TEACHING SCHEME FOR B.TECH "INDUSTRIAL & PRODUCTION ENGINEERING"

Third Semester

IPX-201 MACHINE DRAWING [1 0 6 4]

Section A

Review of Principle of orthographic projections, symbols of standard tolerances machining symbols, sectioning and conventional representation, dimensioning, various types of screw fasteners.
Assembly and disassembly of the following:
Coupling: Pin type, flexible coupling, cone friction clutch

Section B

Boiler Mountings: Steam stop valve, feed check valve, Rams bottom safety valve, blow off cock.
Bearings: Swivel bearing, thrust bearing, plumber block

Section C

Miscellaneous: Screw jack, drill press vice, connecting rod, eccentric
CAD Practices: use of various application software like AutoCAD, 3D- studio etc. for drawing of the above listed machine components.

NOTE: First angle projection to be used. Drawings should contain bill of materials and should illustrate surface finish. The syllabus given above indicates the broad outlines and the scope of the subject to be covered.

Books Recommended:

1. Narayanan Lakshmi and Mathur, "*Text-book of Machine Drawing*"
2. Gill P S, "*Machine Drawing*", S K Kataria and Sons, N. Delhi
3. Bhatt N D, "*Machine Drawing*"
4. Sidheshwar N, "*Machine Drawing*", Tata McGraw Hill Co.,New Delhi
5. Tanta C L, "*Mechanical Drawing*" DhanpatRai and Sons, N.Delhi

IPX-203 STRENGTH OF MATERIALS [3 1 0 4]

Section A

Simple and Compound Stresses and Strains: Concept of stress and strain: St. Venants 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.

Section B

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 Lame'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.

Section C

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

Theories of Failure: Maximum principal stress theory, maximum shear stress theory, maximum strain energy theory, maximum shear strain energy theory, graphical representation and derivation of equation for each and their application to problems relating to two dimensional stress systems only.

Books Recommended:

1. Beer P F and Johnston (Jr) E R, "Mechanics of Materials", SI Version, Tata McGraw Hill, India (2001).
2. Riley William F.,Sturges Leroy D. and Morris Don H., "Mechanics of Materials", Wiley Publishers India, 6th Edition, 2006
3. Popov E P, "Engineering Mechanics of Solids", SI Version 2nd Edition, Prentice Hall of India, New Delhi (2003).
4. Timoshenko S P and Young D H, "Elements of Strength of Materials", 5th Edition, East West Press, New Dlehi (1984).
5. Pytel A H and Singer F L, *"Strength of Materials",* 4th Edition, Harper Collins, New Delhi (1987).

IPX-205 THEORY OF MACHINES [3 1 0 4]

Section A

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.

Section B

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.

Section C

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.
*** Practice Session**
In addition to the tutorials several studies related to mechanism, mechanism trains (Lathe, Milling Machines, and Shaper), automobiles mechanisms, automobile gearbox, differential mechanisms will be performed by the students. Balancing of rotating masses, characteristics of governors, cam and cam profile experiments will be demonstrated during the Practice Session.

Books Recommended:

1. Bevan T, "*The Theory of Machines",* 3rd Edition CBS Publishers and Distributors (2002).
2. Shigley J E and Vickar J J, *"Theory of Machines and Mechanism"*, 2nd Edition, McGraw Hill, New Delhi (1995).
3. Wilson C and Sadler J, *"Kinematics and Dynamics of Machine"*, 3rd Edition, Prentice Hall (2002).
4. Ratan S S, *"Theory of Machines",* 1st Edition, Tata McGraw Hill, New Delhi (1993).
5. Rao J S and Dukkipati R V, *"Mechanism and Machine Theory",* 2nd Edition, New Age International (P) Limited, Delhi (1992).

IPX-207 APPLIED THERMODYNAMICS [3 1 0 4]

Section A

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.

Section B

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.

Section C

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.

Books Recommended:

1. Rogers and Mayhew, "Engineering Thermodynamics", Pearson Education New Delhi (1980).
2. Keartan W J, "Steam Turbine Theory", ELBS Series, London (1958).
3. Joel R, "Basic Engineering Thermodynamics", Addison Wesley Longman, New Delhi (1999).
4. Kostyuk A and Fralov V, "Steam and Gas Turbines", Mir Publishers, Moscow (1988).
5. Lee J F, "Theory and Design of Steam and Gas Turbines", McGraw Hill, New York (1954).

IPX-209 STATISTICS FOR ENGINEERS [3 1 0 4]

Section A

Concept of statistics, collection and representation of data, frequency distribution, graphical representation of data, measure of central tendency and dispersion, coefficient of dispersion, moments, factorial moments, skewness and kurtosis. Different approaches to probability, addition and multiplication theorem of probability, Boole's inequality, conditional probability, Bayes theorem and applications, Moment generating functions

Section B

Random variables – discrete and continuous, distribution function, probability mass function, probability density function, two dimensional random variables, mathematical expectation, expectation of discrete and continuous random variables, properties of expectation, conditional expectation. Discrete and Continuous Probability Distribution: Binomial, Poisson, Normal, Exponential.

Section C

Correlation analysis, Regression analysis, Curve fitting using least square method. Sampling and sampling distribution: chi-square, student-t and F-test.

Books recommended:

1. Bhattacharya G.K. and Johnson R.A.: Statistical Concepts and Methods, John Wiley, New Delhi, 2002.
2. Hogg R. V. And Elliot A.T," Probability and Statistical Inference", Pearson Education, 6th Edition.
3. Hogg R V, Craig A T ,"Introduction to Mathematical Statistics", Siixth Edition, Pearson Education, Delhi
4. Levin & Rubin, "Statistics for Management" 7th Edition, Pearson Education Singapore.
5. Walpole & Mayers, "Probability & Statistics" 8th Ed. Pearson Education, New Delhi.

