SPPU B.E./B.Tech MECH Sem 4 syllabus

Kinematics of Machinery

Unit I Fundamentals of Mechanism
Kinematic link, Types of links, Kinematic pair, Types of constrained motions, Types of Kinematic
pairs, Kinematic chain, Types of joints, Mechanism, Machine, Degree of freedom, Mobility of
Mechanism, Inversion, Grashoff's law, Four-Bar Chain and its Inversions, Slider crank Chain and
its Inversions, Double slider crank Chain and its Conversions, Mechanisms with Higher pairs,
Equivalent Linkages and its Cases - Sliding Pairs in Place of Turning Pairs, Spring in Place of
Turning Pairs, Cam Pair in Place of Turning Pairs

Unit II Kinematic Analysis of Mechanisms: Analytical Method
Analytical methods for displacement, velocity and acceleration analysis of slider crank Mechanism,
Velocity and acceleration analysis of Four-Bar and Slider crank mechanisms using Vector and
Complex Algebra Methods. Computer-aided Kinematic Analysis of Mechanism like Slider crank and
Four-Bar mechanism, Analysis of Single and Double Hook's joint

Unit III Kinematic Analysis of Mechanisms: Graphical Method
Displacement, velocity and acceleration analysis mechanisms by Relative Velocity Method
(Mechanisms up to 6 Links), Instantaneous Centre of Velocity, Kennedy's Theorem, Angular
Velocity ratio Theorem, Analysis of mechanism by ICR method (Mechanisms up to 6 Links),
Coriolis component of Acceleration (Theoretical treatment only)

Unit IV Synthesis of Mechanisms
Steps in Synthesis: Type synthesis, Number Synthesis, Dimensional synthesis, Tasks of Kinematic
synthesis - Path, function and motion generation (Body guidance),

Precision Positions, Chebychev
spacing, Mechanical and structural errors
Graphical Synthesis: Inversion and relative pole method for three position synthesis of Four-Bar
and Single Slider Crank Mechanisms
Analytical Synthesis: Three position synthesis of Four-Bar mechanism using Freudenstein's
equation, Blotch synthesis

Unit V Kinematics of Gears
Gear: Classification
Spur Gear: Terminology, law of gearing, Involute and cycloidal tooth profile, path of contact, arc of
contact, sliding velocity, Interference and undercutting, Minimum number of teeth to avoid
interference, Force Analysis (theoretical treatment only)
Helical and Spiral Gears: Terminology, Geometrical Relationships, virtual number of teeth for
helical gears
Bevel Gear & Worm and Worm Wheel: Terminology, Geometrical Relationships
Gear Train: Types, Analysis of Epicyclic gear Trains, Holding torque - simple, compound and
Epicyclic gear Trains, Torque on Sun and Planetary gear Train, compound Epicyclic gear Train
Unit VI Mechanisms in Automation Systems
Cams & Followers: Introduction, Classification of Followers and Cams, Terminology of Cam
Displacement diagram for the Motion of follower as Uniform velocity, Simple Harmonic Motion
(SHM), Uniform Acceleration and Retardation Motion (UARM), Cycloid motion, Cam Profile
construction for Knife-edge Follower and Roller Follower, Cam jump Phenomenon
Automation: Introductions, Types of Automation
Method of Work Part Transport: Continuous transfer, Intermittent or Synchronous Transfer,
Asynchronous transfer, Different type of transfer mechanisms - Linear transfer mechanisms and
Rotary transfer mechanisms
Automated Assembly-Line: Types, Assembly line balancing Buffer Storages, Automated assembly
line for car manufacturing, Artificial intelligence in automation

Maths - 3

207002 - Engineering Mathematics - III

Credits 04

Unit I Linear Differential Equations (LDE) and Applications
LDE of nth order with constant coefficients, Complementary Function, Particular Integral, General method, Short methods, Method of variation of parameters, Cauchy's and Legendre's DE, Simultaneous and Symmetric simultaneous DE. Modelling of Mass-spring systems, Free &Forced damped and undamped systems.

Unit II Transforms
Laplace Transform (LT): LT of standard functions, properties and theorems, Inverse LT, Application of LT to solve LDE.
Fourier Transform (FT): Fourier integral theorem, Fourier transform, Fourier sine & cosine transforms, Inverse Fourier Transforms.

