

Branch: Mechanical Engineering

Year: III, Semester: V

S. No.	Paper Code	Subject Name	Teaching Scheme			Credits
			L	T	P	
		Theory				
1	EME-501	Industrial Engineering	3	0	0	3
2	EME-502	Machine Design - I	2	1	0	3
3	EME-503	Kinematics of Machines	3	1	0	4
4	EME-504	Manufacturing Science - II	3	1	0	4
5	EME-505	Heat Mass Transfer	3	1	0	4
6	EME-506	Hydraulics Machines & Systems	3	1	0	4
		Practical				
1	EME-551	Machine Design Lab - I	0	0	2	1
2	EME-552	Manufacturing Science Lab - II	0	0	3	1
3	EME-553	Heat Mass Transfer Lab	0	0	2	1
4	EME-554	Hydraulics Machine Lab	0	0	2	1
5	GP-501	GP	-	-	-	0
		Total	17	5	9	26

Year: III, Semester: VI

S. No.	Paper Code	Subject Name	Teaching Scheme			Credits
			L	T	P	
		Theory				
1	EME-601	Operations Research	3	1	0	4
2	EME-602	Dynamics of Machine	3	1	0	4
3	EME-603	Machine Design - II	2	1	0	3
4	EME-604	Internal Combustion Engines	3	1	0	4
5	EME-605	Refrigeration and Air Conditioning	3	1	0	4
6	EME-061/064	Departmental Elective – I *	2	0	0	3
		Practical				
1	EME-651	Theory of Machines Lab	0	0	2	1
2	EME-652	Machine Design Lab - II	0	0	2	1
3	EME-653	Refrigeration and Air Conditioning Lab	1	0	2	1
4	EME-654	Seminar on Industrial Training Report - I	0	0	3	1
5	GP-601	GP	-	-	-	0
		Total	17	5	9	26

*** Departmental Elective – I**

1. **EME-061** Mechanical Vibrations
2. **EME-062** Unconventional Manufacturing Processes
3. **EME-063** Advanced Welding Technology
4. **EME-064** Product Development and Design

EME: 501 INDUSTRIAL ENGINEERING

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Unit-I

Introduction: Concept, Scope, Objective, Functions, Techniques, & Role of Industrial Engineering.

Meaning of Productivity, Difference Between Production & Productivity, Induces of Productivity, Reasons of Low Productivity, Techniques to Improve Productivity. Types of Production.

Unit-II

Time, Motion and Method Study: Meaning & Benefit of Work Study, Time & Motion Study, Micro-Motion Study PMTS, Micro-Machining Diagrams, Flow Charts, Standard Time.

Method Study, Work Measurement, Works Sampling. Basic Concept of Ergonomics.

Unit-III

Inventory control : Inventory, Cost, Deterministic Models, Introduction to supply chain management.

Break Even Analysis and Margin of Safety, Fixed and Variable Costs, Concept of Value Analysis and Value Engineering.

Depreciation and Its Causes, Obsolescence and Basic Ideas of Replacement, Concept and Utility of Maintenance.

Unit-IV

Quality control : Meaning, process control, SQC control charts, single, double and sequential sampling,

Introduction to TQM.

Unit-V

Production Planning & Control: Introduction, Objectives, Phases and Factors of PPC, Its Functions & Effectiveness. Concept of Just in Time & Concept of Supply Chain Management. Inventory, Cost, Deterministic Models, Concepts of In deterministic Model.

Plant layout and Materials Handling: Plant location type of layout, principles of facility layout principles of material handling, Material handling empts.

Replacement Analysis: Depreciation causes, obsolescence, service life of assets, Replacement of items.

