii) Super finishing: Honing, lapping and polishing.

**Limits, Fits & Tolerance and Surface roughness:**
Introduction to Limits, Fits, Tolerances and IS standards, Limit-gauges, and surface-roughness.

Unit-IV
**B. Metal Joining (Welding)**

Unit-V
**C. Introduction to Unconventional Machining and Welding**
Need & benefits, application and working principle of EDM, ECM, LBM, EBM, USM. AJM, WJM. Similarly, non-conventional welding applications such as LBW, USW, EBW, Plasma- arc welding, Diffusion welding, Explosive welding/cladding. Introduction to Hybrid machining processes

Books and References:
Departmental Elective Course-1

I C ENGINES & COMPRESSORS

<table>
<thead>
<tr>
<th>Unit</th>
<th>Description</th>
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<tbody>
<tr>
<td>I</td>
<td>Introduction to I.C Engines: Engine classification and basic terminology, Two and four stroke engines, SI and CI engines, Valve timing diagram. Thermodynamic analysis of Air standard cycles, Otto cycle, Diesel cycle, Dual cycle, Stirling cycle, Ericsson cycles, Comparison of Otto, Diesel and Dual cycles Fuel air cycle, factors affecting the fuel air cycle, Actual cycle.</td>
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<tr>
<td>II</td>
<td>SI Engines: Combustion in SI engine, Flame speed, Ignition delay, Abnormal combustion and it's control, combustion chamber design for SI engines. Carburetion, Mixture requirements, Carburetors and fuel injection system in SI Engine Ignition system requirements, Magneto and battery ignition systems, ignition timing and spark plug, Electronic ignition, Scavenging in 2 Stroke engines, Supercharging and its effect</td>
</tr>
<tr>
<td>III</td>
<td>CI Engine: Combustion in CI engines, Ignition delay, Knock and it's control, Combustion chamber design of CI engines. Fuel injection in CI engines, Requirements, Types of injection systems, Fuel pumps, Fuel injectors, Injection timings Exhaust emissions from SI engine and CI engine and it's control</td>
</tr>
<tr>
<td>V</td>
<td>Compressors: Classification, Reciprocating compressors, Single and Multi stage compressors, Intercooling, Volumetric efficiency. Rotary compressors, Classification, Centrifugal compressor, Axial compressors, Surging and stalling, Roots blower, Vaned compressor.</td>
</tr>
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</table>
BOOKS:
2. Fundamentals of Internal Combustion Engines by H.N. Gupta, Prentice Hall of India
4. I.C Engine Analysis & Practice by E.F Obert.
7. Reciprocating and Rotary Compressors, by Chlumsky, SNTI Publications, Czechoslovakia

MECHATRONICS AND MICROPROCESSOR

Unit I
Introduction, synergy of systems, definition of mechatronics, applications of mechatronics in design and modeling, actuators and sensors, intelligent controls, robotics, manufacturing etc., objectives, advantages and disadvantages of mechatronics, examples of mechatronics systems in industry. Mechanical components in mechatronics, force, friction and lubrication, materials, mechanical behavior of materials, mechanisms used in mechatronics, lever and four bar mechanisms, bearing, belt, chain, cam, slider crank, clutches etc.

Unit II
Electronics elements in mechatronics, conductors, insulators and semiconductors, passive electrical components, resistors, capacitor and inductor, transformer, active elements, semiconductor devices, transistors and integrated circuits, digital electronics components like logic gates, flip-flops, shift register, multiplexer and counter. Computing elements in mechatronics, analog computer, timer, analog to digital converter, digital to analog converter, digital computer, microprocessor and its architecture, micro-controllers, programming logic controllers, their basic structures, mnemonics.

Unit III
System modeling and analysis, control system concepts, transfer function of physical systems, block diagrams representation of systems, transfer function of a system, standard input signals, time response of a first and second order systems to a step input, frequency response analysis, automatic control systems, digital control systems. Motion control devices, actuator types & application areas, hydraulic and pneumatic actuators, electrical actuators, DC servomotor, AC servomotor and stepper servomotor, micro-actuators, drive selection and applications.

