

B. Tech. in PRODUCTION ENGINEERING

Syllabus of Paper – 1

STRENGTH OF MATERIALS

Simple and Compound Stresses and Strains: Stress Concentration, Concept of stress and strain: St. Venant's principle of stress and strain diagram, Hooke's law, Young's modulus, Poisson ratio, stress at a point, stresses and strains in bars subjected to axial loading, Modulus of elasticity, stress produced in compound bars subjected to axial loading, Temperature stress and strain calculations due to applications of axial loads and variation of temperature in single and compound walls.

Two dimensional system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stress, ellipse of stress and their applications, Two dimensional stress-strain system, principal strains and principal axis of strain, circle of strain and ellipse of strain, Relationship between elastic constants. Bending Moment and Shear Force Diagrams: Definition shear force and bending moment, relation between load, shear force and bending moment, BM and SF diagrams for cantilevers, Simply supported and fixed beams with or without overhangs, calculation of maximum BM and SF and the point of contraflexure under Concentrated loads, Uniformity distributed loads over the whole span or part of span, combination of concentrated loads (two or three) and uniformly distributed loads, uniformly varying loads, application of moments. Bending of Beams: Symmetric member in pure bending, stress and deformations in the elastic range, deformations in transverse cross section, bending of members made of several materials, stress concentrations, plastic deformations, residual stresses, eccentric axial loading in a plane of symmetry, unsymmetric bending, general case of eccentric axial loading, bending of curved members, deflection of beams. Torsion: Stresses and deformation in circular shaft, Stresses in elastic range, Angle of twist, statically indeterminate shafts, design of transmission shafts, stress concentration and plastic deformations in circular shafts, circular shafts of an elastoplastic material, residual stresses in circular shafts, torsion of noncircular member, thin walled hollow shafts. Thin and Thick cylinders and Spheres: Derivation of formulae and calculations of hoop stress longitudinal stress in a cylinder, and sphere subjected to internal pressures increase in Diameter and volume Derivation of Lamé's equations, radial & hoop stresses and strains in thick and compound cylinders and spherical shells subjected to internal fluid pressure, wire wound cylinders, hub shrunk on solid shaft. Strain Energy: Definitions, expressions for strain energy stored in a body when load is applied: gradually, suddenly and with impact, strain energy of beams in bending, beam deflections, strain energy of shafts in twisting, energy methods in determining spring deflection, Castigliano's & Maxwell's theorems. Columns and Struts: Column under axial load, concept of instability and buckling, slenderness ratio, derivation of Euler's formulae for the elastic buckling load, Eulers, Rankine, Gordon's formulae Johnson's empirical formula for axial loading columns and their applications, eccentric compression of a short strut of rectangular & circular sections.

THEORY OF MACHINES

Basic Concepts: Kinematics of machine, Kinematic link and their different types, types of kinematic pair, kinematic chain, mechanism and inversions of four bar chain and slider crank mechanism. Degree of freedom, synthesis of linkages – number synthesis, Grashof's criterion and introduction to dimensional synthesis. Velocity Analysis: Motion of a link, velocity of a point on a link by relative velocity method, velocities of slider crank mechanisms, rubbing velocity at a pin joint, velocity of a point on a link by

instantaneous center method, properties and types of I-Center, Kennedy theorem and methods of locating I-centers in a mechanism. Acceleration Analysis: Acceleration of a point on a link, acceleration in slider crank mechanism, Coriolis component of acceleration, Quick-return mechanism. Cams and Follower: Types of cams and followers, cam terminology, types of motion of the follower, analysis of motion of the follower, analysis of motion of the follower for cams with specified contours. Gears: Classification of gears, terminology used in gears, law of gearing, velocity of sliding, forms of teeth, construction and properties of an involute, construction and properties of cycloidal teeth, effect of variation of center distance on the velocity ratio of involute profile tooth gears, length of path of contact, arc of contact, number of pairs of teeth in contact, interference, minimum number of teeth, interference between rack and pinion, undercutting, terminology of helical and worm gears. Gear Trains: Definition of simple, compound, reverted and epicyclic gear trains, velocity ratio of epicyclic gear trains. Belt, Rope and Chain Drive: Types of belt drives, velocity ratio, law of belting, length of belt, ratio of friction tensions, power transmitted, effect of centrifugal tension on power transmission, condition for maximum power transmission, concept of slip and creep. Chain drive, chain length and angular speed ratio. Brakes and Dynamometers: Types of brakes, principle and function of various types of brakes, problems to determine braking capacity, different types of dynamometers. Governors: Different types of centrifugal and inertia governors: hunting, isochronism, stability, effort and power of governor, controlling force. Balancing: Static and dynamic balancing, balancing of several masses in different planes.