Reference Books:

1. Khanna O.P., ;§Industrial Engineering & Management;”, Dhanpat Rai & Sons.
2. Shanker Ravi, ;§Industrial Engineering;”, Galgotia PVT Ltd.
3. Koontz H. & Donnel C. O., ;§Principle of Management & Analysis of Management Functions;”, Tata McGraw Hill Co.
4. Moore J., ;§Manufacturing Management;”, Prentice Hall Englewool cliffs: New Jersey.
5. Telsang Martand, ;§Industrial Engineering and Production Management;”, S. Chand, New Delhi

EME-502: MACHINE DESIGN-I

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2 1 0

UNIT I

Introduction Definition, Design requirements of machine elements, Design procedure, Standards in design, Selection of preferred sizes, Indian Standards designation of carbon & alloy steels, Selection of materials for static and fatigue loads

Design against Static Load Modes of Failure, Factor of Safety, Principal Stresses, Stresses due to Bending and Torsion, Theory of Failure

UNIT II

Design against Fluctuating Loads Cyclic Stresses, Fatigue and Endurance Limit, Stress Concentration Factor, Stress Concentration factor for various machine parts, Notch sensitivity, Design for finite and infinite life, Soderberg, Goodman & Gerber criteria

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

UNIT III

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

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

UNIT IV

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

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

Books and References:

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

EME-503: KINEMATICS OF MACHINES

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3 1 0

UNIT I

Introduction Links-types, Kinematics pairs-classification, Constraints-types, Degrees of freedom of planar mechanism, Grubler's equation, linkage mechanisms, inversions of four bar chain, slider crank chain and double slider crank chain

Velocity in Mechanisms Velocity of point in mechanism, relative velocity method, Velocities in four bar mechanism, slider crank mechanism and quick return motion mechanism, Rubbing velocity at a pin joint, Instantaneous center method, Types & location of instantaneous centers, Kennedy's theorem, Velocities in four bar mechanism & slider crank mechanism

UNIT II

Acceleration in Mechanisms Acceleration of a point on a link, Acceleration diagram, Coriolis component of acceleration, Crank and slotted lever mechanism, Klein's construction for Slider Crank mechanism and Four Bar mechanism, Analytical method for slider crank mechanism

Mechanisms with Lower Pairs Pantograph, Exact straight line motion mechanisms-Peaucellier's, Hart and Scott Russell mechanisms, Approximate straight line motion mechanisms-Grass-Hopper, Watt and Tchebicheff mechanisms, Analysis of Hooke's joint, Davis and Ackermann steering gear mechanisms.

UNIT III

FRICTION Laws of friction, Friction on inclined plane, Efficiency on inclined plane, Friction in journal bearing-friction circle, Pivots and collar friction-uniform pressure and uniform wear, Belt and pulley drive, Length of open and cross belt drive, Ratio of driving tensions for flat belt drive, centrifugal tension, condition for maximum power transmission, V belt drive

Brakes & Dynamometers Shoe brake, Band brake, Band and Block brake, Absorption and transmission type dynamometers

UNIT IV

CAMS Cams and Followers - Classification & terminology, Cam profile by graphical methods with knife edge and radial roller follower for uniform velocity, simple harmonic and parabolic motion of followers, Analytical methods of cam design – tangent cam with roller follower and circular cams with flat faced follower

UNIT V

Gears & Gear Trains Classification & terminology, law of gearing, tooth forms & comparisons, Systems of gear teeth, Length of path of contact, contact ratio, interference & under cutting in involute gear teeth, minimum number of teeth on gear and pinion to avoid interference, simple, compound, reverted and planetary gear trains, Sun and planet gear.

Books and References:

1. Theory of Machines - Thomas Bevan
2. Theory of Machines and Mechanisms- Shigley
3. Theory of Machines and Mechanisms-Ghosh & Mallik
4. Theory of Machines and Mechanisms- Rao & Dukkipati
5. Theory of Machines-S.S. Rattan
6. Kinematics of Machines-Dr. Sadhu singh

Unit-I

A Metal Cutting and Machine Tools Metal Cutting- Mechanics of metal cutting. Geometry of tool and nomenclature .ASA system Orthogonal vs. oblique cutting. Mechanics of chip formation, types of chips. Shear angle relationship. Merchant's force circle diagram. Cutting forces, power required. Cutting fluids/lubricants. Tool materials. Tool wear and tool life. Machinability. Dynamometer. Brief introduction to machine tool vibration and surface finish. Economics of 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.

(iii) Milling : Construction, Milling cutters, up & down milling. Dividing head & indexing. Max chip thickness & power required.

(iv) Drilling and boring : Drilling, boring, reaming tools. Geometry of twist drills.

