

# **B.Tech. in MECHANICAL ENGINEERING**

## **Syllabus of Paper – 1**

### **THEORY OF MACHINES**

Mechanisms: Lower and higher pairs, degrees of freedom, various types of mechanisms, their inversions and applications, Kinematics and structure diagrams, equivalent linkages, steering mechanisms. Coriolis's component of acceleration. CAMS: Cam follower systems, synthesis of roller cams, cam profiles, pressure angles, Gears: Gearing terminology, spur, bevel, helical, worm, gears, motion and synthesis of simple, reverted and epicyclic gear trains, gear corrections.

### **MECHANICS OF SOLIDS**

Definition of stress, stress tensor - normal and shearing stresses in axially loaded members. Normal and shearing strains - stress-strain relationship - Generalized Hooke's Law - Poisson's ratio - relationship between material properties of isotropic materials. - stress-strain diagram for uniaxial loading for ductile and brittle materials - working stress - factor of safety. Composite bars in tension and compression, temperature stresses, statically indeterminate problems. Thin Cylinders and Spherical Shells, Torsion of Circular Shafts and Helical Springs, shear force and bending moment diagrams, pure bending theory, shearing stresses in beams, Deflection of Beams, Theory of Columns, Plane stress and plane strain problems, Energy methods: Strain energy due to axial, torsion, bending and transverse shear. Castigliano's theorem, reciprocity theorem.

### **DESIGN OF MACHINE ELEMENTS**

Introduction to machine design, methodology, strength, rigidity, fracture, wear, and material considerations in design, use of standards, Selection of materials and processes. Standard numbering system including BIS designations of materials. concept of factor of safety. Application of theories of failure to design. Design of Riveted, Welded, Bolted joints, Power screw, shafts, keys and couplings, belt, rope and chain drives, journal bearing and antifriction bearings, springs, clutches and Gears.

### **THERMAL ENGINEERING**

Laws of perfect gas; gas constants, concept of system, surrounding, equilibrium, Heat and work transfer, quasi-static process, temperature and Zeroth law of thermodynamics. Units & Dimensions ; First Law of Thermodynamics: Internal energy, enthalpy, 1<sup>st</sup> law applied to non-flow and steady flow processes ; Second Law: Clausius and Kelvin-Planck statements, Carnot cycle, corollaries, entropy, changes of entropy or perfect gas in various processes. Properties of Pure Substances: Definitions, p-V, p-T, T-s and h-s diagrams for a pure substance, quality, Steam Tables, Charts for thermodynamics properties, Measurement of steam quality ; Vapour Power Cycles: Rankine cycle, Comparison of Rankine and Carnot vapor cycles, Ideal working fluid for vapor power cycles, Binary vapor cycle, ; I.C. Engines: Air standard Otto, Diesel and Dual cycles, C.I. and S.I. engines; Four stroke and two stroke cycles, Indicated Power, Brake Power, Mechanical, Thermal and relative efficiencies. Valve timing Diagram, Fundamental modes of heat transfer: Conduction, Convection and Radiation. ; Conduction: Fourier law, Problem formulation, Boundary conditions, 1-D temperature solution, Lumped system analysis, Heat transfer through extended surfaces (fins), Efficiency and effectiveness of fins. Convection: Forced and natural convection through flat plate and duct. Heat transfer coefficient correlations

for laminar and turbulent convection. Radiation: Stefan law, emissive power, emissivity and reflectivity, equivalent heat transfer coefficient for combined convection and radiation.