APPLIED THERMODYNAMICS

Steam Generators: Review of steam generation process. Classification, Fire and water tube boilers, Description of Cochran, Locomotive, Lancashire Babcock and Wilcox boilers and Sterling Boiler, mountings and accessories: Economizer, super heater etc. Modern high pressure boilers, Characteristics of high pressure boilers, Advantages of forced circulation, steam accumulators, boiler performance, equivalent evaporation, boiler efficiency, Boiler Trial. Steam Engine: Classification and working of steam engine, Simple Rankine cycle, methods of improving efficiency: Feed water heating (Bleeding), reheat cycle, combined reheat and regenerative cycle, Ideal working fluid – Binary vapour cycle, combined power and heating cycles. Nozzle: Types of nozzles and their utility, Flow of steam through nozzles, Critical pressure and discharge, Area of throat and exit for maximum discharge, Effect of friction on Nozzle efficiency, Supersaturated flow. Impulse Turbines: Steam turbines, description of components and advantages, Pressure and velocity compounding, Velocity diagram and work done, Effect of blade friction on velocity diagram, Stage efficiency and overall efficiency, Reheat factor and condition curve. Reaction Turbine: Degree of reaction, velocity diagrams, blade efficiency and its derivation; calculation of blade height, backpressure and extraction turbines and cogeneration; Economic assessment. Method of attachment of blades to turbine rotor, losses in steam turbines, Governing of steam turbines, Labyrinth packing. Condensers: Function, Elements of condensing plant, types of condensers, Dalton's law of partial pressure applied to condenser problems, condenser and vacuum efficiencies. Cooling water calculations. Effect of air leakage, Methods to check and prevent air infiltration. Description of air pump and calculation of its capacity. Reciprocating Air Compressors: Use of compressed air in industry. Classification of air compressors, Operation of single stage reciprocating compressors, Work input and the best value of index of compression. Isothermal and polytropic efficiency. Effect of clearance and volumetric efficiency, multistage compression and its advantages. Optimal multi-staging, work input in multistage compression, Reciprocating air motors. I. C. Engines: Classification, Construction and

working of 2 and 4- stroke SI and CI engines and their valve timing diagram, Combustion process in SI and CI engines, Performance of engines.

DESIGN OF MACHINE ELEMENTS

Introduction: Basic requirements for machine elements, design procedure, system design cycle. Designing for Strength: Theories for failure, factor of safety, stress-concentration, variable loading, impact or shock loading. Joints: Strength of welded joint, design of welded joint for static loads, riveted joint, failure modes of riveted joints, efficiency of riveted joint, design of cotter joint, designing the cotter and gib. Knuckle joint and its design: Keys, types of keys, couplings, rigid and pin type flexible coupling design. Springs: Helical springs design with axial loading, spring scale, erosion springs. Leaf springs, length of leaves, design procedure. Shafts: Failure of shafts under simple loading conditions. Bearings: Sliding bearings, hydrodynamic lubrication, hydrostatics bearing, and journal bearing design. Rolling contact bearing, ball bearing, roller bearing selection procedure under simple loading conditions. Gear drive: Gear nomenclature, materials, types of gear tooth failures, design consideration of straight spur gears, helical spur gears, double helical gears. Belt Drive: Flat belt drive, working stresses, slip and creep, stresses in belts, pulleys, and design procedure. V-belt drives, design procedure.