Unit-III Grinding & Super finishing

(v) Grinding : Grinding wheels, abrasive & bonds, cutting action. Grinding wheel specification. Grinding wheel wear - attritions wear, fracture wear. Dressing and Truing. Max chip thickness and Guest criteria. Surface and Cylindrical grinding. Centerless grinding.

(vi) Super finishing : Honing, lapping, polishing. Standardization & Interchangeability, Limits, Fits & Tolerance and Surface roughness: Introduction to Standardization & Interchangeability Limits, Fits, Tolerances and IS standards, Limit-gauges, and surface-roughness.

Unit-IV Metal Joining (Welding)

Survey of welding and allied processes. Gas welding and cutting, process and equipment. Arc welding : Power sources and consumables. TIG & MIG processes and their parameters. Resistance welding - spot, seam projection etc. Other welding processes such as atomic hydrogen, submerged arc, electroslag, friction welding.

Soldering & Brazing

Thermodynamic and Metallurgical aspects in welding and weld,. Shrinkage/residual stress in welds. Distortions & Defects in welds and remedies. Weld decay in HAZ.

Unit-V Introduction to Un-conventional 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.

Books

1. Manufacturing science by Ghosh and Mallik
2. Fundamentals of Metal Cutting and Machine tools by Boothroyd
3. Production Technology by R.K. Jain
4. Production Technology - H.M.T.
5. Production Engineering Science by P.C. Pandey
6. Modern Machining Processes by P.C. Pandey & H.S. Shan
7. Manufacturing science by Degarmo
8. Fundamentals of metal cutting & machine tools - Juneja & Shekhon
9. Process & materials of manufacturing - Lindburg.

EME-505: HEAT & MASS TRANSFER

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UNIT-1

Introduction to Heat Transfer: Concepts of the mechanisms of heat flows; Conduction, convection and radiation; Effect of temperature on thermal conductivity of materials; Introduction to combined heat transfer mechanism.

Conduction : One-dimensional general differential heat conduction equation in the rectangular, cylindrical and spherical coordinate systems; Initial and boundary conditions.

Steady State one-dimensional Heat conduction : Composite Systems in rectangular, cylindrical and spherical coordinates with and without energy generation; Thermal resistance concept; Analogy between heat and electricity flow; Thermal contact resistance; Critical thickness 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; 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 convective boiling.

Introduction To Mass Transfer :

Introduction; Fick's law of diffusion; Steady state equimolar counter diffusion; Steady state diffusion through a stagnant gas film.

Books:

1. Elements of Heat transfer by Bayazitoglu & Ozisik, McGraw-Hill Book Company.
2. Heat Transfer By J.P. Holman, McGraw-Hill International edition.
3. Schaum's outline of Heat Transfer by Pitts & Sisson McGraw-Hill International edition.
4. Principles of Heat Transfer by Frank Kreith, McGraw-Hill Book co.

EME-506: HYDRAULIC MACHINES & SYSTEMS**L T P**
3 1 0**Unit-I**

Impact of jets: Hydrodynamic force of jets on stationary and moving flat, inclined and curved waves, jet striking centrally and at tip – velocity triangles at inlet and outlet – expressions for work done and efficiency – angular momentum principle.

Unit-II

Hydraulic Turbines: Classification of turbines- Pelton wheel- Reaction turbines- Inward and outward radial flow reaction turbines- Francis turbine- Axial flow reaction turbine- Kaplan turbine- Draft tube- Types- Theory- and efficiency of draft tube. Performance of Turbines: Specific Speed: Determination- Significance- Unit quantities- Unit speed- Unit discharge and unit power- Characteristic curves of hydraulic turbines- Constant head curves- Constant speed curves and Iso-efficiency curves- Governing of turbines.

Unit-III

Centrifugal Pumps: Main parts- Efficiency- Minimum speed for starting- Multi-stage centrifugal pumps- Specific speed of a centrifugal pump- Priming of a centrifugal pump- Characteristic curves- Main, Operational and constant efficiency curves- Cavitation- Effects- Cavitations in Hydraulic machines.

Unit-IV

Reciprocating Pumps: Main parts- Classification- Velocity and acceleration variation in suction and delivery pipes due to piston acceleration- Effect of variation of velocity on friction in suction and delivery pipes- Effect of acceleration in suction and delivery pipes on indicator diagram- Effect of friction- Maximum speed of reciprocating pump- Air vessels.