Unit III Statistics
Measures of central tendency, Measures of dispersion, Coefficient of variation, Moments, Skewness and Kurtosis, Curve fitting: fitting of straight line, parabola and related curves, Correlation and Regression, Reliability of Regression Estimates.

Unit IV Probability and Probability Distributions
Probability, Theorems on Probability, Bayes Theorem, Random variables, Mathematical Expectation, Probability distributions: Binomial, Poisson, Normal, Test of Hypothesis: Chi-Square test, t-test.

UnitV Vector Calculus
Vector differentiation, Gradient, Divergence and Curl, Directional derivative, Solenoidal & Irrotational fields, Vector identities. Line, Surface and Volume integrals, Green's Lemma, Gauss's Divergence theorem and Stoke's theorem.

Unit VI Applications of Partial Differential Equations (PDE)
Basic concepts, modelling of Vibrating String, Solution of Wave equation, One and two dimensional Heat flow equations, Method of separation of variables, use of Fourier series. Solution of Heat equation by Fourier transforms.

Books & Other Resources

Text Books

1. B.V. Ramana, “Higher Engineering Mathematics”, Tata McGraw-Hill
2. B. S. Grewal, “Higher Engineering Mathematics”, Khanna Publication, Delhi

Reference Books

1. Erwin Kreyszig, “Advanced Engineering Mathematics’, 10e, by Wiley India.
2. M. D. Greenberg, “Advanced Engineering Mathematics”, 2e, by Pearson Education.
3. Peter V. O'Neil , “Advanced Engineering Mathematics”, 7e, by Cengage Learning
4. S. L. Ross, “Differential Equations”, 3e by Wiley India.
5. Sheldon M. Ross, “Introduction to Probability and Statistics for Engineers and Scientists”, 5e, by Elsevier Academic Press

Applied Thermodynamics

202048 - Applied Thermodynamics

Credits 04

Unit I Basics of Refrigeration and Psychrometry

Refrigeration: Reversed Carnot Cycle, unit of refrigeration, Simple Vapour Compression Cycle (VCC), Refrigerating Effect, Compressor Power & COP. Simple Vapor Absorption Cycle (VAC), Comparison between VCC & VAC.

Psychrometry: Introduction, Psychrometry and Psychrometric Properties, Basic Terminologies & Psychrometric Relations, Psychrometric Processes, Psychrometric Chart.

Unit II Introduction to Internal Combustion (IC) Engine

IC Engine: Components and Construction details, Terminology, Classification, Applications, Intake and exhaust system, Valves actuating mechanisms, Valve timing diagram.

Fuel, Air and Actual Cycle: Air-standard cycles, fuel air cycles, and actual cycles, Effects of variables on performance, various losses, and Comparison of Air standard with Fuel and Actual cycle.

Unit III SI and CI Engines

SI Engines: Theory of Carburetion and Types of Carburetor, Working of Simple Carburetor, Electronic Fuel Injection System, Combustion

stages in SI engines, Abnormal Combustion, Theory of Detonation and Parameters affecting detonations, Rating of fuels in SI engines, Combustion Chambers used in SI Engine.
CI Engines: Fuel Injection system, Construction and Working of Fuel Pump, Fuel Injector and Various types of Nozzle, Combustion stages in CI engines, Theory of knocking and Parameters affecting knocking, Rating of fuels in CI engines, Combustion Chambers used in CI Engines.

Unit IV IC Engine Testing and Emission
Engine Testing: Engine Testing Procedure, Measurement of indicated power, Brake power, fuel consumption, Air Consumption, Measurement of friction power by Willan's Line Method and Morse Test, calculation of mean effective pressure, various efficiencies, specific fuel consumption, heat balance sheet of IC Engines and performance Characteristic curves.

Emission & Control: Introduction to Indian Driving Cycle (IDC), European Driving Cycle (EDC), SI and CI Engines Emission and controlling methods, Methods to measure emission such as (Non Dispersive Infrared Red (NDIR), Flame Ionization Detector (FID), Chemiluminescent Analyzer, Smoke meter), Euro Norms and Bharat Stage Norms.