HMX-202 ENTREPRENEURIAL DEVELOPMENT AND MANAGEMENT [3 0 0 3]

Section A

Entrepreneurship Development: Meaning, objectives, scope & philosophy, type of entrepreneurs, factors affecting entrepreneurship, entrepreneurial qualities, need for promotion of entrepreneurship & small business, linkage between entrepreneurship and economic development, problem of increasing unemployment, creativity & entrepreneurship, harnessing locally available resources.
Entrepreneurship Support System: SIDBI, SISIs, SSIEC, SFCs, DICs, NSIC, EDI (Ahmadabad), NRDC, NIESBUD, PSIEC and Technical Consultancy Organizations.

Section B

Project Report Preparation: Planning a small scale industry, identifying business opportunities, project report & its importance, various contents of project report: managerial & entrepreneurial capabilities, socio-economic benefits, demand analysis, technical feasibility and financial viability.
Introduction to Marketing Management: Brief introduction to various types of product strategies, pricing strategies, channel strategies and promotional strategies.

Section C

Introduction to Production Management: Types of production systems, production planning and control, functions of production manager & materials management.
Introduction to Human Resource Management: Manpower planning, recruitment, selection, placement & induction, training & development, compensation.
Introduction to Financial Management: Sources of finance and working capital management.

Books Recommended:

1. Prasanna Chandra , Projects : Planning, Analysis, Selection, Implementation & Review, Tata McGraw Hill
2. Kenneth R., Van Voorthis, Entrepreneurship and Small Business Management.
3. B. Gupta & N.P. Srinivasan, Entrepreneurial Development.
4. Gopala Krishnan & V.E Rama Moorthy, 'Project Management', Macmillan India Ltd.
5. Jose Paul and Kumar Ajith N, 'Entrepreneurship Development and Management', Himalaya Publishers, New Delhi (2000).
6. Dollinger, 'Entrepreneurship Strategies and Resources', Pearson Education (2003).
7. Holt David H, 'Entrepreneurship: New Venture Creation', Prentice Hall of India (2000)
8. Kuratko & Hodgetts, 'Entrepreneurship Management: Theory, Process, Practice', (7th Ed), Thomson.

IPX-221 APPLIED THERMODYNAMICS LABORATORY [0 0 2 1]

1. To conduct a load test on a single cylinder, 4-stroke petrol engine and study its performance under various loads.
2. To conduct a load test on single cylinder speed diesel engine and to study its performance under various loads.
3. To conduct a performance test on single cylinder high-speed diesel engine and to study its performance under different loads.
4. To conduct the experiment on two stage Air Compressor and to find out its volumetric efficiency and isothermal efficiency.
5. To conduct Morse Test on 3-cylinder, 4-stroke petrol engine.
6. To conduct a load test on a 4-cylinder, 4-stroke, diesel engine and to study its performance under different loads.
7. To find the coefficient of performance of vapour compression refrigeration test rig using capillary tube as an expansion valve.
8. To find the coefficient of performance of vapour compression refrigeration test rig using thermostatic expansion valve.
9. To determine the thermal conductivity of a solid insulating material by slab method.
10. To study the parallel flow and counter flow heat exchanger.
11. To study the working and the construction of different types of fire tube and water tube boilers.
12. To study the various components of a thermal power plant namely turbines, condensers and nozzles. (Industrial visit)

IPX-223 STRENGTH OF MATERIALS LABORATORY [0 0 2 1]

1. Determination of Young's modulus, tensile, strength and percentage elongation for steel, aluminum, brass and cast iron specimens on universal testing machine. Also plot the stress strain diagram.
2. To perform the compression test for cast iron specimen on universal testing machine.
3. To determine the deflection for mild steel specimen and verify the beam formula for specimen in bending.
4. To determine the stiffness of the following:
   (i) Cantilever beam (ii) Spring under compressive and tensile loading
5. To measure the total energy absorbed in fracturing of the ductile specimen on Charpy and Izod setup.
6. To plot and study the S-N curve for steel, aluminum and fibre reinforced composite material at 25%, 50%, 60% and 75% of ultimate tensile strength of the specimen.
7. Preparation of specimen for hardness test.
8. Testing of prepared specimens for Brinell hardness and Rockwell hardness.
9. To study the behavior of steel and aluminum specimen under torsion.

Fourth Semester

IPX-202 MECHANICAL MEASUREMENT AND METROLOGY [3 1 0 4]

Section A

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.

Section B

Electromechanical transducers: Variable resistance transducers, variable capacitance transducers, pIPzo-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.

Section C

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.

Books Recommended:

1. Jain R K, "Engineering Metrology", Khanna Publishers, New Delhi (2003)
2. Kumar D S, "Mechanical Measurements and Control Engineering" Metropolitan Book Company, New Delhi (2001)
3. Sawney R, "Instrumentation and Mechanical Measurements", Dhanpat Rai and Sons, New Delhi (2003)
4. Holeman J P, "Experimental Methods for Engineers", Tata Mc Graw Hill Publishing Company, Delhi (1998)
5. Beckwith T H, "Mechanical Measurements", Addison Wesley, New York (1990).

IPX-204 MATERIALS ENGINEERING [3 0 0 3]

Section A

Creep: Introduction, time dependent mechanical behavior, creep curve, mechanism of creep, factors affecting creep, effect of alloys, creep under combined stresses, presentation of engineering creep data, fatigue creep interaction.