Unit IV
Sensors and transducers, their static and dynamic performance characteristics, internal sensors, external sensors and micro-sensors, sensors for displacement, position and proximity; velocity, motion, force, fluid pressure, liquid flow, liquid level, temperature, light sensors, selection of Sensors. Stages in designing mechatronics systems, traditional and mechatronic design, possible design solutions, case studies of mechatronics systems, pick and place robot, automatic car park systems, engine management systems etc.

Unit V
Mechatronics in industry, autotronics, bionics and avionics and their various applications, mechatronics in manufacturing, features of mechatronics in manufacturing, flexible manufacturing systems, manufacturing automatic protocol, computer integrated manufacturing, just in time production systems, CNC machines, adaptive control machine system, CNC machine operations, challenges in mechatronics production units.
BOOKS & REFERENCES:

FINITE ELEMENT METHODS

<table>
<thead>
<tr>
<th>Unit</th>
<th>Introduction, exact solution vs approximate solution, principle of FEM, general procedure for finite element analysis, pre-processing, solution, post processing, various approximate methods, weighted residual method, variational or Rayleigh Ritz method, principle of minimum potential energy. Review of matrices, definition, types, addition or subtraction, multiplication, inverse of a matrix, calculus of matrix.</th>
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Unit II
Direct stiffness methods, linear spring as finite element, direct formulation of uni-axial bar, truss and beam elements, local and global coordinates, nodes and elements, stiffness matrix, formulation of global stiffness matrix, application of boundary conditions and forces, essential and natural boundary conditions, elimination method, penalty methods, calculation of element stresses and strains.

Unit III
Finite element formulation of 1-d problems, method of weighted residuals, strong and weak form, the Galerkin finite element method, application of Galerkin’s method to uni-axial bar and truss elements, Galerkin method for one dimensional heat conduction problems like heat transfer through wall, heat transfer through fin etc., one dimensional conduction with convection.

Unit IV
Interpolation or shape functions, compatibility, completeness and convergence requirements, shape functions for one and two dimensional elements, finding shape function using Lagrange polynomials. Application of FEM in scalar field problems, heat transfer in two dimensions, time dependent heat transfer.

Unit V
Concepts of plane stress and plain strain, displacement relation, stress-strain relations, equilibrium and compatibility equations, vector field problems, derivation of constant strain triangular element stiffness matrix and equations, treatment of body and surface forces, stress and strain computation. Practical considerations in finite element application, programming aspects, commercially available FEM packages, desirable features of a FEM packages, problem solving on a general purpose FEM software package like ANSYS, ABAQUS, NISA etc.

Books and References:
1. Fundamentals of Finite Element Analysis by David V Hutton, McGraw-Hill Learning
2. A First Course in Finite Element Method 5e by Daryl L Logan, Cengage Learning
3. Finite Element Analysis by G L Narasaiah, BS Publications.
5. Finite Element Method with Application in Engineering by Desai, Eldho and Shah, Pearson Education.
7. Introduction to Finite Elements in Engineering by Chandrupatla&Belagundu, Pearson Education.

ENGINEERING OPTIMIZATION

UNIT I
Introduction:
Historical Developments, and Review of Engineering applications of Optimization Techniques

Linear Programming:
Simplex method, Revised simplex method, Two phase method, Duality, Dual simplex method, Integer linear programming, 0-1 integer linear programming, solution by branch and bound method.

UNIT II

UNIT-III
Constrained Optimization Techniques: Introduction, Direct methods - Cutting plane method and Method of Feasible directions, Indirect methods - Convex programming problems, Exterior penalty function method, Examples and problems

UNIT-IV

UNIT-V

Books and References:

1. Engineering Optimization by Ravindran, Wiley India
2. Engineering Optimization: Theory and Application by S SRao, Wiley India
3. Linear and Non Linear Programming by Luenberger, Narosa

Design and Simulation - Lab I
Minimum eight experiments out of the following are to be performed.

Students are advised to use design data book for the design. Drawing shall be made wherever necessary on small drawing sheets

1. Design & drawing of Cotter joint.
2. Design & drawing of Knuckle joint.
3. Design of machine components subjected to combined steady and variable loads.
4. Design of eccentrically loaded riveted joint.
5. Design of boiler riveted joint.
6. Design of shaft for combined constant twisting and bending loads.
7. Design of shaft subjected to fluctuating loads.
8. Design and drawing of flanged type rigid coupling.
10. Design and drawing of helical spring.
11. Design and drawing of screw jack.

