



SPPU B.E./B.Tech MECH Sem 5 syllabus

Theory of Machine - II

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Turbo Machines

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Metrology And Quality Control

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Numerical & Statistical Methods

Numerical & Statistical Methods

Unit 1: Roots of Equation and Simultaneous Equations

Roots of Equation: Bracketing method and Newton-Raphson method

Solution of simultaneous equations:

Gauss Elimination Method with Partial pivoting, Gauss-Seidel method, Thomas algorithm for Tri-diagonal Matrix.

Unit 2: Numerical Solution of Differential Equations

Ordinary Differential Equations [ODE]: Taylor series method, Euler Method, Runge-Kutta 4th order. Simultaneous equations using Runge-Kutta 2nd order method.

Partial Differential Equations [PDE]: Finite difference method, Simple Laplace method, PDE's Parabolic explicit solution, Elliptic explicit solution.

Unit 3: Numerical Integration

Numerical Integration (1D): Trapezoidal rule, Simpson's 1/3rd Rule,

Simpson's 3/8th Rule, Gauss Quadrature 2-point and 3-point method.
Double Integration: Trapezoidal rule, Simpson's 1/3rd Rule.

Unit 4: Curve Fitting and Regression Analysis

Curve Fitting: Least square technique- first order, power equation, exponential equation and quadratic equation.

Regression Analysis: Linear regression, Nonlinear regression, Multiple regressions, Polynomial regression. Lagrange's interpolation, Numerical interpolation and differentiation using Newton's forward method, inverse interpolation (Lagrange's method only).

Unit 5: Statistics

Measures of central tendency: mean, median, mode. Measurement of variability and dispersion: Standard deviation, standard error, variance, range. Measure of shape: skewness, kurtosis
Statistical diagram: scattered diagram, histogram, pie charts, and measure of association between two variables. Correlation: Karl Pearson's Coefficient of correlation and its mathematical properties, Spearman's Rank correlation and its interpretations.

Unit 6: Probability and Linear Algebra

Probability: Joint, conditional and marginal probability, Bayes' theorem, independence, theorem of total probability, expectation and variance, random variables. Probability distributions: Binomial, Poisson, Geometric, Uniform, Exponential, Gamma, Normal and Chi square.

Linear algebra: Review of matrix operations, vector and vector spaces, linear mapping.

Heat and Mass Transfer

Heat and Mass Transfer

Unit - 1 Fundamentals of Heat Transfer

Basic Concepts: Different Modes and Laws of heat transfer, 3-D heat conduction equation in Cartesian coordinates (with derivation), and its simplified equations, simplified equations in cylindrical and spherical coordinates (simplified equations, no derivation) thermal conductivity, thermal diffusivity, electrical analogy, Thermal contact Resistance.

Boundary and initial conditions: Temperature boundary condition, heat flux boundary condition, convection boundary condition, radiation boundary condition.

1-D steady state heat conduction without and with heat generation: Heat conduction without heat generation in plane wall, composite wall, composite cylinder, composite sphere. Heat conduction with heat generation in Plane wall, Cylinder and Sphere with different boundary conditions.

Unit - 2 Heat Transfer through Extended Surfaces and Transient Heat Conduction

Thermal Insulation - Critical thickness of insulation, Types and properties of insulating materials, Safety considerations in thermal insulation, Economic and cost considerations, Payback period, Numerical on payback period.

Heat transfer through extended surfaces: Types of fins and its applications, Governing Equation for constant cross sectional area fins, Solution for infinitely long fin (with derivation), adequately long fin with insulated end tip and short fins (no derivation), Fin Efficiency & Effectiveness of fins, estimation of error in Temperature measurement by thermometer.

Transient heat conduction: Validity and criteria of lumped system analysis, Biot Number, Fourier Number, Time Constant and Response of thermocouple, Use of Heisler Charts for plane wall, cylinder and sphere.

Unit - 3 Convection

Principles of Convection: Local and average heat transfer coefficient, Hydrodynamic and Thermal boundary layer for a flat plate and pipe flow.

Forced Convection: Physical significance of non-dimensional numbers, Empirical correlations for flat plate, pipe flow, and flow across cylinders, spheres, tube banks.

Free Convection: Physical significance of non-dimensional numbers, Free convection from a vertical, horizontal surface, cylinder and sphere. Mixed Convection

Boiling and Condensation: Types of boiling, Regimes of pool boiling, Film wise condensation, Drop wise condensation (No Numerical treatment), Critical heat flux.

Unit - 4 Radiation

Thermal Radiation; definition of various terms used in radiation mode; Stefan-Boltzmann law, Kirchhoff's law, Planck's law and Wein's displacement law. Intensity of radiation and solid angle; Lambert's law; Radiation heat exchange between two black surfaces, configuration or view factor. Radiation heat exchange between grey surfaces, Electrical analogy for radiation, Radiation shields, Numerical.

Unit - 5 Mass Transfer

Physical origins, applications of mass transfer, Mixture Composition, Phase diagram, Fick's Law of Diffusion with numerical treatment, Restrictive Conditions, Mass diffusion coefficient, Conservation of Species, The Mass Diffusion equation - Cartesian coordinates deviation, cylindrical coordinates and Spherical coordinates (no derivation), Boundary and initial conditions.

Unit - 6 Heat Exchangers and Equipment Design

Heat Exchangers: Classification and applications of heat exchangers, Heat exchanger analysis - LMTD for parallel and counter flow heat exchangers, Effectiveness- NTU method for parallel and counter flow heat exchangers, cross flow heat exchangers, LMTD correction factor, Heat Pipe, Introduction to electronic cooling - Active and passive methods of augmented heat transfer.