Equilibrium Diagrams for non-ferrous alloys: Review of cooling curves, phase rule, solid state transformation, phase diagram of non-ferrous alloys

Iron Carbon Diagram: Allotropic forms of carbon, solid and liquid state reactions, types of steels, types of cast irons, microstructures at various carbon percentages, properties as a function of microstructures, significance of IC diagram. Cooling curves and equilibrium diagrams for brass and aluminum alloys.

Section B

TTT Diagrams: Time temperature transformations diagram, transformations as a function of cooling rate, mechanism of various transformations, and significance of TTT diagram.

Heat Treatment Methods: Mechanism of annealing and advantages, mechanism of normalizing and advantages, mechanisms of tempering and advantages, mechanism of hardening and advantages, mechanism of case hardening and advantages, mechanism of induction hardening and advantages.

Section C

Chemical Heat Treatment Methods: Introduction to chemical heat treatment, mechanism and methods of carburizing, nitriding, cyaniding, introduction to flame hardening.

Hardenability: Meaning of Harden ability, tests of Harden ability, factors affecting Harden ability

Effect Of Alloying Elements: Effect on strength and hardness, effect on Harden ability, effect on transformation temperature

Books Recommended:

1. Raghavan V, "Introduction to Material Science and Engineering", Prentice Hall of India.
2. Smith W F, "Principles of Material Science and Engineering", McGraw Hill, New York
3. Dieter G E, "Mechanical Metallurgy", McGraw Hill, New York.
4. Van Vlack L H, "Elements of Materials Science and Engineering", Addison Wesley publishers.
5. Lakhtin Y, "Metallurgy and Heat Treatment", MIR Publishers

IPX-206 PRODUCTION PLANING AND CONTROL [3 1 0 4]

Section A

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.

Section B

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.

Section C

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.

Books Recommended:

1. Vollmann Thomas E, Bery William L, Why bark D Clay, "*Manufacturing Planning and Control Systems*" Galgotia Publications, New Delhi (2002).
2. Buffa, "*Modern Production/operations Management*", Wiley Eastern, New York (1999).
3. Muhlemann Alan, Oakland John and Lockyer Keith, "*Production and Operations Management*", Macmillan India Publications Ltd. (2001)
4. Panneer Selvan R,"*Production and Operation Management*", Prentice Hall India, New Delhi (2002).
5. Aswathappa K and Bhat K Shridhara, "*Production and Operations Management*", Himalaya Publishing House, Mumbai (2002).

IPX-208 DESIGN OF MACHINE ELEMENTS [3 0 2 4]

Section A

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, deign 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.

Section B

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 contract bearing, ball bearing, roller bearing selection procedure under simple loading conditions.

Section C

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.

Books Recommended:

1. Sharma P C and Aggarwal D K, "*Machine Design*", Kataria Publishers (2002)
2. Spotts M F, "*Design of Machine Elements*", Prentice Hall of India Pvt. Ltd. (2000)
3. Sharma C S & Purohit Kamlesh, "*Design of Machine Elements*", Prentice Hall, New Delhi (2003)
4. Khurmi R S and Gupta J K, "*A Textbook of Machine Design*", Eurasia Publishing Housing (Pvt.) Ltd., New Delhi (2003)
5. Bhandari, "*Design of Machine Elements",* Tata Mcgraw Hill, New Delhi (2001)

IPX-210 MANUFACTURING TECHNOLOGY [3 1 0 4]

Section A

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: Molding 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 Risering, 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 furnacescupola, 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.

Section B

Forming: Metallurgical aspects of metal forming slip, twining mechanics of plastic deformationeffectsof temperature, strain rate-microstructure and friction in metal forming, yield criteria and theirsignificance-classification of metal forming processes. Principle classification equipment, toolingprocesses, parameters and calculation of forces during forging and rolling processes, Ringcompression 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 Mannessmann processes of seamless pipe manufacturing.

Classification of Forming Processes: Classification conventional and HERF processes, Pressestypesand 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.

Section C

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 characteristicssafety 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 studiesweld 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.

Books Recommended:

1. Taylor H.F Flemings M.C & Wulff J., Foundry Engineering, Wiley Eastern Limited, 1993.
2. Lindberg R.A, Processes and Materials of Manufacture , Prentice Hall of India (P) Ltd.,1996
3. Lancaster J.F., Metallurgy of welding, George Allen and Unwin, 1991.
4. Serope Kalpakjian, Manufacturing engineering and Technology, Edition III - Addision - Wesley Publishing Co., 1995.
5. William F. Hosford & Robert M. Caddel, Metal forming (Mechanics & Metallurgy), Prentice Hall Publishing Co., 1990

IPX-212 HEAT AND MASS TRANSFER [3 0 0 3]

Section A

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.

Section B

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.

Section C

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.

Evaporation: Types of evaporators, single and multiple effect evaporators, capacity and economy, boiling point elevation.

Introduction To Mass Transfer: Introduction; Fick's law of diffusion; Steady state equimolar counter diffusion; Steady state diffusion though a stagnant gas film. 2

Books Recommended:

1. Holman J P, "Heat Transfer", McGraw Hill Book Co. (1992).
2. Incropera F P and DeWitt D P, "Introduction to Heat Transfer," 2nd Ed John Wiley New York (1996).
3. Geankopolis C J, "Transport Processes and Separation Process Principles", Prentice Hall of India, 4th Edition, Eastern Economy Edition (2004)
4. Kern D Q, "Process Heat Transfer", McGraw Hill Book Co. (1997).
5. Coulson J M and Richardson J F, "Chemical Engineering" Volume 1, Pergamon Press (1999).