HEAT & MASS TRANSFER – LAB

Minimum eight experiment of the following

1. Conduction – Experiment on Composite plane wall
2. Conduction – Experiment on Composite cylinder wall
3. Conduction - Experiment on critical insulation thickness
4. Conduction – Experiment on Thermal Contact Resistance
5. Convection - Pool Boiling experiment
6. Convection - Experiment on heat transfer from tube-(natural convection).
10. Convection - Determination of thermal conductivity of fluid
11. Experiment on Stefan's Law, on radiation determination of emissivity, etc.
12. Experiment on solar collector, etc.
13. Heat exchanger - Parallel flow experiment

Heat exchanger - Counter flow experiment

MANUFACTURING TECHNOLOGY-II – LAB
Mini eight experiments out of the following along-with study of the machines / processes

1. Shear-angle determination (using formula) with tube cutting (for orthogonal) on lathe machine.
2. Bolt (thread) making on Lathe machine.
3. Tool grinding (to provide tool angles) on tool-grinder machine.
5. Machining a block on shaper machine.
7. Drilling holes on drilling machine and study of twist-drill.
8. Study of different types of tools and its angles & materials.
9. Experiment on tool wear and tool life.
10. Experiment on jigs/Fixtures and its uses.
SEMESTER - VI

FLUID MACHINERY

UNIT-I
Introduction: Impulse of Jet and Impulse Turbines:
Classification of Fluid Machines & Devices, Application of momentum and moment of momentum equation to flow through hydraulic machinery, Euler’s fundamental equation. Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat & curve), Classification of turbines, Impulse turbines, Constructional details, Velocity triangles, Power and efficiency calculations, Governing of Pelton wheel

UNIT-II
Reaction Turbines:
Francis and Kaplan turbines, Constructional details, Velocity triangles, Power and efficiency calculations, Degree of reaction, Draft tube, Cavitation in turbines, Principles of similarity, Unit and specific speed, Performance characteristics, Selection of water turbines.

UNIT-III
Centrifugal Pumps:
Classifications of centrifugal pumps, Vector diagram, Work done by impellor, Efficiencies of centrifugal pumps, Specific speed, Cavitation & separation, Performance characteristics.

UNIT-IV
Positive Displacement and other Pumps:
Reciprocating pump theory, Slip, Indicator diagram, Effect of acceleration, air vessels, Comparison of centrifugal and reciprocating pumps, Performance characteristics.

UNIT-V
Hydraulic accumulator, Hydraulic intensifier, Hydraulic Press, hydraulic crane, hydraulic lift, hydraulic Ram, hydraulic coupling, hydraulic torque converter, air lift pump, jet pump.

Spoken Tutorial (MOOCs):
Spoken Tutorial MOOC, 'Course on OpenFOAM', IIT Bombay(http://spoken-tutorial.org/)

BOOKS:
3. Fluid Mechanics and Machinery by C.S.P.Ojha, R. Berndtsson, P.N. Chandramouli, Oxford University Press
4. Fluid Mechanics and Fluid Power Engineering by D S Kumar, S K Kataria& Sons
5. Fluid Mechanics and Turbo machines by Das, PHI
6. Fluid Power with Applications, by Esposito, Pearson
7. Fluid Mechanics and hydraulic machines by Modi& Seth, Standard Book House
8. Fundamentals of Turbomachinery by Venkanna B.K., PHI
THEORY OF MACHINES

Unit I

Introduction, mechanisms and machines, kinematics and kinetics, types of links, kinematic pairs and their classification, degrees of freedom of planar mechanism, Grubler’s equation, mechanisms, inversion of four bar chain, slider crank chain and double slider crank chain.

Velocity analysis:
Introduction, velocity of point in mechanism, relative velocity method, velocities in four bar mechanism, instantaneous center.

Acceleration analysis:
Introduction, acceleration of a point on a link, acceleration diagram, Corioli’s component of acceleration, crank and slotted lever mechanism.