Unit-V

Hydraulic Devices – Hydraulic press - Hydraulic accumulator- Differential hydraulic accumulator- Hydraulic intensifier- Hydraulic ram- Hydraulic lift- Hydraulic crane- Fluid coupling- Hydraulic torque converter. Introduction to open and closed loop systems, Hydraulic and Pneumatic systems.

Text Books:

1. Fluid Mechanics and Hydraulic Machinery, R.K.Bansal, Laxmi publications.
2. Hydraulics and Fluid Mechanics by Modi and Seth, Standard book House

References:

1. Fluid Flow Machines, by N.S.Govinda Rao, Tata McGraw Hill pub. company Ltd.
2. Fluid Mechanics and Hydraulic Machines by K.R.Arora

3. Fluid Mechanics and Hydraulic Machines by R.K.Rajput
4. Elements of Hydraulic Machines & Fluidics by Jagadish Lal

EME-551: MACHINE DESIGN-I LAB

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Note: *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
9. Design and drawing of flexible coupling
10. Design and drawing of helical spring
11. Design and drawing of screw jack

EME-552: MANUFACTURING SCIENCE -II – LAB

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Say, min 8 experiments out of the following.

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.
4. Gear cutting on milling machine.
5. Machining a block on shaper machine.
6. Finishing of a surface on surface-grinding 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
11. Gas welding experiment
12. Arc welding experiment
13. Resistance welding experiment.
14. Soldering & Brazing experiment
15. Experiment on unconventional machining.
16. Experiment on unconventional welding.
17. Experiment on TIG/MIG Welding.
18. Macro and Microstructure of welding joints, HAZ.

EME-553: HEAT & MASS TRANSFER – LAB

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Minimum 10 experiment of the following.

1. Conduction - Composite wall experiment
2. Conduction - Composite cylinder experiment
3. Convection - Pool Boiling experiment
4. Convection - Experiment on heat transfer from tube-natural convection.
5. Convection - Heat Pipe experiment.
6. Convection - Heat transfer through fin-natural convection .
7. Convection - Heat transfer through tube/fin-forced convection.
8. Any experiment on Stefan's Law, on radiation determination of emissivity, etc.
9. Any experiment on solar collector, etc.
10. Heat exchanger - Parallel flow experiment
11. Heat exchanger - Counter flow experiment
12. Any other suitable experiment on critical insulation thickness.
13. Conduction - Determination of thermal conductivity of fluids.
14. Conduction - Thermal Contact Resistance Effect.

EME-554: HYDRAULICS MACHINE LAB

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Minimum 8 experiments from following.

1. Impact of Jet experiment.
2. Turbine experiment on Pelton wheel.
3. Turbine experiment on Francis turbine.
4. Turbine 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 detailed 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

EME-601: OPERATIONS RESEARCH

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Unit-I

Introduction: Basics of Operations Research

Linear Programming: Introduction & Scope, Problem formulation, Graphical Method, Simplex methods, primal & dual problem sensitivity analysis.

Unit-II

Transportation & Assignment problems

Deterministic Dynamic Programming - Multistage decision problems & solution, Principle of optimality.

Unit-III

Decision theory: Decision under various conditions.

Game Theory: Two Person Zero sum game, Solution with / without Saddle point, Dominance Rule, Different Methods like Algebraic, Graphical, Linear Programming

Sequencing: Basic assumption, n Jobs through two / three machines, 2 Jobs on m machines.

Unit-IV

Stochastic inventory models: Single & multi period models with continuous & discrete demands, Service level & reorder policy

Simulations: Use, advantages & limitations, Monte-carlo simulation, Application to queuing, inventory & other problems.

Unit-V

Queuing models: Characteristics of Queuing Model, M/M/1 & M/M/S system, cost consideration

Project Management: Basic concept, Rules for drawing the network diagram, Applications of CPM and PERT techniques in Project planning and control; crashing of operations; resource allocation.