IPX-222 MECHANICAL MEASUREMENTS AND METROLOGY LABORATORY [0 0 2 1]

1. To measure the acceleration of a vibrating body using strain gauges
2. To measure the acceleration of a rotating machinery using Piezo-electric sensors.
3. To measure the velocity of a rotating shaft using Tachometer.
4. To measure the angle of rotation of a rotating shaft using Photoelectric sensors.
5. To measure the dynamic power of a shaft using instantaneous power measuring dynamometer.
6. To measure the load of compressive nature using load cells.
7. To measure the angle of a taper rod using sine bar and slip gauges.
8. To measure the straightness of machine tool surface by sensitive spirit level.
9. To measure the angle and width of a V- groove
10. To measure the gear tooth thickness by using gear tooth vernier calliper.
11. To measure the elements of screw thread using tool makers microscope.
12. To measure the elements of screw thread using profile projector

IPX-224 MANUFACTURING TECHNOLOGY LABORATORY [0 0 2 1]

1. Study of Tools and Equipments used in foundry.
2. Preparation of moulds of simple objects like flange, gear V- grooved pulley etc.
3. Study of Tools and Equipments used in welding
4. Arc Welding of butt joint, Tap Joint, Tee fillet etc.,
5. Demonstration of gas welding.
6. TIG and MIG welding Jobs
7. Spot welding job
8. Die design and manufacturing for forming.

IPX-226 HEAT AND MASS TRANSFER LABORATORY [0 0 2 1]

1. Determination of emissivity of the given test plate
2. Determination of thermal conductivity of the given liquid
3. Determination of thermal conductivity of insulating powder
4. Determination of heat transfer coefficient by forced convection
5. Determination of heat transfer coefficient for pin fin by natural convection
6. Determination of heat transfer coefficient for pin fin by forced convection
7. Determination of overall heat transfer for parallel flow in double pipe heat exchange
8. Determination of overall heat transfer coefficient for counter flow in double pipe heat exchanger
9. To conduct test on heat pipe and comparison of the temperature distribution

TEACHING SCHEME FOR B.TECH "INDUSTRIAL & PRODUCTION ENGINEERING"

F**ifth Semester**

IPX-301 MACHINE TOOL DESIGN [3 1 0 4]

Section A

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.

Section B

Milling Process: **I**ntroduction, 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

Section C

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.

Books Recommended:

1. Lindberg Roy A, "*Processes and materials of manufacture*", Fourth edition PHI, 1990.
2. Ostwald Phillip F, "*Manufacturing processes and systems*", John Wiley and Sons, ninth edition (1998).
3. Rao P N, "*Manufacturing technology*", Tata McGraw-Hill, 2002.
4. Gerling, "*All About Machine Tools*", New Age International (P) Limited, sixteenth edition, 2000.
5. Chapman W A J, "*Workshop Technology*", Part1, 2,3, CBS Publishers and distributors.,2000
6. Grant Hiram E, "*Jigs & Fixtures*", Tata McGraw Hill Publishing Company, 1994.
7. Sharma P C, " *Production Engineering*", S Chand & Company,1997.
8. Kalpakjian S, "*Manufacturing Engineering & Technology*", Addison Wesley Longman, Pvt.Ltd., Low Price Edition, 2000.

IPX-303 WORK STUDY AND ERGONOMICS [3 1 0 4]

Section A

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.

Section B

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.

Section C

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.

Books Recommended:

1. Barnes Ralph M., "*Motion & Time study: Design and Measurement of Work*", Wiley Text Books, 2001.
2. Marvin E, Mundel & David L, "*Motion & Time Study: Improving Productivity*", Pearson Education, 2000.
3. Benjamin E Niebel and Freivalds Andris, "*Methods Standards & Work Design*", Mc Graw Hill, 1997.
4. International Labour organization, "*Work-study*", Oxford and IBH publishing company Pvt. Ltd., N.Delhi, 2001.
5. Sanders Mark S and McCormick Ernert J, "*Human Factors in Engineering and Design*", McGraw-Hill Inc., 1993.

IPX-305 QUALITY MANAGEMENT [3 1 0 4]

Section A

Review of 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 Shewhart control charts.

Process Control: Charts for variables; for individuals, 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 X bar and R charts.

Section B

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.

Section C

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. Dodge - Romig Tables, MIL-STD-105D.

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.

Books Recommended:

1. Grant E L and Leavenworth R S, "*Statistical Quality Control*", McGraw Hill, Sixth Edition (2000)
2. Hansen Bertrand L and Ghare Prabhakar M, "*Quality Control and Applications*" Prentice Hall of India Pvt. Ltd., First Edition (1993)
3. Amitav Mitra, "*Fundamentals of Quality Control and Improvement*", Pearson Education Asia, First Edition (2004)
4. Goetsh & Davis, "Understanding & Implementing ISO 9000: 2000", Pearson Education Asia, 2002.
5. Zaidi A., "*SPC: Concepts, Methodologies and Tools*", Prentice Hall of India, First Edition, (2003)

IPX-307 OPERATIONS RESEARCH [3 1 0 4]

Section A

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.

Section B

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.

Section C

Waiting line models: queuing systems and concepts, various types of queuing situations, single server queues with poison 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.