Unit V Engine Systems and Alternative Fuels
Cooling system: Air Cooling, Liquid cooling, Lubrication system: Objectives of lubrication system, properties of lubricant, Methods of lubrication system, Ignition system: battery coil ignition system, magneto ignition system, Electronics Ignition (CDI, TCI), Maximum Brake Torque (MBT) & spark advance. Supercharging and Turbo-charging.
Alternative Fuels: Bio-diesel, Ethanol, LPG, CNG and Hydrogen.

Unit VI Compressor
Reciprocating Compressor: Applications of compressed air, single stage compressor (without clearance and with clearance volume), volumetric efficiency, isothermal efficiency, effect of clearance volume, free air delivery (FAD), actual indicator diagram for air compressor, Multi staging of compressor, optimum intermediate pressure, intercooler, after cooler, Capacity control of compressors.
Rotary Compressors: Roots blower, Vane type, Screw compressor and Scroll compressor.

Books & Other Resources

Text Books

1. Arora C. P., “Refrigeration and Air Conditioning”, Tata McGraw-Hill
2. V. Ganesan, “Internal Combustion Engines”, Tata McGraw-Hill
3. M. L. Mathur and R.P. Sharma, “A course in Internal combustion engines”, Dhanpat Rai & Co.
4. H.N. Gupta, “Fundamentals of Internal Combustion Engines”, PHI Learning Pvt. Ltd.

Reference Books

1. Dossat Ray J, “Principles of refrigeration, S.I. version”, Willey Eastern Ltd, 2000
2. Heywood, “Internal Combustion Engine Fundamentals”, Tata McGraw-Hill
3. Domkundwar & Domkundwar, “Internal Combustion Engine”, Dhanpat Rai & Co.
4. R. Yadav, “Internal Combustion Engine”, Central Book Depot, Ahmedabad.
5. S.Domkundwar,C.P. Kothandaraman,A.Domkundwar,“Thermal Engineering”,DhanpatRai & Co.

Fluid Mechanics

202049 - Fluid Mechanics

Credits 04

Unit I Properties of Fluid

Definition of fluid, concept of continuum, density, specific weight, specific gravity, viscosity, viscosity laws, types of fluid and rheology, measurement of viscosity, application based numerical on viscosity-flow through pipe, lubrication, bearing, brake fluids, parallel plates, rotating shafts etc., vapor pressure surface tension, capillarity, compressibility

Unit II Fluid Statics

Laws of fluid statics: forces acting on fluid element, pascal’s law, hydrostatics law, hydraulic ram
Pressure measurement: pressure scale, piezometer, barometer, manometer - simple, inclined, differential, micro manometer, inverted
Forces acting on surfaces immersed in fluid: total pressure and center of pressure on submerged plane surfaces, curved surface submerged in liquid including numerical on dam gate
Buoyancy: flotation, stability of bodies

Unit III Fluid Kinematics
Flow description methods, types of flows, velocity and acceleration fields, continuity equation in 1D & 3D flow, flow visualization (path line, stream line and streak line), stream tube, angularity, vorticity, stream function and velocity potential function, flow net

Unit IV Fluid Dynamics
Euler's equation of motion differential form and Navier Stokes equation, Euler's equation of motion along streamline, Bernoulli's theorem and modified Bernoulli's theorem, stagnation pressure, HGL, TEL
Flow measurement: venturimeter, orifice meter, pitot tubes, static pitot tube, introduction to coriolis flow meter, introduction to orifices, notches & weirs
Laminar flow: Entrance region theory, velocity and shear Stress distribution for laminar flow through pipe, fixed parallel plates and Couette flow, velocity profile of turbulent flow

Unit V Internal & External Flow
Internal Flow: Losses - major & minor losses, hydro dynamically smooth and rough boundaries, Moody's chart, compounding of pipes & equivalent pipe, siphons, transmission of power
External Flow: Boundary layer formation over a flat plate, boundary layer thickness, displacement thickness, momentum thickness and energy thickness, boundary layer separation and methods to control separation, drag and lift concepts, types of drag, drag & lift coefficient, aerofoil, bluff body, streamline body

Unit VI Dimensional Analysis & Similitude
Dimensional Analysis: Introduction, system of dimensions, Dimensional homogeneity, Buckingham-Pi Theorem, repeating variables, dimensionless numbers and their physical significance
Similitude & Model Testing: Model & prototype, similarity, scaling parameters , model laws, objectives , importance and application of model studies.

