SEMESTER-V

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Paper Code- ME-501
Credit- 4

MACHINE DESIGN-I

Course Outcomes:

1. Recall the basic concepts of Solid Mechanics to understand the subject and Classify various machine elements based on their functions and applications.
2. Apply the principles of solid mechanics to machine elements subjected to static and fluctuating loads.
3. To understand the riveting/bolted/welded methodology for the industrial application.
4. To understand the energy absorbing phenomena by the spring.
5. To understand the power transmission, locking and holding devices as shaft, keys and coupling for machine parts.

UNIT-I

Introduction to machine design, Definition, Classifications, Design requirements of machine elements, Design procedure, Standards in design, Selection of preferred sizes, Indian Standards designation of carbon & alloy steels, Classification of engineering materials, Selection materials for static and fatigue loads. Mechanical property of metals.

UNIT-II

Design for Static Loading: Modes of failure, Factor of safety, Principal stresses, Stresses due to bending and torsion, Theory of failure.

Design for Dynamic Loading: Cyclic loading, Type of cyclic stress, Terminology of stress cycle, static loading v/s dynamic loading, Fatigue and fatigue failure, Finite and infinite life, log S-log N curve, Endurance limit, Stress concentration, Stress concentration factor and stress concentration for various machine parts, Soderberg, Goodman & Gerber criteria, Notch sensitivity factor.

UNIT-III

Riveted Joints

Riveting methods, materials, Types of rivet heads, Types of riveted joints, Terminology of riveted joints, Caulking and Fullering, Mode of failure of riveted joint, Efficiency of riveted joint, Eccentric loaded riveted joint.

Bolted Joints

Threaded Fasteners and Power Screws Stresses in threaded fasteners, Effect of initial tension, Design of threaded fasteners under static loads, Design of eccentrically loaded bolted joints. Types of power screws, efficiency and self-locking, Design of power screw, Design of screw jack

Welded Joints

Introduction, Advantage and disadvantage, Type of welded joints, Strength of parallel fitted lap joint and Transverse fitted lap joint, Special cases of fillet welded joints.

UNIT-IV

Mechanical Springs

Definitions, Types of spring, Advantages of helical spring, Terminology of spring, End connections for compression helical spring, Stresses and deflection in helical springs of circular wire, Connection of spring: Spring in series and parallel.

UNIT-V

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.

Keys and Couplings

Types of keys, splines, Selection of square & flat keys, Strength of sunk key, Couplings, Requirement of good shaft coupling, Types of Shaft coupling, Design of rigid and flexible couplings.

Note: Design data book is allowed in the examination

Text /Reference Books:

1. Design of Machine Elements,V.B. Bhandari,TataMcGraw Hill Co,2020.
2. Machine Design-Sharma and Agrawal, S.K. Kataria&Sons,2013.
3. Machine Design, U C Jindal, Pearson Eductaion,2013.
4. Design of Machine Elements, Sharma and Purohit, PHI,2013.
5. Design of Machine Elements-M.F. Spott, Pearson Eductaion,2019.
6. Mechanical Engineering Design, 9e - Joseph E. Shigely, McGraw Hill Education,2011.
7. Elements of Machine Component Design, Juvinal & Marshek, John Wiley & Sons,2017.

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Paper Code- ME-502
Credit- 4

KINEMATICS OF MACHINE

Course Outcomes:

1. Understand the principles of kinematics of machines.
2. Calculate the velocity and acceleration for 4-bar and slider crank mechanism and Develop cam profile for followers executing various types of motions.
3. Apply the concept of gear, gear train and flywheel for power transmission.
4. Apply force analysis for slider crank mechanism and balance rotating & reciprocating masses in machines.
5. Apply the concepts of governors in fluctuation of load and brake & dynamometer in power transmission.

UNIT- I

Introduction, mechanisms and machines, kinematics and kinetics, types of links, kinematic pairs and their classification, types of constraint, 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, Coriolis 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. Turningmoment on crankshaft due to force on piston, Turning moment diagrams single cylinder double acting steam engine, four stroke IC engine and multi-cylinder e 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

Reference Books:

1. Kinematics and dynamics of machinery: Wilson and Sadler, Third edition, Pearson,2002.
2. Theory of Mechanisms and Machines: AmitabhaGhosh and Ashok kumarMallik, Third Edition Affiliated East-West Press,2008.
3. Theory of Machines and Mechanisms: Joseph Edward Shigley and John Joseph Uicker, Jr. Oxford University Press ,2014.
4. Kinematics and dynamics of machinery: R L Norton, McGraw Hill,2017
5. Theory of Machines: S.S. Rattan, McGraw Hill,2019

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Paper Code- ME-503
Credit- 4

HEAT AND MASS TRANSFER

Course Outcomes:

1. To understand the basics of various heat transfer phenomenon
2. To learn about the application of fins and understand other associated aspect.
3. To understand the basics of free and forced convection
4. To learn the basics of thermal radiation and laws associated with it
5. To understand the application and working principal of heat exchanger.