Books Recommended:

1. Taha,H A, "*Operations Research - An Introduction*", Sixth Edition, Prentice Hall of India Private Limited, N. Delhi, 2004.
2. Hillier, F S, "*Operations Research*", First Indian Edition, CBS Publishers & Distributors, Delhi, 1994.
3. Wagner H M, "*Principles of Operations Research*", Second Edition, Prentice Hall of India Private Limited, New Delhi, 2003.
4. Mustafi C K, "*Operations Research*", Third Edition, New Age International Pvt. Ltd., New Delhi, 1996.
5. Gupta P K, & Hira D.S., "*Operations Research*", Third Edition, S Chand & Company Ltd., New Delhi, 2005.

IPX- 309 AUTOMOBILE ENGINEERING [3 0 0 3]

Section A

Introduction to automobile: Importance, applications, job opportunities, classification, types of vehicles, basic structure, general layout, hybrid vehicles.

Automotive electric and electronic systems: Electric and electronics principles, systems, and circuits, automotive batteries, construction, and operation, starting system, charging system, operation and service, ignition system, electronic ignition and fuel control, engine management, electric vehicles, electronic fuel injection system - monopoint and multipoint systems.

Section B

Automotive drive trains: Clutch - types and construction, fluid flywheel, gear boxes, manual and automatic - overdrives - propeller clutches, drive shafts, universal joints, drive axles.

Automotive chassis: Vehicle construction, chassis, frame and body, construction, operation, performance, steering system, wheel alignment, brakes, wheels and tyres.

Section C

Maintenance and Trouble Shooting: Automobile performance, drivability, emissions and emission norms, noise and vibration, engine tuning, equipment for measuring various vehicle parameters such as BHP, A/F ratio, noise, vibration and emission, comfort and safety.

Newer Fuels: Use of natural gas, LPG, hydrogen, bio- diesel in automobiles as fuels, electric and hybrid vehicles, fuel cells. Other recent advances in automobiles and automotive components.

Books Recommended:

1. Crouse – Anglin, "*Automotive Mechanics*", McGraw Hill, 10th Edition, Singapore.
2. Pulkrabek Willard W., "Engineering *Fundamental of the Internal Combustion Engine*", Prentice Hall of India, New Delhi, 2002.
3. Bosch, "*Automotive Handbook*", SAE Publication.
4. Denton Tom, "*Automobile Electrical and Electronics Systems*", Butterwoth, Heinemann, 2003.
5. Layne Ken, "*Automotive Engine Performance: Tune up, Testing and Service*", Englewood Prentice Hall of India, 1996.

IPX-321 Machine Tool Design Laboratory [0 0 2 1]

Students are required to perform various jobs in the machine shop as given below:

1. Practice on Lathe : 05 Jobs
   (Jobs should cover various lathe operations like centring, facing, turning, stepped turning, parting, threading, taper turning, chamfering and knurling)
2. Practice on Shaper : 01 Job (Slot cutting)
3. Practice on milling machine : 01 Job (Slot cutting)
4. Practice on Surface grinder : 01 Job (Creating Flat surface)
5. Practice on Drilling Machine : 01 Job (Marking and drilling operations)
6. Practice on EDM 01 Job
7. Practice on wire cut – 01 Job

IPX-323 Work Study and Ergonomics Laboratory [0 0 2 1]

List of Experiments

1. Method to improve the assembly and dis-assembly of a Bolt, a nut and three washers
2. Methods Improvement – Assembling pins on cardboard
3. Rating Practice –Walking on level grounds and dividing a pack of cards into four equal piles.
4. Rating Practice – Films and analysis.
5. Work sampling exercises
6. Stop watch time study on drilling machine, lathe machine and CNC machine
7. Calibration of an individual using Tread Mill as a loading-device.
8. To measure the autonomic tone of an individual using multichannel polygraph.
9. Measurement of anthropometrics data and analysis of data.
10. Audiometric examination a through pure tone audiogram of a subject using portable audiometer in a portable audiometric testing cabin.
11. To measure the middle ear latency response of an individual using BERA.
12. To measure the respiratory parameter of an individual.
13. To measure the ambience noise and to check the noise dose of an individual in industrial noisy environment using sound level meter and noise dosimeter.
14. To measure the heat stress of an individual using area heat stress monitor.
15. To measure the dust exposure of an individual using dust sampler.

Sixth semester

HMX-306 MARKETING MANAGEMENT [3 1 0 4]

Section A

Nature of Marketing: Marketing concept, marketing approaches, marketing tasks, marketing as a system and modern practices, marketing of services.

Global and Indian Marketing Environment: Introduction, comparison, differences and similarities, micro & macro environmental variables.

Consumer Behavior: Factors influencing consumer behavior, buying process consumers' motives, reference groups & industrial buying behavior.

Section B

Marketing Information System: Concepts & importance, components & functions of each component.

Marketing Segmentation & planning: Marketing segmentation & targeting, marketing planning, strategic planning process.

Product Decisions: Product mix, product differentiation & positioning, new product development process, consumer adoption process, product life cycle & strategies, packaging & labeling.

Section C

Pricing Decisions: Objective of pricing, factors influencing pricing decisions, pricing methods, pricing policies.

Channel Decisions: Nature and types of marketing channels, channel management decisions, retailing & whole selling.

Promotion Decisions: Promotion mix, advertising, sales promotion, personal selling, media buying & media planning.

Books Recommended:

1. Azhar Kazmi, (2007), 'Business Policy and Strategic Management', Tata Mc Graw Hill: New Delhi.
2. Douglas West, John Ford and Essam Ibrahim, (2007) 'Strategic Marketing', Oxford University Press: New Delhi..
3. Adrian Palmer, (2007) 'Introduction to Marketing – Theory and Practice', Oxford University Press: New Delhi..
4. V. S. Ramaswamy and S. Namakumari, (2007) 'Marketing Management', Macmillan India Ltd.
5. Philip Kotler, (2007) 'Marketing Management', Pearson Education: New Delhi.
6. Kurtz & Boone, 'Principles of Marketing', (12th Ed), Thomson.
7. Cinzkota & Kotabe, 'Marketing Marketing', (2nd Ed). Thomson.