HEAT AND MASS TRANSFER

Conduction: Basic law of heat conduction – Fourier's law, thermal conductivity, its dependence on temperature, steady state heat conduction through a composite solid and its electric analogue, steady state heat conduction through cylinders, spheres and variable area of solids, different insulating materials and their applications for process equipment and pipelines, Fourier's law in three dimensions, lumped capacity method of unsteady state conduction. Convection: Convection heat transfer and the concept of heat transfer coefficient, individual and overall heat transfer coefficient, heat transfer between fluids separated by plane wall, heat transfer between fluids separated by cylindrical wall (pipes), critical/optimum insulation thickness, heat transfer through extended surfaces. Forced Convection: Over a flat plate, thermal boundary layer, dimensionless groups and Dimensional analysis, Buckingham Pi-theorem, heat transfer correlations- internal and external flows, laminar and turbulent flows. Free convection: Heat transfer correlations for free convection, free convection from flat surfaces, free convection from a cylinder. Heat Transfer with phase change: Boiling phenomena and analysis of boiling curve, correlation for nucleate boiling, critical heat flux, condensation phenomena, film condensation on a vertical surface (Nusselt equation, effect of non-condensable gases, drop wise condensation. Radiation: Basic principle of radiation from a surface, blackbody radiation, Planck's law, Wein's displacement law, the Stefan Boltzmann law, Kirchhoff's law, gray body, radiation exchange between black bodies & gray bodies. Heat Exchanger: Types of heat exchangers; fouling factors; overall heat transfer coefficient; Logarithmic mean temperature difference (LMTD) method; Effectiveness-NTU method. Introduction To Mass Transfer: Introduction; Fick's law of diffusion; Steady state equimolar counter diffusion; Steady state diffusion through a stagnant gas film.

WORK STUDY AND ERGONOMICS

Productivity: Definition, reasons for low productivity, methods to improve productivity, work-study and productivity. Human factor in work-study: Relationship of work-study man with management, supervisor & workers, qualities of a work-study man. Method-study: Definition, objectives, step-by-step procedure, questioning techniques, charts and diagrams for recording data.

Like outline process charts, flow process charts, multiple activity charts, two handed process chart, string diagram, travel chart, cycle graph, Chrono-cycle graph, therbligs, micro motion study and film analysis, Simo chart, principles of motion economy. Development and installation of new method. Work-Measurement: Definition, various techniques of work-measurement work-sampling, stopwatch time study & its procedure, Job selection, Equipment and forms used for time study, rating, methods of rating, allowances and their types, standard time, numerical problems, predetermined – time standards and standard data techniques. Incentive: Meaning, objectives of an incentive plan, various types of incentive plans. Ergonomics: Introduction, history of development, man-machine system and its components. Introduction to structure of the body- features of the human body, stress and strain, metabolism, measure of physiological functions - workload and energy consumption, biomechanics, types of movements of body members, strength and endurance, speed of movements. NIOSH lifting equation, Lifting Index, Maximum acceptable Weights and Forces, Distal upper extremities risk factors, Strain Index, RULA, REBA. Applied anthropometry - types, use, principles in application, design of work surfaces and seat design. Visual displays for static information, visual displays of dynamic information, auditory, tactual and olfactory displays and controls. Assessment of occupational exposure to noise, heat stress and dust. Effect of vibration/ noise, temperature, illumination and dust on human health and performance.

QUALITY MANAGEMENT

Statistical concepts: Graphical representation of grouped data, continuous & discrete probability distributions, central limit theorem, skewness and kurtosis, tests of normality for a given data, chi-square test. Introduction: Process control and product control, difference between SQC and SPC, chance and assignable causes of quality variation, advantages of control charts. Process Control: Charts for variables; for individuals, \bar{X} bar, R and sigma charts; fixation of control limits; Type I and Type II error; theory of runs; Interpretation of 'out of control' points. Initiation of control charts, trial control limits. Determination of aimed-at value of process setting. Rational method of sub grouping. Control chart parameters. Limitations of \bar{X} bar and R charts. Control limits verses specification limits: natural tolerances limits, relationship of a 'process in control' to upper & lower specification limits. Process capability studies, process capability indices for bilateral specifications & unilateral specification cases, remedial actions for indices less than one. Control charts for Attributes: fraction defective chart and number of defectives chart, varying control limits, high defectives and low defectives, seriousness classification of defects, defects chart, U-chart. Quality rating, Average Run Length (ARL), Relative efficiency or sensitivity of control charts. Product Inspection: 100% inspection, no inspection and sampling inspection. Application of hyper geometric, binomial & Poisson distributions in acceptance inspection. Operating Characteristic Curve (O-C curve); Effect of sample size and acceptance number, type A and type B O.C. curves. Single, Double and Multiple Sampling Plans. Product Inspection (Contd.): Acceptance/rejection and acceptance/ rectification plans. Producer's risk and consumer's risk. Indifference quality level, Average Outgoing Quality (AOQ) curve, AOQL. Quality protection offered by a sampling plan. Average Sample Number (ASN) curve, Average Total Inspection (ATI) curve. Design of single sampling plans. Economics of Product Inspection: Use of Break-even analysis in decision for selection of economic acceptance plan option. ISO 9000: introduction, characteristics of quality assurance system. ISO-9000: scope, application, terms & definitions, evolution of ISO-9000 series, process approach, PDCA methodology, commentary on ISO-9000 requirements, guidelines for preparation of Quality Manual. Steps for certification, implementation schedule for certification.

