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DEPARTMENT OF MECHANICAL ENGINEERING

5th Semester:

SL.No	Course code	Subject	Teaching Scheme			Credits
Theory			**L**	**T**	**P**	
1.	MEL1501	Heat Transfer	2	1	0	3
2.	MEL1502	Manufacturing Science and Technology-II	3	0	0	3
3.	MEL1503	Dynamic of Machines	2	1	0	3
4.	MEL1504	Machine Design– I	2	1	0	3
5.	MEL1505	Industrial Management & Operation Research	3	0	0	3
Practical						
7.	MEP1501	Thermal Laboratory- I	0	0	2	1
8.	MEP1502	Manufacturing Laboratory- II	0	0	2	1
9.	MEP1503	Dynamics of Machines Laboratory	0	0	2	1
					Total	**18**

MEL1501: Heat Transfer

1. Course Description:

Heat Transfer introduces you to the concept of One- dimensional heat conduction equation for slab, cylinder, sphere and composite medium (with and without heat generation), Concept of critical thickness of insulation. Numerical methods for solution of heat conduction problems. Analysis of steady- state heat transfer for fins of uniform cross section, Fin performance. Nature of thermal radiation, Radiative properties, Kirchhoff's law, Black body radiation intensity and total emissive power, Displacement law, Radiation heat transfer between black/grey surfaces, network method of solving radiation problems, Concept of view factor. Application of dimensional analysis to free and forced convection, Concept of velocity and thermal boundary layer, Equations of motion and energy, Empirical equations of convective heat transfer, Reynolds analogy, Heat transfer in boiling and condensation. Basic types of heat exchanger, LMTD and NTU method of heat exchanger analysis. Computational studies in heat transfer processes in Conduction, Convection and Radiation. Experimental techniques related to heat transfer analysis. Heat transfer analysis from commercial software.

2. Learning Outcome:

On completion of the course, the students will be able to:

- Comprehend the different mode of heat transfer and develop heat transfer equipment as per need.
- Formulate basic equations and Laws for heat transfer problems.
- Design and calculate performance of thermal systems related to one dimensional, steady state and transient state for conduction and convection heat transfer
- Calculate and execute the impact of boundary conditions on the solutions of heat transfer in conduction and convection problems like extended surfaces (Fins)
- Determine performance of thermal systems related to one dimensional, natural and Forced Convection heat transfer by Theoretically and Experimentally.
- Deal with heat transfer configurations for radiation between objects with simple geometries
- Implement the knowledge acquired to evaluate effectiveness and rating of heat exchangers for single and multiphase phenomenon.

3. Broad Course Outline:

- Conduction Heat Transfer
- Transfer For Extended Surfaces
- Radiation Heat Transfer
- Convection

- Heat Exchangers

4. Text & Reference Books:

- R Yadav: Heat Transfer: Central Publishing House, Allahabad.
- R.K Rajpoot: Heat and Mass Transfer: S. Chand
- D.S.Kumar: Heat and Mass Transfer" S.K Kataria & sons
- Y.V.C Rao: Heat Transfer: University Press
- Bayazitouglu & Ozisik: Elements of Heat transfer: T.M.H
- J.P Holman: Heat Transfer: McGraw-Hill International edition
- Pitts & Sisson: Schaum's outline of Heat Transfer: McGraw-Hill International edition
- Frank Kreith: Principles of Heat Transfer", McGraw-Hill Book