UNIT-I

Introduction to Heat Transfer: Thermodynamics and Heat Transfer. Modes of Heat Transfer: Conduction, convection and radiation. Effect of temperature on thermal conductivity of materials; Introduction to combined heat transfer mechanism. 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-II

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-III

Free convection: Physical mechanism of natural convection; Buoyant force; Empirical heat transfer relation for natural convection over vertical planes and cylinders, horizontal plates and cylinder, sphere, combined free and forced convection.

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.

UNIT-IV

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 nonblack bodies in an enclosure; Radiation shields; Radiation combined with conduction and convection; Absorption and emission in gaseous medium; Solar radiation; Greenhouse effect.

UNIT-V

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 and References:

1.Fundamentals of Heatand Mass Transfer, by Incroperra& DeWitt, John Wiley and Sons,2018
2.Heat and Mass Transfer by Cengel, McGraw-Hill,2020
3. Heat Transfer by J.P. Holman, McGraw-Hill,2009
4.Heat and Mass Transfer by Rudramoorthy and Mayilsamy, Pearson Education,2010
5. Heat Transfer by Ghoshdastidar, Oxford University Press,2012

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Paper Code- PE-012
Credit- 4

ADDITIVE MANUFACTURING

Course Outcomes:
At the end of this course students will demonstrate the ability to
1. Understand the overall principle and various processes for additive manufacturing.
2. Select a particular additive manufacturing process based on the end application.
3. Plan the steps in fabricating a given part using additive manufacturing.
4. To understand powder based and lesser based additive manufacturing process
5. To understand the various application of additive manufacturing.

UNIT-I

Introduction to Additive Manufacturing (AM): Evolution of AM/3D printing; Comparison with subtractive and forming processes; Advantages of AM; Classification of AM processes; Key steps in AM.

UNIT-II

Liquid State-based AM Processes: Stereo lithography – Process and working principle; Photopolymers; Photo polymerization, layering technology, Laser and Laser scanning; Micro-stereolithography; Equipment and specifications; Applications, advantages, disadvantages, examples; Solid ground curing: Process, Working principle; Equipment and specifications; Applications, advantages, disadvantages, examples.

UNIT-III

Solid State-based AM Processes: Fused Deposition Modeling – Process, working principle and materials; Equipment and specifications; Laminated object manufacturing – Process and working principle; Equipment and specifications; Applications, advantages, disadvantages, examples; Other solid-state processes – Ultrasonic consolidation, Gluing, Thermal bonding; Demonstration of equipment.

UNIT-IV

Powder Based AM Processes: Powder Bed Fusion Processes – Working principle and materials; Powder fusion mechanism and powder handling; Various LBF processes (principle, materials, applications and examples) – Selective laser Sintering, Electron Beam Melting, Laser Engineered Net Shaping, Binder Jetting and Direct Metal Deposition; Comparison between LBF processes; Materials-process-structure-property relationships; relative advantages and limitations.

UNIT-V

Applications of AM: Product development lifecycle applications – Rapid prototyping, concept models, visualization aids, replacement parts, tooling, jigs and fixtures, moulds and casting;

Application sectors – aerospace, automobile, medical, jewelry, sports, electronics, food, architecture, construction and others.

Text /Reference Books:

1. Sabrie Soloman, 3D Printing & Design, Khanna Book Publishing Company, New Delhi, 2020.
2. Ian Gibson, David W Rosen, Brent Stucker, "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping and Direct Digital Manufacturing", Springer, 2015'
3. Chua Chee Kai, Leong Kah Fai, "3D Printing and Additive Manufacturing: Principles & Applications," World Scientific, 2015.
4. C.P Paul, A.N Junoop, "Additive Manufacturing: Principles, Technologiesand Applications," McGrawHill, 2021.