Unit II

Cams
Introduction, classification of cams and followers, cam profiles for knife edge, roller and flat faced followers for uniform velocity, uniform acceleration,

Gears and gear trains
Introduction, classification of gears, law of gearing, tooth forms and their comparisons, systems of gear teeth, length of path of contact, contact ratio, minimum number of teeth on gear and pinion to avoid interference, simple, compound, reverted and planetary gear trains, sun and planet gear train.

Unit III

Force analysis:
Static force analysis of mechanisms, D’Alembert’s Principle, dynamics of rigid link in plane motion, dynamic force analysis of planar mechanisms, piston force and crank effort. Turning moment on crankshaft due to force on piston, Turning moment diagrams for single cylinder double acting steam engine, four stroke IC engine and multi-cylinder engines, Fluctuation of speed, Flywheel.

Unit IV

Balancing:
Introduction, static balance, dynamic balance, balancing of rotating masses, two plane balancing, graphical and analytical methods, balancing of reciprocating masses,

Governors:
Introduction, types of governors, characteristics of centrifugal governors, gravity controlled and spring controlled centrifugal governors, hunting of centrifugal governors, inertia
governors. Effort and Power of governor

Unit V

**Brakes and dynamometers:**
Introduction, Law of friction and types of lubrication, types of brakes, effect of braking on rear and front wheels of a four wheeler, dynamometers, belt transmission dynamometer, torsion dynamometer, hydraulic dynamometer

**Text/Reference Books:**


MACHINE DESIGN-II

**UNIT I**
Principle of transmission and conjugate action

**Spur Gears**
Tooth forms, System of gear teeth, contact ratio, Standard proportions of gear systems, Interference in involute gears, Backlash, Selection of gear materials, Gear manufacturing methods, Design considerations, Beam strength of gear tooth, Dynamic tooth load, Wear strength of gear tooth, Failure of gear tooth, Design of spur gears, AGMA and Indian standards.

**Helical Gears**
Terminology, Proportions for helical gears, Forces components on a tooth of helical gear, Virtual number of teeth, Beam strength & wear strength of helical gears, Dynamic load on helical gears, Design of helical gears.

**UNIT II Bevel gears**
Terminology of bevel gears, Force analysis, Virtual number of teeth, Beam strength and wear strength of bevel gears, Effective load of gear tooth, Design of a bevel gear system.

**Worm Gears**
Types of worms, Terminology, Gear tooth proportions, Efficiency of worm gears, Heat dissipation in worm gearing, Strength and wear tooth load for worm gears, Design of worm gearing system.

**UNIT III Sliding Contact Bearing**
Types, Selection of bearing, Plain journal bearing, Hydrodynamic lubrication, Properties and materials, Lubricants and lubrication, Hydrodynamic journal bearing, Heat generation, Design of journal bearing, Thrust bearing-pivot and collar bearing, Hydrodynamic thrust bearing,
UNIT IV
Rolling Contact Bearing
Advantages and disadvantages, Types of ball bearing, Thrust ball bearing, Types of roller bearing, Selection of radial ball bearing, Bearing life, Selection of roller bearings, Dynamic equivalent load for roller contact bearing under constant and variable loading, Reliability of Bearing, Selection of rolling contact bearing, Lubrication of ball and roller bearing, Mounting of bearing

UNIT V
IC ENGINE parts
Selection of type of IC engine, General design considerations, Design of cylinder and cylinder head; Design of piston and its parts like piston ring and gudgeon pin etc.; Design of connecting rod; Design of crankshaft

Note: Design data book is allowed in the examination

Books and References:
4. Design of Machine Elements, Sharma and Purohit, PHI.
5. Design of Machine Eesign-M.F. Spott, Pearson Eductaion

DepartmentalElective Course-II

REFRIGERATION & AIR CONDITIONING  L T P
3 1 0
Unit-1
Refrigerat
ion:
Introduction to refrigeration system, Methods of refrigeration, Carnot refrigeration cycle, Unit of refrigeration, Refrigeration effect & C.O.P.

Air Refrigeration cycle:
Open and closed air refrigeration cycles, Reversed Carnot cycle, Bell Coleman or Reversed Joule air refrigeration cycle, Aircraft refrigeration system, Classification of aircraft refrigeration system. Boot strap refrigeration, Regenerative, Reduced ambient, Dry air rated temperature (DART).