IPX-304 FLUID MECHANICS & MACHINERY [3 1 0 4]

Section A

Review of Fluid Properties: Engineering units of measurement, mass, density, specific weight, volume and gravity, surface tension, capillarity, viscosity, bulk modulus of elasticity, pressure and vapour pressure, Fluid Statics: Pressure at a point, pressure variation in static fluid, absolute and gauge pressure, manometers, Forces on plane and curved surfaces (Problems on gravity dams and tainter gates); buoyant force, stability of floating and submerged bodies, relative equilibrium

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, circulation stagnation point, separation of flow, sources and sinks, velocity potential, stream function, flow nets there utility and method of drawing flow nets

Ideal Fluid Flow: Rectilinear flow, superimposed flow pattern, source and sink, half body flow, Doubled, flow over circular cylinder, Doubled in a uniform flow, doubled and free vortex in a uniform flow.

Section B

Dynamics of Flow: Euler's equation of motion along a streamline and derivation of Bernouli's equation application of Bernouli's equation, energy correction factor, linear momentum equation for steady flow, momentum correction factor, the moment of momentum equation, forces on fixed and moving vanes and other applications, fluid measurements: velocity measurements (Pitot tuve, Prandtl tuve, current meters etc.), flow measurement (orifices, nozzles, mouth pieces, orifice meter, nozzlemeter, venture-meter, weirs and notches)

Dimensional Analysis and Dynamic Similitude: Dimensional analysis, dimensional homogeneity, use of Buckingham-pi theorem, calculation of dimensionless numbers, similarity laws, specific model investigations (submerged bodies, partially submerged bodies, weirs, spillways, rotodynamic machines etc.)

Laminar Flow: Introduction to laminar and turbulent flow, Reynolds experiment and Reynolds number, relation between shear and pressure gradient, laminar flow through circular pips 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 Wiesdack's Equation, drag force on flat plate, rough and smooth boundary.

Section C

Hydraulic Machines: Introduction, classification of turbines, impulse turbins, pelton wheel turbine, (efficiency of runner, mechanical efficiency and volumetric efficiency, overall efficiency), Reaction Turbine,: francis turbine, Keplan Turbine, (efficiency of runner, mechanical efficiency and volumetric efficiency, overall efficiency) Draft tube, types of draft tubes, Centrifugal pump.

Books Recommended:

1. White Frank M., Fluid Mechanics, McGraw Hill Companies, Third edition, 2005
2. Cengel Yunis A and Cimbala John M., Fluid Mechanics Fundamental and Application, Second edition, 2010
3. Modi P.N., Seth S.N., Hydraulics and Fluid Mechanics, Standard Book House, Fourth edition, 1980
4. Logan Earl, Turbomachinery Basic, Theory and Applications, Second edition, Michael Dekker, 1993
5. Jain A.K., Fluid Mechanics, Khanna Publications,
6. Bansal R.K., Fluid Mechanics, Firewall Media, 2005
7. Kumar K.L, Engineering Fluid Mechanics, S.Chand Publication, Revised Edition 2007

IPX- 306 SIMULATION OF PRODUCTION SYSTEMS [3 1 0 4]

Section A

Introduction: Basic concepts of systems, Elements of systems, event driven models, simulation as a decision making tool, types of simulation, system modeling, types of modeling

Basic factory dynamics: Basic definitions and Parameters; Simple relationships, Little's Law; Bottleneck Rates and Cycle Times; Labour Constrained Systems

Statistical models in Simulation: Review of terminology and concepts, Probabilistic and statistical models in simulation. Introduction to some discrete and continuous probability distributions including Bernoulli, Poisson, Geometric, Uniform, Exponential, Gamma, Erlang, Normal, and Triangular distributions. Relevance to simulation modelling.

Section B

Random Numbers: properties of random numbers, pseudo random numbers, techniques for generating random numbers, test for random numbers, techniques for random variate generation.

Analysis of simulation data: Input data modelling, Data collection, parameter estimation, distributional assumptions and hypothesis testing. Chi-square and Kolmogorov-Smirnov Goodness-of-fit tests.

Section C

Recent advances and case studies/mini project: Development of simulation models for systems like queuing systems production, inventory, maintenance, material handling and replacement systems-Investment analysis etc. Introduction to the special purpose simulation language

Model verification and validation techniques. Output data analysis of terminating and non terminating Systems. Variance reduction techniques. Introduction to simulation experimental design methods.

Books Recommended:

1. Gray Beal, Wajne J and Pooch U W, "*Simulation Principles & Methods*", Winthrop Publishing Incorporate.
2. Severance Frank, "System Modelling and Simulation", John Wiley and Sons, 2005
3. Banks, Carson, Nelson and Nicole, "Discrete *Event System Simulation*", Pearson Education, Asia, 2001.
4. Hopp W.J. and Spearman M.L., Factory Physics, Mc-Graw Hill Higher Education, 2000.
5. Kelton W.D., Sadowski R.P., and Swets N.B., Simulation with Arena, Mc-Graw-Hill, 2010.
6. Banks Jerry and Carson John S., "*Discrete event system simulation*", Prentice Hall, 2001.

IPX-308 FACILITIES PLANNING AND DESIGN [3 1 0 4]

Section A

Introduction: Introduction to facilities planning and design, plant layout, material handling and their interrelationship.