MEL1502: Manufacturing Science and Technology-II

1. Course Description:

Manufacturing Science and Technology-II introduces you to the concept of Mechanics of Metal Cutting. Geometry of Tool and Nomenclature, ASA System, Mechanics of Chip Formation, Types of Chips. Merchant's Circle Analysis, Cutting Forces, Power Required, Tool Material, Tool Wear and Tool Life, Machinability. Grinding Wheel, Abrasive & Bonds, Grinding Wheel Specifications, Grinding Wheel Wear, Attritions Wear & Fracture Wear, Dressing & Truing, Surface Grinding, Cylindrical Grinding & Center less Grinding. Working Principle,Constructions and Operations of Turret and Capstan Lathe, Tool Lay Out Turret and Capstan Lathe, Shaper, Planer, Slotter, Milling, Dividing Head and Indexing. Introduction to Rapid Prototyping Technology (RPT), Rapid Manufacturing, Rapid Tooling Application and Advancement. Introduction of Solid Based (SB), Liquid Based (LB), Powder Based (PB) Rapid Prototyping..Working Principle & Applications of Laser Beam Machining (LBM), Electron Beam Machining (EBM), Electro chemical Machining (ECM), Electric Discharge Machining (EDM), abrasive Jet Machining (AJM), Ultrasonic Machining (USM) and Plasma Arc Machining(PAM). Introduction of Hybrid Machining. Super-Finishing Process: Honing, Lapping & Buffing, Magnetic Abrasive Finishing (MAF)

2. Learning Outcome:

On completion of the course, the students will be able to:

- Explain the mechanics of metal cutting, cutting tool materials, tool wear and cutting fluids.
- Discuss about the constructional feature of different types of lathe and their operations.
- Describe the construction & working of shaping, milling &drilling machines and gear cutting & finishing process.
- Illustrate the various types of grinding machines and broaching machines.
- Explain the construction feature of different types of CNC machine and manual part programming for a given component.

3. Broad Course Outline:

- Machining
- Machine Tools
- Advanced Machining

4. Text & Reference Books:

- P N Rao: Manufacturing Technology Vol 2- Metal Cutting and Machine Tools: Tata McGraw Hill
- Schey: Introduction to Manufacturing Process: McGraw-Hill
- S K Hajra Choudhury: Workshop Technology Vol II Machine Tools: Media Promoters & Publishers Pvt. Ltd.
- G Boothroyd & W A Knight: Fundamentals of Machining and Machine Tools: CRC Press Taylor & Francis Group
- H Gerling: All About Machine Tools: New Age Int. (P) Ltd.
- R K Jain: Production Technology: Khanna Publishers
- A. Ghosh & A. K. Mallik: Manufacturing Science: Affiliated East-West Press Pvt. Ltd.
- B S Raghuwanshi: A Course in Workshop Technology Vol II (Machine Tools): Dhanpat Rai & Co.

MEL1503: Dynamics of Machines

1. Course Description:

Dynamics of Machines introduces you to the concept of Static Equilibrium of Two/Three Force Members, Static Equilibrium of Member With Two Forces and Torque, Static Force Analysis of Linkages, D'alembert's Principle, Equivalent Offset Inertia Force, Dynamic Force Analysis of Four Link Mechanism and Slider Crank Mechanism, Engine Force Analysis-Piston and Crank Effort. 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. 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, Hameer Blow. 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. Pivots and Collar Friction-Uniform Pressure and Uniform Wear, Frictional, Centrifugal Clutches, 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. Shoe Brake, Band Brake, Band and Block Brake, Absorption and Transmission Type Dynamometers.
Gyroscopic Torque, Effect of Gyroscopic Couple on the Stability of Two Wheeler and Four Wheeler, Ships and Aero-Planes. Types of Vibrations, Degrees of Freedom, Single Degree Free & Damped Vibrations, Forced Vibration of Single Degree System Under Harmonic Excitation, Critical Speeds of Shaft.

2. Learning Outcome:

On completion of the course, the students will be able to:

- Explain the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
- Explain the undesirable effects of unbalances resulting from prescribed motions in mechanism.
- Calculate the natural frequencies for undamped and damped vibrating systems.
- Solve problem on effect of Dynamics of undesirable vibrations.
- Explain the principles in mechanisms used for speed control and stability control.