Unit-2
Vapour Compression System:
Single stage system, Analysis of vapour compression cycle, Use of T-S and P-H charts, Effect of change in suction and discharge pressures on C.O.P, Effect of sub cooling of condensate & superheating of refrigerant vapour on C.O.P of the cycle, Actual vapour compression refrigeration cycle, Multistage vapour compression system requirement, Removal of flash gas, Intercooling, Different configuration of multistage system, Cascade system.

Unit-3
Vapour Absorption system;

**Refrigerants:**
Classification of refrigerants, Nomenclature, Desirable properties of refrigerants, Common refrigerants, Secondary refrigerants and CFC free refrigerants. Ozone layer depletion and global warming considerations of refrigerants

**Unit 4**
**Air Conditioning:**
Introduction to air conditioning, Psychometric properties and their definitions, Psychometric chart, Different Psychometric processes, Thermal analysis of human body, Effective temperature and comfort chart, Cooling and heating load calculations, Selection of inside & outside design conditions, Heat transfer through walls & roofs, Infiltration & ventilation, Internal heat gain, Sensible heat factor (SHF), By pass factor, Grand Sensible heat factor (GSHF), Apparatus dew point (ADP). Air Washers, Cooling towers & humidifying efficiency.

**Unit 5**
**Refrigeration Equipment & Application:**
Elementary knowledge of refrigeration & air conditioning equipment e.g compressors, condensers, evaporators & expansion devices, Food preservation, Cold storage, Refrigerates Freezers, Ice plant, Water coolers, Elementary knowledge of transmission and distribution of air through ducts and fans, Basic difference between comfort and industrial air conditioning.

**Books:**
1. Refrigeration and Air conditioning by C.P Arora, McGraw-Hill
3. Refrigeration and Air conditioning by R. C. Arora, PHI
6. Refrigeration and Air conditioning by Arora&Domkundwar. DhanpatRai

**PRODUCTION PLANNING & CONTROL**

<table>
<thead>
<tr>
<th>Unit-I</th>
<th>Introduction:</th>
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<tr>
<td>Types and characteristics of Manufacturing systems and Production systems, Objective and functions of Production, Planning &amp; Control, organization</td>
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<th>Unit-II</th>
<th>Production Planning:</th>
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<tr>
<td>Product development and design. BEP, profit volume chart, Material Resource Planning, Selection of material, methods, machines &amp; manpower. Routing, Loading, Scheduling, Job shop scheduling, sequencing of production operation, line balancing</td>
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Unit-III
Production Control:
Dispatching rules, dispatching of work card, move card, inspection card and reports, Control boards and charts. Expediting, progress reporting, corrective action, change in schedules.

Unit-IV
Evaluation and Analysis:
Elements of network and its development, Introduction to CPM and PERT techniques.

UNIT-V
Material Planning and Control:
Field and scope, material planning, inventories, types and classification, ABC analysis, economic lot (batch) size, lead time and reorder point, modern trends in purchasing, store keeping, store operations, Introduction to manufacturing resource planning (MRP) and enterprise resource planning (ERP)

Books and References:
5. Production Planning and Inventory Management by J.F. Magee & David Morris BOODMAN, McGraw Hill.

MECHANICAL VIBRATIONS

UNIT - I
Introduction, Classification of Vibration Systems, Harmonic motion, Vector representation of harmonic motion, Natural frequency & response, Effects of vibration, superposition of simple harmonic motions, beats, Fourier analysis-analytical and numerical methods.


UNIT - II

UNIT- III
Two Degree Freedom systems Introduction, Principal modes, Double pendulum, Torsional system with damping, Coupled system, Principle of vibration absorber, Undamped dynamic vibration absorbers, Torsional vibration absorber, Centrifugal pendulum absorbers, Vibration isolators and Dampers.

UNIT- IV
Multi-degree Freedom system: Exact Analysis, Undamped free and forced vibrations of multi-degree freedom systems, influence coefficients, Reciprocal theorem, Torsional vibration of multi-degree rotor system, Vibration of gear system, Principal coordinates, Continuous systems- Longitudinal vibrations of bars, Torsional vibrations of circular shafts.