FLUID MECHANICS & MACHINERY

Introduction of Fluid Properties: Engineering units of measurement, mass, density, specific weight, volume and gravity, surface tension, capillarity, viscosity, compressibility and bulk modulus of elasticity, pressure and vapour pressure. Fluid Statics: Pressure at a point, pressure variation in static fluid, absolute and gauge pressure, Manometers, Hydrostatic forces on plane and curved surfaces (Problems on gravity dams); Buoyant force, Stability of floating and submerged bodies- Metacentre.

Kinematics of Flow: Types of flow – Ideal & real, steady & unsteady, uniform & non-uniform, one, two and three dimensional flow, path lines, streak-lines, streamlines and stream tubes, continuity equation for one and three dimensional flow, Rotational and irrotational flow, Laminar and Turbulent Flow, Circulation, Velocity potential, Stream function, Flow nets. Dynamics of Flow: Euler's equation of motion along a streamline and derivation of Bernoulli's equation and its application Fluid measurements: Velocity Measurements (Pitot tube), Flow Measurement (Venturi-meter, Orifice meter, Nozzles, Mouth pieces, Rotameter), Energy correction factor, Linear momentum equation for steady flow, Momentum correction factor. Dimensional Analysis and Similitude and Modelling: Dimensional analysis, dimensional homogeneity, use of Buckingham-pi theorem, calculation of dimensionless numbers, similarity laws, specific model investigations. Laminar and Turbulent Flow: Introduction to laminar and turbulent flow, Reynolds experiment and Reynolds number, relation between shear and pressure gradient, laminar flow through circular pipes laminar flow between parallel plates, laminar flow through porous media, Stokes law, lubrication principles. Concept of boundary layer, development of boundary layer in flat surfaces and pipes, pipe flow and pipe networking, hydraulic gradient line, total energy line, Darcy Wiesbach's Equation, Drag force on flat plate, Rough and smooth boundary. Impact of jet: Forces on fixed and moving vanes and other applications. Hydraulic Machines: Introduction, classification of turbines, impulse turbines, Pelton wheel turbine, (efficiency of runner, mechanical efficiency and volumetric efficiency, overall efficiency), Reaction Turbine, Francis turbine, Kaplan Turbine, (efficiency of runner, mechanical efficiency and volumetric efficiency, overall efficiency) Draft tube, types of draft tubes, Centrifugal pump.

Syllabus of Paper - 2

MECHANICAL MEASUREMENT AND METROLOGY

Basics of measurement: Characteristics of measuring instruments, elements of an instrument, calibration of instruments, types of error in instruments, selection of instruments. Speed measurement: Revolution counter, Tachoscope, various types of tachometer, stroboscope. Force measurement: Beam balance, various types of load cells. Torque measurement: Various types of dynamometers, characteristics of dynamometers, direct power measurement systems. Electromechanical transducers: Variable resistance transducers, variable capacitance transducers, piezo-electric transducers, photoelectric transducers, strain gauges, use of various transducers. Measuring Standards: Classification of standards, basic standards used worldwide, airy points for minimum deflection.

Length and Angle Measurement: Slip gauges, angle gauges, spirit level, bevel protector, sine bar. Interchangeability: Meaning of interchangeability, types of interchangeability, and advantages of interchangeability. Design of Gauges: Indian standard for design of fits and tolerances, Taylor's principle, design of limit gauges, advantages of limit gauges. Comparators: Meaning of comparators, types of comparators, advantages of various types of comparators.