Text Book: 1. Operation Research, by TAHA (PHI)

References:

1. Operations Research Methods and Problems, by M.Sasiene, A.Yespal and L.Friedman. (John Wiley)
2. O.R., by S.D.Sharma.(Kedarnadh Ramnadh & Co.,
3. Operations Research, by Kanthi swaroop,Gupta & Man Mohan

EME-602: DYNAMICS OF MACHINES

UNIT-I

Static Force Analysis: Introduction, Static Equilibrium, Equilibrium of Two-force and Three-force members, Member with Two force and a torque, Force convention, free body diagrams, Superposition.

Dynamic force Analysis: Introduction, D'Alemberts principle, Equivalent Offset inertia force, Dynamic analysis of Four bar and Single slider mechanisms, Klein's construction, velocity and acceleration of piston, angular velocity and angular acceleration of connecting rod, piston effort, turning moment on crank shaft, Inertia of connecting rod, Inertia forces in reciprocating Engines(Graphical method).

UNIT-II

Turning Moment & Flywheel: Turning moment on crankshaft, Turning moment diagrams-single cylinder double acting steam engine, four stroke IC engine and multi-cylinder steam engine, Fluctuation of energy, Flywheel

Gyroscope: Introduction, Precessional angular motion, gyroscopic couple, effect of gyroscopic couple on an aero plane, effect of gyroscopic couple on a naval ship during steering, gyroscopic couple on a naval ship during pitching, gyroscopic couple on a naval ship during rolling, stability of a four wheel drive moving in a curved path, stability of a two wheel vehicle taking a turn.

UNIT III

Balancing of Machines: Static and dynamic balancing, Balancing of several masses in the same plane and different planes, Balancing of reciprocating masses, Balancing of primary force in reciprocating engine, Partial balancing of two cylinder locomotives, Variation of tractive force, swaying couple, hammer blow.

UNIT IV

Governors: Terminology, Centrifugal governors-Watt governor, Dead weight governors-Porter & Proell governor, Spring controlled governor-Hartnell governor, Sensitivity, Stability, Hunting, Isochronism, Effort and Power of governor, Controlling force diagrams for Porter governor and Spring controlled governors

Mechanical Vibrations: Types of vibrations, Degrees of freedom, Single degree free & damped vibrations, Forced vibration of single degree system under harmonic excitation, Critical speeds of shaft.

Text Books:

1. Theory of machines by SS Rattan, Tata Mc Graw Hill publications.

References: 1. Theory of Machines by Thomas Bevan.

2. Theory of Machines by W.G.Green.

3. Theory of Machines by R.S. Khurmi & J.K.Gupta

4. Theory of Machines by Dr. Jagadishlal

5. Theory of Machines and Mechanisms by PL Ballaney

6. Theory of Machines and Mechanisms by Amitaba Ghosh and Ashok kumar

Mallik (EWP)

7. Design of Machinery by R.L.Norton

EME-603: MACHINE DESIGN-II

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UNIT-I

Friction Clutches Function, Types, friction materials Torque transmitting capacity of disc, cone and centrifugal clutches -Uniform Wear theory and Uniform pressure theory.

Brakes Energy equations block brake with short shoe and long shoe, Pivoted block brake with long shoe, Internal expanding brake, Band brake, Band and Block Brake, Disc Brake, self locking and self Energizing brakes.

UNIT-II

Belt Drives-Construction and classification, Analysis of belt tensions, Condition for Maximum power, Design of pulleys for flat belts.V-belts, Selection of V- belts, Grooved Pulleys.

Ropes drives-classification, Design of fiber and wire ropes

Chain drives- Roller chains, Geometric relationships, Polygon action of chain, power rating and design of Chain drives.

UNIT-III

Design of Sliding contact bearings - Lubrication modes, , Bearing modulus, McKee equations, Journal bearing design, Collar and thrust bearings. Bearing Failures.

Design of Roller and ball bearings – Classification, Static and dynamic load capacity, Stribeck's Equation, Equivalent bearing load, Load-life relationships, Load factor, Selection of bearings from manufacturers catalogue.

UNIT-IV

Design of Gears - Classification of gears, Spur, Helical, Bevel and Worm gears, , Standard tooth systems,

Spur and Helical gears- Terminology, Tooth failure, Face width and beam strength, Lewis equation, Design for dynamic and wear loads.

Bevel gears- Terminology, Force analysis, Beam Strength and Wear Strength of bevel Gears.

Worm gears- Terminology, proportions, Force analysis, friction in worm gears, design of worm gears.