3. Broad Course Outline:

- Static & Dynamic Force Analysis
- Turning Moment & Flywheel
- Balancing of Rotating and Reciprocating Masses
- Governors

- Friction
- Brakes & Dynamometers
- Gyroscopic Motion
- Mechanical Vibrations

4. Text & Reference Books:

- Norton: Kinematics and Dynamics of Machinery (SIE): Mc Graw-Hill, 1/e,
- Rattan: Theory of Machines: Mc Graw-Hill, 3/e
- Gowda: Mechanical Vibrations: Mc Graw-Hill, 1/e
- J. S. Rao & R.V. Dukkipati: Mechanism & Machine Theory: New Age International Publication
- B. C. Kuo: Automatic Control System: Prentice Hall International
- A.Ghosh & A.K. Mallick: Theory of Mechanisms & Machines: Affiliated East West Press Pvt Ltd
- Kenneth J. Waldron and Gary L. Kinzel: Kinematics, Dynamics and Design of Machinery: Wiley India

MEL1504: Machine Design-I

1. Course Description:

Machine Design-I introduces you to the concept of 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. Statistical Considerations, Selective Assembly, Design Consideration in Machining, Castings, Forgings, Welding. Modes of Failure, Factor of Safety, Principal Stresses, Stresses Due to Bending and Torsion, Theories of Failure. 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 Criteria. Types of Riveted Joints, Failure of Riveted Joint, Efficiency of Riveted Joint, Design of Boiler Joints, Eccentric Loaded Riveted Joint. Design of Bolted Joint, Eccentrically Loaded Bolted Joint. Stresses in Butt and Fillet Welds, Eccentrically Loaded Joint. 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. Types of Keys, Splines, Design of Square & Flat Keys, Couplings-Design of Rigid and Flexible Couplings. 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, Design of Leaf Spring. Forms of Threads, Multiple Threads, Efficiency of Square Threads, Trapezoidal Threads, Stresses in Screws, Design of Screw Jack.

2. Learning Outcome:

On completion of the course, the students will be able to:

- Apply the principle of solid mechanics to design machine member under variable loading.
- Calculate the diameter of shafts based on strength, rigidity and design various types of coupling based on application.
- Calculate design parameters of permanent and temporary joint on various loading application.
- Calculate the design parameter for energy storage element and engine components.
- Calculate the design parameters of various types of bearings.

3. Broad Course Outline:

- Introduction
- Manufacturing Consideration in Design
- Design Against Static Load
- Design Against Fluctuating Loads
- Design of Riveted Joints
- Design of Threaded Joint
- Design of Welded Joints
- Keys and Couplings
- Mechanical Springs
- Power Screws

4. Text & Reference Books:

- Sharma and Agrawal: Machine Design: S.K. Katara & Sons.
- V.B Bhandari: Design of Machine Elements: Tata McGraw Hill Co.
- E Joseph Shigely: Mechanical Engineering Design: McGraw Hill Publications.
- Alex Valance and Doughtie: Design of Machine Members: McGraw Hill Co.
- M.F Spott: Machine design: Prentice Hall India.
- Maleev and Hartman: Machine Design: CBS Publications.
- Black & Adams: Machine design: Mc Graw Hill.

MEL1505: Industrial Management & Operation Research

1. Course Description:

Industrial Management & Operation Research introduces you to the concept of Historical background; Work study definition; Role of work study in improving productivity; Ergonomics and work study. Work study procedure: selection of jobs; Information collection and recording; Recording techniques -charts and diagrams; critical analysis; developing better method; installation and follow up of standard method. Memo motion and Micro motion study; therbligs; cycle graph and chrono cycle graph; SIMO chart;