## **FLUID MECHANICS**

Introduction: Definition of fluid, Concept of shear stress, Concept of continuum; Properties of fluids; Classification (like Ideal and Real fluids, Newtonian and Non-Newtonian fluids, Internal versus External Flow, Compressible versus Incompressible Flow, Laminar versus Turbulent Flow, Natural versus Forced Flow, Steady versus Unsteady Flow, One-, Two-, and Three-Dimensional Flows, etc.). Fluid Statics: Pressure at a point, Pascal's law, Variation of pressure within a static fluid – equation of hydrostatic pressure distribution, Variation of properties in static atmosphere; Measurement of pressure; Hydrostatic thrust on plane and curved surfaces; Buoyancy, Stability of submerged and floating bodies; Fluid masses subjected to uniform accelerations. Fluid Kinematics: Eulerian and Lagrangian description of fluid flow, Velocity and acceleration of fluid particles; Stream line, Streak line and path line, stream tube, Equation of continuity for a stream tube; Deformation of a fluid element – linear and angular deformation and rotation, Vortex motion- irrotational flow; Pressure and stress tensor; Stream function and velocity potential. Fluid Dynamics: Principle of conservation of mass and momentum, Stokes law of viscosity and Navier-Stokes equations – some exact solutions; Inviscid flow – Euler equation, Derivation of Bernoulli's equation and physical significance of different terms, Applications of Bernoulli's equation; Characteristics Of Laminar & Turbulent Flow: Reynolds experiment, critical Reynolds number; Laminar flow through pipe – Hagen Poiseuille equation. Flow Through Closed Conduits: Darcy Weisbach equation, Friction factor, Moody's diagram; Minor losses – at sudden expansion, contraction, at bends, at valves and fittings, etc.

## **GAS TURBINES**

Gas Turbines: Brayton cycle; Components of a gas turbine plant; open and closed types of gas turbine plants; Optimum pressure ratio; Improvements of the basic gas turbine cycle; multi stage compression with inter-cooling; multi stage expansion with reheating between stages; exhaust gas heat exchanger, Applications of gas turbines. Problems.

## **MECHANICAL VIBRATION**

Undamped Free Vibration: Systems with single degree of freedom, Equilibrium method, The energy method, Rayleigh's method, Stiffness of spring elements. Damped Free Vibrations: Viscous damping, laws of damping, logarithmic decrement. Forced Vibration with Harmonic Excitation: Steady state solution with viscous damping, Method of complex algebra, Reciprocating and rotating unbalance, Base excitation, Vibration isolation, Air springs, Energy dissipated by damping, Equivalent viscous damping, Structural damping, Sharpness of resonance, Vibration measuring instruments, Whirling of rotating shafts, Rigid shafts supported by flexible bearings. Two degree of freedom system: Vibration of undamped two degree of freedom system, coordinate coupling, vibration absorber. Multi-degree freedom system: Influence coefficients, generalized co-ordinates, matrix method, matrix iteration method, Stodola Method, Holzer's Method, Dunkerley's method, Vibration of Continuous systems, Vibration of String, Longitudinal Vibration of Rods, Torsional Vibration of Rods, Vibration of Beams.

## **Syllabus of Paper - 2**

### **PRIMARY PRODUCTION PROCESSES**

Foundry : Introduction to patterns and foundry process, Sand binders and different additives, Sand testing and melting furnaces for ferrous and non-ferrous metals such as cupola, Induction furnace, Arc furnace & Resistance Furnace. Solidification of castings, Continuous casting process: Precision investment casting, centrifugal casting, Die casting, Casting defects. Welding and cutting: Introduction to gas welding, cutting, Arc welding and equipment's. TIG (GTAW) and MIG (GMAW) welding, resistance welding and thermit welding. Weldability, Newer Welding methods like plasma Arc, Laser Beam, Electron Beam, Ultrasonic, Explosive and friction welding. Brazing and soldering, welding defects. Destructive and non-destructive testing of castings and weldings. Brief introduction to powder metallurgy processes. Plastic deformation of metals: Variables in metal forming and their optimization. Dependence of stress strain diagram on Strain rate and temperature. Hot and cold working of metals. Rolling: Pressure and Forces in rolling, types of rolling mills, Rolling defects. Forging: Smith Forging, Drop and Press forging, M/c forging. Forging defects. Extrusions, Direct, Indirect, Impact and Hydrostatic extrusion and their applications. Extrusion of tubes. Wire drawing methods and variables in wire-drawing. Optimum die shape for extrusion and drawing. Brief introduction to sheet metal working: Bending, Forming and Deep drawing.