UNIT-V

Design of I.C. Engine components Selection of type of IC engine, General design considerations, Design of Cylinder and cylinder head; Design of piston, piston ring and gudgeon pin; Design of connecting rod; Design of centre crankshaft.

Text book: 1. Design of Machine Elements by V.B. Bhandari, TMH Co. Ltd., New Delhi.

References: 1. Machine Design by R.K. Jain, Khanna publications.

2. Machine Design by R.S. Khurmi & J.K.Gupta

3. Machine Design by Pandyah and Shah

4. Mechanical Engineering Design by J.E.Shigley

EME-604: INTERNAL COMBUSTION ENGINES

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Unit-I

Introduction to I.C Engines: Engine classification, Air standard cycles, Otto cycle, Diesel cycle, Dual cycle, Comparison of Otto, Diesel and Dual cycles, Stirling cycle, Ericsson cycles, Actual cycle analysis, Two and four stroke engines, SI and CI engines, Valve timing diagram, Rotary engines, stratified charge engine.

Fuels: Fuels for SI and CI engine , Important qualities of SI and CI engine fuels, Rating of SI engine and CI engine fuels, Dopes, Additives, Gaseous fuels, LPG, CNG, Biogas, Producer gas, Alternative fuels for IC engines.

Testing and Performance: Performance parameters, Basic measurements, Blow by measurement, Testing of SI and CI engines.

Unit-II

SI Engines: Combustion in SI engine, Flame speed, Ignition delay, Abnormal combustion and its control, combustion chamber design for SI engines

Carburetion: Mixture requirements, Carburetor types, Theory of carburetor, MPFI.

Ignition system requirements, Magneto and battery ignition systems, ignition timing and spark plug, Electronic ignition.

Unit-III

CI Engine: Combustion in CI engines, Ignition delay, Knock and its control, Combustion chamber design of CI engines.

Fuel injection in CI engines, Requirements, Types of injection systems, Fuel pumps,

Fuel injectors, Injection timings.

Scavenging in 2 Stroke engines, pollution and its control.

Unit-IV

Engine Cooling: Different cooling systems, Radiators and cooling fans. 1

Lubrication: Engine friction, Lubrication principle, Type of lubrication, Lubrication oils, Crankcase ventilation.

Supercharging: Effect of altitude on power output, Types of supercharging

Unit-V

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.

Air Pollution and Control: Sources and classification, Effects of air pollution, Pollutants from I.C. engines, Mechanism of formation of pollutants, Particulate emissions, Exhaust gas treatment.

BOOKS:

1. Fundamentals of Internal Combustion Engine by Gill, Smith,Ziurs, Oxford & IBH Publishing CO
2. IC Engines, by Rogowsky, International Book Co.

3. A Course in International Combustion Engines, by Mathur & Sharma, Dhanpat Rai & Sons.
4. I.C Engine Analysis & Practice by E.F Obert.
5. I.C Engine, by Ganeshan, Tata Mc Graw Hill Publishers.
6. I.C Engine, by R. Yadav, Central Publishing House, Allahabad
7. Reciprocating and Rotary Compressors, by Chlumsky, SNTI Publications, Czechoslovakia
8. Turbines, Compressors and Fans, by S.M.Yahya, Tata Mc Graw Hill Pub.

EME-605: REFRIGERATION AND AIR CONDITIONING

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Unit-I

Introduction to Refrigeration: Necessity and applications – Unit of refrigeration and C.O.P – Mechanical Refrigerations – Types of ideal cycle of refrigeration.

Air Refrigeration: Bell Coleman cycle and Brayton Cycle, Open and Dense air systems – Actual air refrigeration system – Refrigeration needs of Air crafts air systems – Actual air refrigeration system – Refrigeration needs of Air crafts Application of Air Refrigeration, Justification – Types of systems.

Unit-II

Vapour compression refrigeration: working principle and essential components of the plant – simple vapour compression refrigeration cycle – COP – Representation of cycle on T-S, P-H and H-S charts – effect of sub cooling and super heating – cycle analysis – Actual cycle influence of various parameters on system performance – Use of P-H charts.

Refrigerants – Desirable properties – common refrigerants used – Nomenclature.