MATERIALS ENGINEERING

Crystal Structure and Dislocations: various types of crystal structure and its types, Point, line and volume imperfections. Dislocation and strengthening mechanism: Nature of dislocations: edge and screw type, dislocation characteristics slip system and plastic deformation, energy of screw dislocation, burger vector notation, stress fields around dislocations, deformation by twinning, stacking faults, strengthening by grain size reduction, solid solution strengthening, strain hardening, recovery, recrystallization, and grain growth. Super critical and ultra-super critical materials. Diffusion: Atomic mechanism of diffusion, interstitial and substitution diffusion, atomic mobility, diffusion path, Fick's first law and second Law of diffusion, steady and non-steady state diffusion, temperature dependence of diffusivity, formula for depth of penetration. Solidification: Thermodynamics of solidification, Nucleation in pure metals, homogeneous and heterogeneous nucleation, growth of pure solid, solidification of ingots, freezing, metallic glass, equilibrium and non-equilibrium solidification. Phase Diagrams: Gibb's Phase rule, lever rule, Theory of alloy Phases: Hume-Rothery rules, Unary systems, Binary Isomorphous phase diagrams, Phase Diagrams of Binary Eutectic and off-eutectic composition, peritectic and eutectoid alloys, Iron-carbon phase diagram and microstructures of plain carbon steel and cast iron. Phase Transformations: Diffusional and diffusion-less transformation, Microstructural transformation, different types of energies involved (bulk Gibb's free energy, strain energy and interfacial energy), first order transformation its nucleation and growth, undercooling of system, critical size of nucleus, nucleation barrier, melting point of nano - crystal and its melting behaviour, atomic perspective of nucleation and nucleation barrier, heterogeneous versus homogeneous nucleation rates, growth transformation rate, TTT Diagrams, eutectoid transformations, CCT Curves, pearlite, bainite and martensite transformation, glass transition. Heat Treatment: Mechanism of annealing, normalizing, tempering, hardening and case hardening, Introduction to chemical heat treatment, mechanism and methods of carburizing, nitriding, cyaniding, introduction to flame hardening.

PRODUCTION PLANNING AND CONTROL

Production Processes: discrete and process types, mass, batch, unit flexible manufacturing types, manufacturing operations: selection of a process, difference between manufacturing and service operations, classification of manufacturing processes, 5 Ps in the organization. Process Design: Systems approach to process planning and design, linkage between product planning and process planning, distinction between process planning and facilities planning, types of process design, product mix, process planning aids, process design procedure. Forecasting: characteristics of demand over time, forecasting qualitative model: Delphi, naïve quantitative models: simple average, simple moving average, weighted moving average, exponential smoothing, smoothing coefficient selection, adaptive exponential smoothing, incorporating trend and seasonal components, linear regression, selection of forecasting models. Aggregate Planning: Concept, strategies for aggregate planning: three pure planning strategies, graphical method for aggregate output planning, master production scheduling (MPS), and procedure for developing MPS. Shop floor planning and control: Nature, factors determining production planning, factors determining production control, phases in production planning and control, limitations of PPC, measuring effectiveness of PPC, production activity control, operations planning and scheduling, scheduling process-focused production systems, scheduling techniques for job shop, stages in scheduling, load charts and machine loading charts, dynamic sequencing rules, scheduling product – focused systems, scheduling for flexible manufacturing system. Resource Requirements Planning: Nature, resource requirement planning system, MRP-I, MRP-II, MRP Computational procedure, issues in MRP, implementation of MRP, evaluation of MRP, Introduction to ERP. Manufacturing planning & Control systems: JIT, CIM and WCM. Learning curves in services and manufacturing: Applying the learning curve, arithmetic approach, logarithmic approach, learning - curve coefficient approach; strategic implications & limitations of learning curves.