### **METAL CUTTING**

Geometrical parameters of cutting tool edges and their effect on tool force and power consumption, Mechanics of chip formation at low and high cutting speeds. Orthogonal and oblique cutting ; Controlled contact cutting, Shear angles, Force and velocity relationships, Cutting forces in turning ; Planning, Drilling and milling operations, controlled Contact Cutting, Chip-Breaking Effect, stress-distribution ; Types of Tool Wear: Flank wear, Crater wear, Wear measurement, Cutting fluid and its effect ; Machinability Criteria, Tool life and Taylor's equation, Effect of variables on tool life, and surface finish, Tool-life test ; Economics of Machining, Economic tool life, Gilbert's Model. ; Introduction to cutting tool materials, types of cutting tools.

### **METROLOGY AND QUALITY CONTROL**

METROLOGY: Line and End Standards, Principles of Measurements, Calibration, Accuracy and Precision; Measurement of Surface Roughness, Screw, Thread and Gears; Limits, Fits and Gauges, Assembly by full, partial and group interchangeability, geometric tolerances;

QUALITY ASSURANCE: Some useful Probability Distribution, Testing of hypothesis, type I and type II errors, central limit theorem. Taguchi's Loss function, Orthogonal Arrays, Linear Graphs, parametric design, signal-to-noise Ratio, ANOVA. Causes of Variation, standard error of mean, process capability, PCR, Natural tolerance Limits, Specification Limits, Trial and Revised control Limits, Rational subgroups, Control charts for variables (X-bar, R), Control charts for fraction non-conforming, control charts for non-conformation. Design of single & Double sampling plan. OC curve.

### **ADVANCED MANUFACTURING SYSTEMS**

Definition and broad characteristics of Flexible Manufacturing Cells, Systems, Islands and Flexible transfer lines - Place of flexible manufacturing systems in CIM - FMS: Economics and technological. Scheduling problems - FMS hardware CNC machines tools, robots, AGVs, ASRs, Inspection and Cleaning stations - Control aspects of FMS-DNC of machine tools, cutting tools,

robots, quality control and inventories - Personnel and infrastructural aspects - Flexible machining cells and islands. FMS in action: Understanding Flexibility, Types of Flexibility in FMS, Role of Integrated and automated material handling systems, Typical FMS operation, IT based Tools: Computer simulation and AI for FMS, Group technology, Decision Support Systems, Design, Planning, Scheduling and Control Issues in FMS, Real time control strategies, Various FMS configurations, Benefits and Justification for FMS, Role of Information Technology.