Unit-III

Vapour Absorption System: Calculation of max COP – description and working of NH₃ – water system – Li – Br system. Principle of operation three Fluid absorption system, salient features – Electrolux refrigerator.

Unit-IV

Non conventional refrigeration system: Thermo electric refrigeration – advantages, disadvantages, applications. Vortex tube refrigeration: construction & working, advantages, disadvantages, applications. Pulse tube refrigeration: construction & working, advantages, disadvantages, applications.

Unit-V

Introduction to air Conditioning: Psychometric Properties & Process – sensible and latent heat loads – characterization and SHF – Need for Ventilation, infiltration – concepts of RSHF, ASHF, ESHF and ADP. Concept of human comfort and effective temperature – comfort Air conditioning - industrial air conditioning and 115

Requirements – Air conditioning load calculations.

Air Conditioning systems - classification of equipment , cooling , heating humidification and dehumidification, filters, grills and registers, deodourants, fans and blowers. Heat pump – Heat sources – different heat pump circuits – Application.

Text books:

1. Refrigeration and Air Conditioning by Manohar Prasad , New Age
2. Refrigeration and Air Conditioning by CP Arora , Tata McGraw Hill
3. A course in Refrigeration and Air Conditioning by CP Arora & Domukundwar , Dhanpatrai & sons

Reference:

1. Principles of Refrigerations by Dossat, Willey

Departmental Elective – I
EME-061: MECHANICAL VIBRATIONS

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Unit-I

Fundamentals of Vibration: Brief history of vibration, Importance of the study of vibration, Basic concepts of vibration, Classification of vibrations, Vibration analysis procedure, Spring elements, Mass or inertia elements, Damping elements, Harmonic analysis.

Free Vibration of Single Degree Of Freedom Systems: Introduction, Free vibration of an undamped translational system, Free vibration of an undamped torsional system, Stability conditions, Raleigh's energy method, Free vibration with viscous damping, Free vibration with coulomb damping, Free vibration with hysteretic damping.

Unit-II

Harmonically Exited Vibrations: Introduction, Equation of motion, Response of an undamped system under harmonic force, Response of a damped system under harmonic force, Response of a damped system under harmonic motion of the base, Response of a damped system under rotating unbalance, Forced vibration with coulomb damping, Forced vibration with hysteresis damping.

Unit-III

Vibration Under General Forcing Conditions: Introduction, Response under a general periodic force, Response under a periodic force of irregular form, Response under a non periodic force, Convolution integral.

Two Degree of Freedom Systems: Introduction, Equation of motion for forced vibration, Free vibration analysis of an undamped system, Torsional system, Coordinate coupling and principal coordinates, Forced vibration analysis.

Unit-IV

Multidegree of Freedom Systems: Introduction, Modeling of Continuous systems as multi degree of freedom systems, Using Newton's second law to derive equations of motion, Influence coefficients, Free and Forced vibration of undamped systems, Forced vibration of viscously damped systems.

Determination Of Natural Frequencies And Mode Shapes: Introduction, Dunkerley's formula, Rayleigh's method, Holzers method, Matrix iteration method, Jacobi's method.

Unit-V

Continuous Systems: Transverse vibration of a spring or a cable, Longitudinal vibration of bar or rod, Torsional vibration of a bar or rod, Lateral vibration of beams, critical speed of rotors.

Text Book:

1. Mechanical Vibrations by S.S.Rao, Addison Wesley Publishing (or Pearson education)
References: 1. Mechanical Vibrations by G.K. Grover, Nem Chand Publishers
2. Mechanical Vibrations by W.T. Thomson, Addison-Wesley Publisher

EME-062: UNCONVENTIONAL MANUFACTURING PROCESSES

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Unit-I Introduction: Limitations of conventional manufacturing processes, need of unconventional manufacturing processes & its classification and its future possibilities.

Unit-II Unconventional Machining Process: Principle and working and applications of unconventional machining process such as Electro-Discharge machining, Electrochemical machining, ultrasonic machining, Abrasive jet machining etc.

Unit-III Unconventional Machining Process (continued) :Principle and working and application of unconventional machining processes such as Laser beam machining, Electron beam machining, Ultrasonic machining etc. (these can also be used for welding).