Process Equipment Design: Condenser Design, Introduction to TEMA standards, Design considerations for heat exchangers, Materials of construction and corrosion, Temperature effects, Radiation effects, Economic consideration, Condenser and Heat exchanger design and performance calculations, Design of shell and tube type Heat Exchanger.

Design of Machine Elements

Design of Machine Elements

Unit - 1 Design of Simple Machine Elements

Factor of safety, Selection of Factor of Safety, Service factor, Design of Cotter joint, Knuckle joint, Design of hand / foot lever, lever for safety valve, bell crank lever, Design of components subjected to eccentric loading.

Unit - 2 Design of Shafts, Keys and Couplings

Shaft design on the Strength basis, torsional rigidity basis and lateral rigidity basis, Design of shaft as per A.S.M.E. code. Design of square and rectangular keys, Kennedy key and splines. Design of Flange Coupling and Bushed-Pin Flexible Coupling.

Unit - 3 Design of Power Screws

Terminology of Power Screw, Torque analysis and Design of power screws with square and trapezoidal threads, Collar friction torque, Self-locking screw, Efficiency of square threaded screw, Efficiency of self-locking screw, Design of screw, nuts and C-Clamp. Design of screw jack, Differential and Compound Screw and Re-circulating Ball Screw (Theoretical treatment only).

Unit - 4 Design against Fluctuating loads

Stress concentration and its factors, Reduction of stress concentration factors, fluctuating stresses, fatigue failures, endurance limit, S-N curve, Notch sensitivity, Endurance limit, Endurance strength modifying factors, Reversed stresses - Design for Finite and Infinite life, Cumulative damage in fatigue failure, Soderberg, Gerber, Goodman Lines, Modified Goodman diagrams, Fatigue design under combined stresses:- (Theoretical treatment only.)

Unit - 5 Threaded and Welded joints

Introduction to threaded joints, Bolts of uniform strength, locking devices, eccentrically loaded bolted joint in shear, Eccentric load perpendicular and parallel to axis of bolt, Eccentric load on circular base. Introduction to welded joints, Strength of butt, parallel and transverse fillet welds, Axially loaded unsymmetrical welded joints, Eccentric load in plane of welds, Welded joints subjected to bending and torsional moments.

Unit - 6 Design of Springs

Types and applications of springs, Stress and deflection equations for helical compression Springs, Springs in series and parallel, Design of helical springs, concentric helical springs, surge in spring, Design of Multi-leaf springs, Nipping of Leaf springs, Shot Peening.

Mechatronics

Mechatronics

Unit 1: Introduction to Mechatronics, Sensors & Actuators

Introduction to Mechatronics and its Applications Measurement Characteristics (Static/Dynamic),

Sensors: Types of sensors; Motion Sensors - Encoder (Absolute & incremental), Lidar, Eddy Current, Proximity (Optical, Inductive, Capacitive), MEMS Accelerometer;

Temperature sensor - Pyrometer, Infrared Thermometer; Force / Pressure Sensors - Strain gauges, Piezoelectric sensor; Flow sensors - Electromagnetic, Ultrasonic, Hot-wire anemometer; Color sensor - RGB type; Biosensors - Enzyme, ECG, EMG

Actuators: Servo motor; Hydraulic and Pneumatic (must be restricted to classification and working of one type of linear and rotary actuator); linear electrical actuators Selection of Sensor & Actuator.

Unit 2: Data Acquisition and Signal Communication

Signal Communication: Serial, Parallel; Synchronous, Asynchronous Introduction to DAQ, Types, Components of a Data Acquisition System (Sensor, Signal conditioning, processing, controlling and storage/display/action)

Data Acquisition: Signal collection, Signal conditioning - Isolation & Filtering, Amplification, Sampling, Aliasing, Sample and hold circuit, Quantization, Analog-to-digital converters (4 bit Successive Approximation type ADC), Digital-to-Analog converters (4 bit R2R type DAC), Data storage Applications: DAQ in Household, Digital Pressure Gauge, Digital Flow measurement, DVB Digital Video Broadcast, AM/FM.

Unit 3: Control systems & transfer function based modelling

Introduction to control systems, need, Types- Open and Closed loop, Concept of Transfer Function, Block Diagram & Reduction principles and problems; Applications (Household, Automotive, Industrial shop floor).

Transfer Function based modeling of Mechanical, Thermal and Fluid system; Concept of Poles & Zeros; Pole zero plot, Stability Analysis using Routh Hurwitz Criterion (Numerical Approach).

Unit 4: Time and Frequency Domain Analysis

Time Domain Analysis - Unit step Response analysis via Transient response specifications (Percentage overshoot, Rise time, Delay time,

Steady state error etc.)

Frequency Domain Analysis - Frequency Domain Parameters - Natural Frequency, Damping Frequency and Damping Factor; Mapping of Pole Zero plot with damping factor, natural frequency and unit step response ; Introduction to Bode Plot, Gain Margin, Phase Margin.

Unit 5: Controllers

Introduction to controllers, Need for Control, Proportional (P), Integral (I) and Derivative (D) control actions; PI, PD and PID control systems in parallel form; (Numerical approach), Feed forward anticipatory control

Manual tuning of PID control, Ziegler-Nichols method

Applications: Electro-Hydraulic/Pneumatic Control, Automotive Control.

Unit 6: Programmable Logic Controller (PLC)

Introduction to PLC; Architecture of PLC; Selection of PLC; Ladder Logic programming for different types of logic gates; Latching; Timers, Counters; PLC control of Hydraulics / Pneumatics / Mechatronics systems involving timing and counting operations.