Books & Other Resources

Text Books
1. Sukumar Pati, "Fluid Mechanics and Hydraulics Machines", TATA McGraw Hill.
2. Munson, Young and Okiishi, "Fundamentals of Fluid Mechanics", Wiley India
3. Potter Wiggert, "Fluid Mechanics", Cengage Learning

4. Fox, Pichard, “Introduction to Fluid Mechanics”, McDonald- Wiley
5. Modi P. N. and Seth S. M, “Hydraulics and Fluid Mechanics”,Standard Book House.
6. Cengel & Cimbla, “Fluid Mechanics”,TATA McGraw-Hill
7. F. M. White, “Fluid Mechanics”, TATA McGraw-Hill
8. R. K. Bansal, ”Fluid Mechanics & Hydraulic Machines”, Laxmi Publication

Reference Books

1. Kundu, Cohen, Dowling, “Fluid Mechanics”, Elsevier India
2. Chaim Gutfinger David Pnueli, “Fluid Mechanics” Cambridge University press.
3. Edward Shaughnessy, Ira Katz James Schaffer, “Introduction to Fluid Mechanics”,Oxford University Press

Manufacturing Processes

202050 - Manufacturing Processes

Credits 03

Unit I Casting Processes

Introduction to casting processes, Patterns: Pattern materials, types of pattern, allowances pattern design, Moulding sand, Properties of moulding sands, Core making, Melting practices and furnaces, Pouring and Gating system design, Numerical estimation to find mold filling time, Riser design and placement, Principles of cooling and solidification of casting, Directional and Progressivesolidification Estimation of solidification rate, Cleaning and Finishing of casting, Defects and remedies, Principle and equipments of Permanent mould casting, Investment casting, Centrifugal casting, Continuous casting

Unit II Metal Forming Processes

Plastic deformation. Stress-strain diagram for different types of material, Hot and Cold working, Factors affecting plastic deformation, Yield criteria, Concept of flow stress, Forming Limit diagram

Rolling Process: Rolling terminology, Friction in rolling, Calculation of rolling load

Forging: Open and closed die forging, Forging operations

Extrusion: Types, Process parameter

Wire and Tube Drawing: Wire and tube drawing process, Die profile

Friction and lubrication in metal forming, Forming defects, causes and remedies for all forming processes

Unit III Sheet Metal Forming
Types of sheet metal operations, Press working equipment and terminology, Types of dies, Clearance analysis, Estimation of cutting forces, Centre of pressure and blank size determination, Design of strip lay-out, Blanking die design, Introduction to Drawing, Bending dies, Methods of reducing forces, Formability and forming limit diagrams

Unit IV Welding Processes
Classification of joining processes, Welding terminology and types of joints
Arc Welding Processes: Principles and equipments of Single carbon arc welding, FCAW, TIG, MIG, SAW
Resistance Welding: Spot, Seam and Projection weld process, Heat balance in resistance welding Gas Welding and Cutting, Soldering, brazing and braze welding
Welding Metallurgy and Heat Affected Zone, Weld inspection, Defects in various joints and their remedies

Unit V Processing of polymers
Thermoplastics and Thermosetting, Processing of polymers, Thermoforming, Extrusion
Moulding: Compression moulding, Transfer moulding, Blow moulding, Rotation moulding, Injection moulding - Process and equipment
Extrusion of Plastic: Type of extruder, extrusion of film, pipe, Cable and Sheet – Principle Pressure forming and Vacuum forming

Unit VI Manufacturing of Composites
Introduction to composites, Composite properties, Matrices, Fiber reinforcement
Composite Manufacturing Processes: Hand lay-up Process, Spray lay-up, Filament winding process, Resin transfer moulding, Pultrusion, and Compression moulding process, Vacuum impregnation process, Processing of metal matrix composites, Fabrication of ceramic matrix composites, Carbon-carbon composites, Polymer matrix and nano-composites

Books & Other Resources

Text Books

1. P. N. Rao, “Manufacturing Technology Vol. I & II” , Tata McGraw Hill Publishers
2. P. C. Sharma, “Production Engineering”, Khanna Publishers

Reference Books

1. R. K. Jain, “Production Technology”, Khanna Publishers
2. K. C. Chawala, “Composite Materials”, Springer, ISBN 978-0387743646, ISBN 978- 0387743653
3. Brent Strong, “Fundamentals of Composites Manufacturing: Materials, Methods”, SME Book series