Unit-IV Unconventional welding processes: Explosive welding, Cladding etc. Under water welding, Metalizing, Plasma arc welding/cutting

Unit-V Unconventional Forming processes: Principle, working and applications of High energy forming processes such as Explosive Forming, Electromagnetic forming, Electro- Discharge forming, water hammer forming, explosive compaction etc.

Electronic-device Manufacturing: Brief description of Diffusion and Photo- Lithography process for electronic-device manufacturing.

Books

1. Modern Machining Processes – P.C. Pandey
2. Unconventional Machining – V.K. Jain

EME-063: ADVANCED WELDING TECHNOLOGY

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Unit-I Introduction : Importance and application of welding, classification of welding process. Selection of welding process.

Brief review of conventional welding process : Gas welding, Arc welding, MIG, TIG welding. Resistance welding. Electroslag welding, Friction welding etc. Welding of MS, CI, Al, Stainless steel & Maurer/Schaefflar Diagram. Soldering & Brazing.

Unit-II Advanced welding Techniques- Principle and working and application of advanced welding techniques such as Plasma Arc welding, Laser beam welding, Electron beam welding, Ultrasonic welding etc.

Unit-III Advanced welding Techniques (continued) : Principle and working and application of advanced welding techniques such as explosive welding/ cladding, Underwater welding, Spray-welding / Metallising, Hard facing.

Unit-IV Weld Design : Welding machines/equipments and its characteristics and arc-stability, Weld defects and distortion and its remedies, Inspection/testing of welds, Weld Design, Welding of pipe-lines and pressure vessels. Life prediction.

Unit-V Thermal and Metallurgical consideration.: Thermal considerations for welding, temperature distribution, Analytical/Empirical analysis/formulae, heating & cooling curves. Metallurgical consideration of weld, HAZ and Parent metal, micro & macrostructure. Solidification of weld and properties.

Books

Welding Hand Book

EME -064: PRODUCT DEVELOPMENT AND DESIGN

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Unit-I: Introduction to Product Design Introduction to PDD, Applications, Relevance, Product Definition, Scope, Terminology.

Design definitions, the role and nature of design, old and new design methods, Design by evolution. Examples such evolution of bicycle, safety razor etc. Need based development, technology based developments. Physical reliability & Economic feasibility of design concepts.

UNIT II: Morphology of Design Divergent, transformation and convergent phases of product design. Identification of need, Analysis of need. Design for what? Design criteria, functional aspects. Aesthetics, ergonomics, form (structure). Shape, size, color. Mental blocks, Removal of blocks, Ideation Techniques. Creativity, Checklist.

UNIT III: Transformations Brainstorming & Synectics. Morphological techniques. Utility concept, Utility value, Utility index. Decision making under multiple criteria. Economic aspects of design. Fixed and variable costs. Break-even analysis.

UNIT IV: Reliability Reliability considerations, Bath tub curve, Reliability of systems in series and parallel. Failure rate, MTTF and MTBF. Optimum spares from reliability consideration. Design of displays and controls, Man-Machine interface, Compatibility of displays and controls. Ergonomic aspects. Anthropometric data and its importance in design. Applications of Computers in product design.

UNIT V: Product Appraisal Information and literature search, patents, standards and codes. Environment and safety considerations. Existing techniques such as work-study, SQC etc. which could be used to improve method & quality of product. Innovation versus Invention. Technological Forecasting.

Recommended Books:

1. Product Design & Manufacturing - A.K.Chitab & R.C.Gupta, PHI (EEE).
2. The Technology of Creation Thinking - R.P. Crewford – Prentice Hall

EME-651: THEORY OF MACHINES LAB

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Note: Eight experiments out of the following are to be conducted

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

EME-652: MACHINE DESIGN-II LAB

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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 (3practical 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 theory subject (5practical 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.

EME-653: REFRIGERATION & AIR CONDITIONING LAB

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Minimum 8 experiments out of following

1. Experiment on refrigeration test rig and calculation of various performance parameters.
2. To study different types of expansion devices used in refrigeration system.
3. To study 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. To study air washers
7. Study of window air conditioner.
8. Study & determination of volumetric efficiency of compressor.
9. Visit of a central air conditioning plant and its detailed study.
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.

13. Study of Hermetically sealed compressor.
14. Experiment on Desert coolers.