MANUFACTURING TECHNOLOGY

Introduction to casting: Steps involved in casting, advantages, limitations and applications of casting process. Pattern types, allowances for pattern, pattern, materials color coding and storing of patterns. Moulding methods: Moulding methods and processes-materials, equipment, molding sand ingredients, essential requirements, sand preparation and control, testing, cores and core making. Design considerations in casting, gating and Riser, directional solidification in castings. Sand castings-pressure die casting-permanent mould casting-centrifugal casting-precision investment casting, shell moulding, CO₂ moulding, continuous casting-squeeze casting-electro slag casting. Fettling and finishing, defects in Castings. Foundry melting furnaces: Selection of furnace-crucibles oil fired furnaces, electric furnaces cupola, calculation of cupola charges, hot blast, cupola-Degasifications, inoculation-pouring equipment, Inspection of castings. Need-Areas for mechanization-Typical layout-sand reclamation techniques-material handling, pollution control in Foundry, Computers in casting process. Forming: Metallurgical aspects of metal forming slip, twinning mechanics of plastic deformation effects of temperature, strain rate-microstructure and friction in metal forming, yield criteria and their significance-classification of metal forming processes. Principle classification equipment, tooling processes, parameters and calculation of forces during forging and rolling processes, Ring compression tests, Post forming heat treatment, Defects (cause and remedy) applications. Classification of extrusion processes, tool, equipment and principle of these processes, influence of friction, Extrusion force calculation, Defects and analysis: Rod/wire drawing-tool, equipment and principle of processes defects, Tube drawing and sinking processes, Mannesmann processes of seamless pipe manufacturing. Classification

of Forming Processes: Classification conventional and HERF processes, Presses types and selection of presses, formability of sheet metals, Principle, process parameters, equipment and application of the following processes. Deep drawing, spinning, stretch forming, plate bending, press brake forming, Explosive forming, electro hydraulic forming, magnetic pulse forming. Super plastic forming, electro forming-fine blanking, P/M forging-Isothermal forging-high speed, hot forging high velocity extrusion. Welding: Types of welding-gas welding-arc welding-shielded metal arc welding, TAW, GMAW, SAW, ESW-Resistance welding (spot, seam, projection, percussion, flash types)-atomic hydrogen arc welding-thermit welding soldering, brazing and braze welding. Welding symbols-Positions of welding-joint and groove design-weld stress- calculations-design of weld size estimation of weld dilution, heat input, preheat, and post heat temperature-computer applications in weld design. Electron beam and Laser beam welding-plasma arc welding-stud welding-friction welding-explosive welding ultrasonic welding-underwater welding-roll bonding-diffusion bonding-cold welding-welding of plastics, dissimilar metal. Gas welding equipments-welding power sources and characteristics safety aspects in welding-automation of welding, seam tracking, vision and arc sensing-welding robots. Defects in welding-causes and remedies-destructive testing methods. Non Destructive Testing of weldments: Testing of pipe, plate, boiler, drum, tank-case studies weld thermal cycle- residual stresses-distortion-relieving of stresses, weldability of cast iron, steel, stainless steel, aluminium alloys-effect of gases in welding-fatigue failure in weldments.

MACHINE TOOL DESIGN

Metal Cutting Theory: Introduction, tool materials, tool geometry, mechanics of metal cutting, tool wear in metal cutting, tool life, cutting forces and power, machinability, cutting fluids. Turning Operations: Introduction, constructional features of a center lathe, cutting tools, operations performed on a center lathe, taper turning methods, thread cutting methods, special attachments, machining time estimation.

Hole Making Process: Introduction, drilling, types of drilling machines, reaming, boring, tapping, other hole making operations, machining time estimation. Milling Process: Introduction, types of milling machines, milling cutters, milling operations, dividing head, indexing. machining time estimation. Abrasive process: Introduction, grinding wheel designation and selection, grinding process, grinding process parameters, honing, lapping. Reciprocating Machine Tools: Shaper and planer, quick return mechanism. Other Machine Tools : Broaching, Introduction to NC, DNC and CNC machines

Principles of jigs and fixture design: Basic principles of location, locating methods and devices, radial or angular location, bush location, the basic principles of clamping, clamping devices. Drilling jigs, types, drill bushings, Fixtures and economics, types of fixtures, lathe fixtures, grinding fixtures, milling fixtures, automatic clamping devices. Press operations: Types of power presses, press selection, cutting action in punch and die operations, die clearance, cutting forces, methods of reducing cutting forces, bending dies, drawing dies.