Principles of motion economy; Design of work place layout. Performance rating; Definition and Procedure; Concept of normal time; allowances. Work sampling technique of work measurement. Introduction to pre-determined motion time system. Introduction and definitions of quality, Evolution of Quality: Inspection, Quality Control, Customer-Orientation: Internal & External Customer Concept, Life cycle approach to quality costs-Prevention; Appraisal and Failure costs. Seven QC tools (Histogram, Check sheets, Ishikawa diagrams, Pareto, Scatter diagrams, Control charts). Factors influencing the selection, rural and urban locations of sites, optimum decision on choice of site and analysis. Plant Layout: Types of production, types of layouts, advantages and disadvantages of layout, factor affecting layout, systematic layout planning, Material handling: importance, principles of material handling. General methodology of OR, application of OR, Formulation of linear programming, deterministic models, graphical solution, simplex algorithm. Inventory related costs, EOO model, EPO model, Inventory models allowing shortages, Inventory models allowing price discounts, Inventory model under risk conditions, Inventory control systems: continuous review, periodic review, optional replenishment etc., Inventory classification systems: ABC, FMS, VED etc, MRP. Project scheduling with CPM, Project scheduling with PERT. Loading and Scheduling , General scheduling problem, Significance of loading and scheduling, Factors affecting scheduling, Scheduling system, Flow shop scheduling, Job shop scheduling, Sequencing, Line balancing.

2. Learning Outcome:

On completion of the course, the students will be able to:

- Identify and formulate LP problems using various methods for maximization and minimization problems.
- Apply mathematical techniques in different application areas of operations research like transportation and network models.
- Formulate mathematical models for quantitative analysis of Inventory control practice in industry.
- Calculate the queue length and waiting time for queuing models to make business decisions in operational research.
- Apply mathematical techniques to solve decision models using search technique and dynamic programming method.

3. Broad Course Outline:

- Introduction
- Performance rating
- Quality
- Site Selection
- Operation Research
- Inventory
- CPM and PERT

4. Text & Reference Books:

- S.N. Chary: Production And Operations Management: McGraw Hill Publ, 5th Edition
- Chase: Operations and Supply Management (SIE): McGraw Hill Publ, 12/e
- Saxena: Production and Operations Management: McGraw Hill Publ, 2/e
- O.P. Khanna: Industrial engineering and management: Dhanpat Rai & Sons

MEP1501: Thermal Laboratory-I

1. Course Description

The Lab sessions would include experiments on:

- Determination of thermal conductivity of insulating powder at average temperature
- Determination of thermal conductivity of metal rod (Brass, Copper, Aluminium)
- Study of heat transfer in natural convection
- Study of heat transfer in forced convection
- Demonstration of thermal conductivity of heat pipe
- Study of heat exchanger service unit
- Study of Stefan-Boltzman apparatus

2. Learning Outcome:

On completion of the course, the students will be able to:

- Understand thoroughly about various types of heat transfer machines and devices
- Grasp knowledge about thermal conductivity
- Know about heat transfer in natural, forced convection
- Understand heat exchangers, heat pipes, Stefan-Boltzman apparatus

3. Broad Course Outline:

- Predict the thermal conductivity of different setup and apparatus
- Analyze heat pipes
- Analyse and study the heat transfer in natural and forced convection and compare
- Study different setups for heat exchanger and Stefan-Boltzman apparatus

MEP1503: Dynamic of Machines Laboratory-I

1. Course Description:

The Lab sessions would include experiments on:

- Experimental investigation of the Characteristics of Dead Weight Mechanical Governor.
- Experimental investigation of the Characteristics of Spring Controlled Governor.
- Determination of Critical Speed in Whirling of Shafts.
- Study of the Principles of Gyroscope and Verification of the Equation of Gyroscopic Couple.
- Study of the Concept of Statics & Dynamic Balancing of Rotating Masses in Single and Multi Planes and Verification of Balancing Principles.
- Measurement of Slip in Flat Belt under Different Belt Tensions and Varying Load Conditions.
- Measurement of Slip in V Belt under Different Belt Tensions and Varying Load Conditions. Measurement of Creep in Flat Belt.
- Measurement of Creep in V Belt.

2. Learning Outcome:

- Understand the working of different types of Governor
- Understand the different conditions of whirling of shafts
- Measurement of Slip
- Measurement of Creep
- Working principle of Gyroscope

3. Broad Course Outline:

- Predict and investigate the characteristics of Governors
- Analyse and study the critical speed in whirling of shafts
- Study the principle of Gyroscope
- Measurement of Slip and Creep in V-belt, flat belt

MEP1502: Manufacturing Laboratory-II

Laboratory work based on the subject MEL1502.