Site Location: Importance of location, hierarchy of location problems, factors affecting site location; factors in heavy manufacturing location, light industry location, warehouse location, retail location. Various theories/models of site location like bid rent curves, Weber's isodapanes, Weber's classification of industries, Hoover's tapered transport rates, agglomeration, factor rating method, single facility location, load-distance model, break-even analysis, transportation method. New plant location and shut down under dynamic conditions.

Section B

Plant Layout: Objectives of a good plant layout, principles of a good layout, classical types of layouts like product layout, process layout, fixed-position layouts, cellular layouts and hybrid layouts. Factors affecting plant layout: man, material, machine, movement, waiting, service, building and change, features and considerations of each factor. P - Q chart, systematic layout planning, relationship (REL) chart, traditional layout configuration, production space requirements, manual CORELAP algorithm and examples, preparing process layouts and the considerations thereon.

Product Layouts: basic features of mass manufacturing, advantages & disadvantages of flow-line production, product-oriented layout – assumptions & types, assembly line layout, assembly line balancing. Design of an assembly line, layout heuristics for assigning tasks in assembly line balancing, assembly line balancing equations.

Section C

Computerized Layout: Evaluation of layout, computerized layout, flowcharts of various techniques like CRAFT, ALDEP and CORELAP.

Material Handling: Concept of material handling, principles of material handling, factors affecting material handling, objectives, material handling equation.

Material Handling Equipments: Selection of material handling systems and equipments: Automated Guided Vehicles, types, features, usage. Conveyors: basic functionality requirements, types of Conveyors, application considerations, operational considerations. Cranes, hoists and industrial trucks.

Books Recommended:

1. James Apple, "Plant Layout & Material Handling", The Ronalt Press Co., New Delhi, 1998.
2. Francis, McGinnis and White, "Facilities Layout & Location –an analytical Approach" Prentice Hall of India Pvt Ltd., New Delhi, 2001.
3. Richards Muther, "Practical Plant Layout", McGraw Hill Book Co., New York, 1982.
4. Ronald H Ballou, "Business Logistics", Pearson Education, Inc. New Delhi, 2004.
5. Tompkins J A & J A White, "Facilities Planning", John Wiley & Sons, Inc. New York, 1984

IPX-310 ADVANCED MANUFACTURING PROCESSES [3 1 0 4]

Section A

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

Section B

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)

Section C

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

Books Recommended:

1. "Materials and Processes in Manufacturing" (8th Edition), E. P. DeGarmo, J. T Black, R. A. Kohser, Prentice Hall of India, New Delhi (ISBN 0-02- 978760).
2. "Manufacturing Science" A. Ghosh, and A. K. Mallik, Affiliated East-West Press Pvt. Ltd. New Delhi.
3. "Nontraditional Manufacturing Processes", G.F. Benedict, Marcel Dekker, Inc. New York (ISBN 0-8247-7352-7).
4. Rao P N, "*Manufacturing Technology*", Tata McGraw Hill Publilishing Company, 2000.
5. Mishra P K,"*Non Conventional Machining*", Narosa Publishers, 2001.
6. Singh K K "Unconventional Manufacturing Processes" Dhanpat Rai & Company, New Delhi 2007.

IPX-322 FLUID MECHANICS & MACHINERY LABORATORY [0 0 2 1]

1. To find the performance of Hydraulic turbines and Pumps
2. To determine the local point pressure with the help of pitot tube
3. To find out the terminal velocity of spherical body in water
4. Calibration of orifice meter and venture meter
5. Determination of C_C, P_V and C_D of orifices
6. Calibration of nozzle meter and mouthpiece
7. Reynolds experiment for demonstration of streamline and turbulent flow
8. Determination of meta centric height
9. Determination of friction factor of pipe
10. To study the characteristics of Centrifugal pumps
11. Verification of impulse momentum principal

TEACHING SCHEME FOR B.TECH "INDUSTRIAL & PRODUCTION ENGINEERING"

Seventh semester

IPX-401 INDUSTRIAL AUTOMATION [3 1 0 4]

Section A

Hydraulic System Elements: Pumps, types, working, characteristics, applications: Types of conductors, and connectors, their selection: Seals and packing, types, materials, applications.

Hydraulic Actuators: Linear and Rotary, types, working, cushioning effect, mounting, calculation of force and velocity of piston System components: Accumulators, Intensifiers, their types, working, applications.

Control Elements: Pressure control Valves, direct acting type, pilot operated, sequence, counterbalancing, unloading, pressure reducing, construction and working: Direction control valves, types, construction and working, spool actuation methods, spool center positions, Flow control valves – compensated and non compensated types, construction and working.

Section B

Hydraulic Circuits and their Applications: Speed control circuits, regenerative, sequencing, counterbalancing, synchronizing, interlocking, circuits with accumulator and intensifier. Introduction to Fluidics and study of simple logic gates: Hydraulic clamping and braking systems.

Pneumatics: Air compressors, types, working, selection criteria; FRL unit , construction and working; Pneumatic cylinders and air motors, construction and working, types, calculation of force and air consumption, Comparison of air, hydraulic and electric motor.

Pneumatic System Control Elements: Direction control valves, types, control methods for spool working; Flow control valves, working of variable flow control, quick exhaust, time delay and shuttle valve; Pressure control valves, types and working.

Section C

Pneumatic Circuits: Basic circuit, impulse operation, speed control, sequencing, time delay circuits and their applications. Pneumatic clamping and braking systems, Pneumatic power tools.