OPERATIONS RESEARCH

Nature and development of Operations Research: some mathematical preliminaries, OR and managerial decision making, OR applications in industrial and non-industrial fields. Linear Optimization Models: formulation of linear programming problem, graphical solution, sensitivity analysis in graphical solution, comparison of graphical and simplex algorithm, simplex algorithm, computational procedure in simplex, penalty method, two phase method, degeneracy, duality and its concept, application of LP model to product mix and production scheduling problems. The transportation model: solution methods, balanced

and unbalanced problems, Vogel's approximation method, degeneracy in transportation problems. Assignment problem, methods for solving assignment problems. The traveling salesman problem. Numericals on transportation, assignment and traveling salesman method. Computer algorithms for solution to LP problems. Dynamic programming problems: model formulation, computational procedures, solution in different stages. Decision making under conditions of risk, assumed certainty. Waiting line models: queuing systems and concepts, various types of queuing situations, single server queues with poisson arrivals and exponential service times, finite queue length model, industrial applications of queuing theory. Simulation: advantages and limitations of the simulation technique: generation of random numbers, Monte-Carlo simulation, computer-aided simulation, applications in maintenance and inventory management.

ADVANCED MANUFACTURING PROCESSES

Advanced Machining Processes: Introduction, Process principle, Material removal mechanism, Parametric analysis and applications of processes such as ultrasonic machining (USM), Abrasive jet machining (AJM), Water jet machining (WJM) Abrasive water jet machining (AWJM), Electrochemical machining (ECM), Electro discharge machining (EDM), Electron beam machining (EBM), Laser beam machining (LBM) processes, working principal of Plasma arc machining. Advanced Casting Processes: Metal mould casting, Continuous casting, Squeeze casting, Vacuum mould casting, Evaporative pattern casting, Ceramic shell casting. Advanced Welding Processes: Details of electron beam welding (EBW), laser beam welding (LBW), ultrasonic welding (USW). Advanced Metal Forming Processes: Details of high energy rate forming (HERF) process, Electro-magnetic forming, explosive forming Electro-hydraulic forming, Stretch forming, Contour roll forming.

CAD/CAM & ROBOTICS

Introduction: CAD/CAM Processes, Role of CAD/CAM/CAE in the Product Cycle, CAD tools to support the design process and manufacturing, Benefits of CAD/CAM/CAE in the industry. Geometric Modeling: Wire frame modeling – entities, curve representation methods, parametric representation of analytic and synthetic curves, Surface modeling – parametric representation of analytic and synthetic surfaces, Solid modeling – Boundary representation, constructive solid geometry. Geometrical transformation: Two-dimensional transformation Three-dimensional transformation representation of matrix : translation, scaling, rotation, mirror, shearing, Solid modeling types : parametric, solid , surface. Standards for CAD: Need, Graphics and Computing standards, Data Exchange standards, Communications Standards. Application of CAD in Design: Application to Drafting, 3 – D Modeling, Applications, Integration of Design, Analysis and CAD, System Customization and Design Automation Parametric and Variational Modeling, Feature based modeling, Design information system. Fundamental of Solid Mechanics : concepts of Stress Strain Curve, true stress, true strain, stress tensor, strain tensor, Plane stress and strain, Principal stress and strain, yield criteria- Tresca and Von Mises. Finite Element Analysis: Step in FEA, Pre processing, Solution, Post Processing, Result Interpretation, Types of Analysis: Static, Dynamic, Linear, Non-linear, Thermal, Crash. Descritization: Types of elements 1-D, 2-D, 3-D and their selections, interpolation and shape functions, geometrical approximations for FEM, concept of free and mapped meshing, Size and number of elements, Quality checks for element shapes, Co-ordinate systems in FEA. Analysis of Spring Element: stiffness matrix, displacement, stress and strain. Analysis of Link element: 1d link, Matrix formation, Calculations of displacement, stress and strain. Analysis of 2D truss element. Analysis of Beam element: Displacement, Stress and strain analysis. Part

Program Terminology: G and M Codes, Types of interpolation, Methods of CNC part programming, Manual part programming, Computer Assisted part programming: APT language, CNC part programming using CAD/CAM- Introduction to Computer Automated Part Programming. Cutting tool materials: Hard metal insert tooling, Choosing Hard Metal tooling-ISO specification, Chip breakers- Non insert tooling, Qualified and pre-set tooling, Tooling System- Turning center-Machining center. Factors influencing selection of CNC Machines: Cost of operation of CNC Machines-cost of Operation of CNC Machines-Practical aspects of introduction of CNC-Maintenance features of CNC Machines-Preventive Maintenance. Rapid prototyping: - Introduction to rapid prototyping, need of RP in context of batch production, FMS and CIM and it's applications, Basic principles of RP, classification of different RP techniques, advantages of RP.