UNIT- V
Multi Degree Freedom system: Numerical Analysis by Rayleigh’s method, Dunkerley’s, Holzer’s and Stodola methods, Rayleigh-Ritz method

Critical speed of shafts, Whirling of uniform shaft, Shaft with one disc with and without damping, Multi-disc shafts, Secondary critical speed.

Books and References:
2. Mechanical Vibrations-Theory & Practice, S Bhave, Pearson Education.
6. Mechanical Vibrations – Tse, Morse & Hinkle
7. Mechanical Vibrations – V. Rama Murthy, Narosa Publications
8. Mechanical Vibrations – D. Nag, Wiley

RELIABILITY ENGINEERING L TP

UNIT-I
Introduction: Definition of reliability, Failures & failures modes, Failure rates, MTTF, MTBF, Bath tub curve, Definition and factors influencing system effectiveness, various parameters of system effectiveness.

UNIT-II
Reliability Mathematics, Definition of probability, laws of probability, conditional probability, Bay's theorem, Various probability distributions, Data collection, Recovery of data, Data analysis Procedures, Empirical reliability calculations.

UNIT-III

UNIT-IV
Reliability Improvements: Methods of reliability improvement, component redundancy, system redundancy, types of redundancies-series, parallel, series - parallel, stand by and hybrid, effect of maintenance

UNIT-IV

Reliability Testing, Life testing, requirements, methods, test planning, data reporting system, data reduction and analysis, reliability test standards.

Books & references:


FLUID MACHINERY Lab

Minimum ten experiments out of the following along with study of the machines and processes

1. Impact of Jet experiment.
2. Experiment on Pelton wheel.
3. Experiment on Francis turbine.
4. Experiment on Kaplan turbine.
5. Experiment on Reciprocating pump.
6. Experiment on centrifugal pump.
7. Experiment on Hydraulic Jack/Press
8. Experiment on Hydraulic Brake
9. Experiment on Hydraulic Ram
10. Study through visit of any water pumping station/plant
11. Any other suitable experiment/test rig such as comparison & performance of different types of pumps and turbines.
12. Experiment on Compressor
13. Experiment for measurement of drag and lift on aerofoil in wind tunnel

THEORY OF MACHINES LAB

Minimum eight experiments out of the following:

1. Study of simple linkage models/mechanisms
2. Study of inversions of four bar linkage
3. Study of inversions of single/double slider crank mechanisms
4. Experiment on Gears tooth profile, interference etc.
5. Experiment on Gear trains
6. Experiment on longitudinal vibration
7. Experiment on transverse vibration
8. Experiments on dead weight type governor
9. Experiment on spring controlled governor
10. Experiment on critical speed of shaft
11. Experiment on gyroscope
12. Experiment on static/dynamic balancing
13. Experiment on Brake
14. Experiment on clutch

**Design And Simulation - Lab II**

L T P  
0 0 2

A. **Computer and Language**: Students are required to learn the basics of computer language such as C and C++ so that they should be able to write the computer programme (*3 practical turns*)

B. **Writing Computer programme for conventional design**: Students are required to write computer program and validate it for the design of machine components done in the theory subject (*5 practical turns*)

C. **Mini Project**: Each student will be given a real life problem for the complete design of a subsystem/system using either manual calculation with the help of design handbook or through computer programme, if needed. This will be done as home assignment to be submitted at the end of the semester.

**REFRIGERATION & AIR CONDITIONING Lab**

L T P  
0 0 2

**Minimum eight experiments out of the following:**

1. Experiment on refrigeration test rig and calculation of various performance parameters.
2. Study of different types of expansion devices used in refrigeration system.
3. Study of different types of evaporators used in refrigeration systems.
4. To study basic components of air-conditioning system.
5. Experiment on air-conditioning test rig & calculation of various performance parameters.
6. Experiment on air washers
7. Study of window air conditioner.
8. Study & determination of volumetric efficiency of compressor.
10. Visit of cold-storage and its detailed study.
11. Experiment on Ice-plant.
12. Experiment on two stage Reciprocating compressor for determination of volumetric efficiency, PV diagram and effect of intercooling.
14. Experiment on Desert coolers.