## **PRODUCTION AND OPERATION MANAGEMENT**

Production Management: Integrated Production Management, System Productivity, Capital Productivity, Labour Productivity, Personnel Productivity, Training. Operations Management: Introduction, Operations Management and Strategy, Tools for Implementation of Operations, Industry Best Practices. Operations Strategy: Operations Strategy, Competitive Capabilities and Core Competencies, Operations Strategy as a Competitive Weapon, Linkage Between Corporate, Business, and Operations Strategy, Developing Operations Strategy, Elements or Components of Operations Strategy, Competitive Priorities, Manufacturing Strategies, Service Strategies, Global Strategies and Role of Operations Strategy. Forecasting: Introduction, The Strategic Importance of Forecasting, Benefits, Cost implications and Decision making using forecasting, Classification of Forecasting Process, Methods of Forecasting, Forecasting and Product Life Cycle, Selection of the Forecasting Method, Qualitative Methods of Forecasting, Quantitative Methods, Associative Models of Forecasting, Accuracy of Forecasting, 5-Location Strategies: Introduction, Location Planning Process, Facility or Layout Planning and Analysis: Introduction, Objectives of Layout, Classification of Facilities, Basis for Types of Layouts, Why Layout decisions are important, Nature of layout problems, Redesigning of a layout, Manufacturing facility layouts, Types of Layouts, Layout Planning, Evaluating Plant Layouts, Assembly Line Balancing, Material handling, Total Quality Management: Introduction, Meaning and Dimensions of Quality, Quality Control Techniques, Quality Based Strategy, Total Quality Management (TQM), Towards TQM – ISO 9000 as a Platform – Working with Intranet, Total Productive Maintenance (TPM), Business Process Modelling: Introduction, Importance of Business Process Modelling, Business Process Modelling, Data Driven Approach to Process Definition. Logical vs. Physical Database Modelling, Business Process, the Way Forward Project Management – Planning Process: Introduction, need, Project Management Principles, Essentials of Project Management Philosophy, Project Planning, Project Process Flows, Project Implementation-Control and Closure: Introduction, Project Management Life Cycle, Project Monitoring and Control, Change Control, Risk Management, Project Closure. Aggregate Planning: Introduction, Requirement of Aggregate Plan, Steps in Developing an Aggregate Plan, Advantages of Aggregate Plan, Aggregate Planning Strategies, Planning Options. Selecting the Method in Aggregate Planning, Aggregate Planning in Services. Operations Scheduling: Introduction, Purpose of Operations Scheduling, Factors Considered while Scheduling, Scheduling Activity under PPC. Just-In-Time: Introduction, Characteristics of JIT, Key Processes to Eliminate Waste, Implementation of JIT, Pre-requisites for implementation, JIT Inventory.

## **MODERN MANUFACTURING PROCESSES**

Modern Machining Processes: Electro Discharge Machining(EDM), Processes mechanism of material removal, parameters effects EDM & application, Electrical Discharge Grinding(EDG), Traveling Wire EDM, Electro-chemical Machining (ECM), Processes, Mechanism of material removal, Tool design, Parameters affecting ECM, Applications, Electro-chemical Honing(ECH), Electrochemical Debarring (ECD), Electrochemical Grinding(ECG), Electrochemical Discharge

Grinding, Chemical Machining, Ultrasonic Machining, Cutting Tool System Design, Mechanism of cutting, Parameters affects USM applications, Abrasive Jet Machining, Variables of AJM, Nozzle Design, Laser Beam Machining, Thermal and Non-thermal analysis, and applications, Electron – Beam Machining and its mechanism, Applications, Plasma arc machining, Equipments, Arc transfer mechanism, Metallurgical efforts, Safety precautions and applications, Plasma arc surfacing and plasma Arc Springing and water Jet Machining. Modern forming processes.

## **BASIC MANUFACTURING PROCESSES**

Introduction about manufacturing process; classification of manufacturing process; Foundry : Introduction to patterns and foundry, Sand binders and different additives, Sand testing; melting furnaces for ferrous and non-ferrous metals such as cupola, Induction furnace, Arc furnace & Resistance Furnace; sand casting, continuous casting, investment casting, centrifugal casting, die casting, Casting defects. Welding: classification of welding, gas welding, arc welding, TIG (GTAW) and MIG (GMAW) welding, resistance welding and thermit welding; Advanced Welding methods: plasma Arc, Laser Beam, Electron Beam, Ultrasonic, Explosive and friction welding; Brazing and soldering, welding defects. Plastic deformation of metals: Hot and cold working of metals; Rolling: types of rolling mills, Rolling defects ; Forging: Smith Forging, Drop and Press forging, M/C forging, Forging defects; Extrusions: Direct, Indirect, Impact and Hydrostatic extrusion, Extrusion of tubes; Wire drawing methods and variables in wire-drawing; Sheet metal working: Bending, Forming and deep drawing. Powder Metallurgy Method: Steps and Applications Different types of machine tools for metal cutting: Lathe, Milling machine, Drilling machine, Grinding machine; Tool holding and job holding methods in different M/C tools, Indexing mechanism and thread cutting mechanism.

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