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Paper Code- OE-012
Credit- 3

MACHINE LEARNING

Course Outcome (CO):

1. Understand and explain the fundamental concepts of machine learning, including supervised, unsupervised, and reinforcement learning, and their applications in solving real-world problems.
2. Apply various machine learning algorithms, such as linear regression, decision trees, support vector machines, and neural networks, to build predictive models using appropriate datasets.
3. Analyze and evaluate the performance of machine learning models using metrics such as accuracy, precision, recall, F1 score, and ROC curves, and improve model accuracy through techniques like cross-validation and hyper parameter tuning.
4. Implement and utilize machine learning libraries and frameworks, such as Scikit-learn, Tensor Flow, and PyTorch, to develop and deploy machine learning solutions in practical scenarios.
5. Address ethical considerations and societal impacts of machine learning, including issues related to bias, fairness, privacy, and transparency in algorithmic decision-making.

UNIT-I

Basic Concepts, Introduction to Machine Learning, Applications of ML, Design Perspective and Issues in ML, Supervised, Unsupervised, Semi-supervised learning with applications and issues, A Formal Learning Model, The Runtime of Learning.

UNIT-II

Model (or hypothesis) representation, decision boundary, cost function, gradient descent, regularization, Diagnostic: debugging a learning algorithm, evaluating a hypothesis (Model selection), training/validating/testing procedures, diagnosing bias versus variance and vice versa, regularization and bias/variance, learning curves, Accuracy and Error measures: classifier accuracy measures, predictor error measure, evaluating the accuracy of a classifier or predictor, Confusion metric, precision, recall, tradeoff between both, accuracy.

UNIT-III

Clustering: Unsupervised learning technique, Similarity and Distance Measures, k-means and k-medoids algorithm, optimization objective, random initialization, choosing value of k, EM algorithm Bayesian networks, bag of words classifiers, N-gram models; Markov and Hidden Markov models, Graphical Models, Combining Multiple Learners.

UNIT-IV

Reinforcement Learning: Elements of Reinforcement Learning, Model-Based Learning, Temporal Difference Learning, Generalization, Design and Analysis of Machine Learning Experiments.

UNIT-V

Genetic Algorithm, Schemata Theorem, Differential Evolution, Particle Swarm Optimization, Ant Colony Optimization, Convergence Analysis.
Genetic Algorithm, Schemata Theorem, Differential Evolution, Particle Swarm Optimization, Ant Colony Optimization, Convergence Analysis.

Text Book (s):

1. Ethem Alpaydin, Introduction to Machine Learning, PHI.
2. H. Witten and E. Frank, Data Mining: Practical Machine Learning Tools and Techniques Morgan Kaufmann.
3. Tom Mitchell, Machine Learning, McGraw-Hill.
4. Shai Shalev-Shwartz, and Shai Ben-David, "Understanding Machine Learning", Cambridge University Press
5. Haykin S., Neural Networks and Learning Machines, Third Edition, Prentice Hall.
6. NPTEL lectures on Introduction to Machine Learning

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Paper Code- ME-551
Credit- 1

MACHINE DESIGN LAB

Course Outcomes:

1. Apply the principles of solid mechanics to design various machine Elements subjected to static and fluctuating loads.
2. To understand the basics of riveted joint and perform the strength testing
3. To design spring for industrial purpose.
4. To understand the basics of power transmission elements.

List of Experiments: (At least 8 of the following)

1. Design a knuckle joint subjected to given tensile load.
2. Design and drawing of riveted joint.
3. Design a transverse fillet welded joint subjected to given tensile load.
4. Design of leaf spring.
5. Design of helical spring.
6. Design of Flat and square keys.
7. Design of shafts subjected to torsion, bending moment and combined bending and torsion.
8. Design of shaft subjected to fluctuating loading.
9. Design of rigid coupling.
10. Design of flexible coupling.

Paper Code- ME-552
Credit- 1

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THEORY OF MACHINE LAB

Course Outcomes:

1. Demonstrate various mechanisms, their inversions and brake and clutches in Automobiles.
2. Apply cam-follower mechanism to get desired motion of follower.
3. Apply the concepts of gears and gear train to get desired velocity ratio for power transmission.
4. Apply the concept of governors to control the fuel supply in engine.
5. Determine the balancing load in static and dynamic balancing problem.

List of Experiments: (At least 8 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

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Paper Code- ME-553
Credit- 1

HEAT TRANSFER LAB

Course Outcomes:

1. Apply the concept of conductive heat transfer.
2. Apply empirical correlations for both forced and free convection to determine the value of convection heat transfer coefficient.
3. Apply the concept of radiation heat transfer for black and grey body.
4. Analyze the thermal behaviour of parallel or counter flow heat exchangers.

List of Experiments: (At least 8 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).
7. Convection - Heat Pipe experiment.
8. Convection - Heat transfer through fin-(natural convection) .
9. Convection-Heat transfer through tube/fin-(forced 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.
14. Heat exchanger - Counter flow experiment.