Hydro pneumatic systems: concept, working and applications. Fluid power maintenance, troubleshooting and safety.

Automation devices: Feeders, orienters, catchment devices, PLC architecture and programming

Books Recommended:

1. Espositio A., "*Fluid Power with Applications"*, Pearson, 2002.
2 Majumdar S. R. ,"*Oil Hydraulic Systems"* , Tata McGraw Hill 2000
3. Majumdar S. R. , "*Pneumatic systems-principles and Maintenance"*, TataMc Graw Hill, 2000.
4. Janakiraman P.A., "*Robotics and image processing"*, Tata McGraw Hill, 1995.
5. Yoram Koren, "*Robotics"*, McGraw Hill, 1992.

IPX-403 ENVIRONMENTAL PLANNING AND CONTROL [3 1 0 4]

Section A

Introduction to environment management: Environment and its components, ecology and its divisions, structure of function of ecosystem, data base management for environmental appraisal, monitoring & warning system. environmental hazards, terminology and classification of natural resources, environmental impact analysis, environmental planning.

Environmental pollution: Concept and nature of pollution, sources and types of pollution and their effects, air, water, noise, thermal pollution monitoring and its parameters.

Section B

Environment and law: Environment legislations and its uses, water Act, air Act water Cess Act, hazardous waste handling Act, biomedical waste management Act, solid waste management Act, role of environmental enforcement organizations, kyoto protocol.

Systems of environment management: Management of air pollution control, management of water pollution, management of prevention of thermal pollution, management of waste heat.

Section C

Systems of environment management (**Contd.)** Management of solid waste disposal, hazardous wastes, management of noise pollution, biomedical waste management, management of agricultural pollution.

Environmental control: Introduction to ISO-14000, its parameters, importance of ISO 14000 in production and service sector various pollution control methods and devices.

Books Recommended:

1. Della-Giustina Denial E, "*Safety and environment management*", Johan Wiley Publications.
2. Markman Howard J, "*Environmental Management and Cleaner Production*", John Wiley Publications.
3. Johnson Perry, "*ISO14000, The Business Managers Complete Guide to Environment Management*", John Wiley Publication.
4. Nemesow Nelson L, "*Zero Pollution for Industry*", John Wiley Publication.
5. Gilbert M. Masters, "Introduction to Environmental Engineering and Science", Pearson education, 2004.

IPX-405 MATERIALS MANAGEMENT [3 1 0 4]

Section A

Integrated approach to materials management: Introduction, materials productivity and role of materials management techniques in improved materials productivity. Cost reduction and value improvement, value analysis for right choice and rationalization of materials**.**

Purchasing function: Objectives, purchase requisitions, types of specification, centralized versus decentralized purchasing, timing of purchases. Purchasing research, identification of right sources of supplies. Make or buy decisions, vender selection and vender rating. Negotiations, purchase price analysis and price determination. Purchasing organization, procedures, forms, records and reports. Purchasing as a dynamic profession, transition to supply management, Reverse auctioning.

Inventory management: Inventory concepts, reasons for holding inventory, types of inventory, inventory reduction tactics. Inventory turnover ratio. Selective Inventory management: ABC, VED, and FSN analysis etc., identifying critical items with selective inventory management.

Section B

Operating policies: continuous review system, periodic review system, comparative advantages and disadvantages of continuous and periodic review systems, hybrid systems. Inventory management across the organization.

Optimizing Inventory: Assumptions for Wilson's lot size model, inventory costs, hidden costs, composition of costs, estimation of inventory related costs, lead time, stock out point, number of time periods, calculating Economic Order Quantity (EOQ), sensitivity analysis of EOQ model.

Special inventory models: Finite replenishment rate model, lot size models with planned backlogging, generalized model with uniform replenishment rate, inventory model with lost sales, quantity discount model, one period decisions. Determination of safety stock, service level and uncertainty in demand. Information systems for inventory management.

Section C

Stores management: Introduction, stores functions, stores organization, stores systems and procedures, stores accounting and verification systems, stores address systems, stores location and layout, store equipment.

Discussion on modern materials management techniques like JIT, SMED, DBR & MRP

Books Recommended:

1. Arnold and Chapman "*Introduction to Materials Management*", Pearson Education Asia, Fourth Edition, (2001)
2. Narsimhan, Mcleavey & Billington, "*Production Planning & Inventory Control*", Prentice Hall of India, Second Edition (2003)
3. Dobler Donald W., Burt David N., "*Purchasing and Supply Management*", Tata McGraw Hill, Sixth Edition (2001)
4. Menon K S, "*Purchasing and Inventory Control*", Wheeler Publishing New Delhi, Third Edition (1997)
5. Krajewski L J and Ritzman L P, "*Operations Management*", Pearson Education Asia, Sixth Edition (2004)

IPX-421 INDUSTRIAL AUTOMATION LABORATORY [0 0 2 1]

LIST OF EXPERIMENTS

1. Speed control circuits on hydraulic trainer
2. Sequencing circuit on hydraulic trainer
3. Counterbalancing circuit on hydraulic trainer
4. Synchronizing circuit on hydraulic trainer
5. Design of any hydraulic circuit and selection of components
6. Sequencing circuit using Pneumatics
7. Manual and automatic forward and reverse with solenoid control / pilot control
8. on pneumatic trainer
9. AND and OR logic circuits on pneumatic trainer
10. At least one industrial visit to study applications related to the subject and submission of the relevant report.
11. PLC program for control of control of various pneumatic cylinders
12. Robot Program

Eighth Semester

IPX-402 ENGINEERING ECONOMY [3 0 0 3]

Section A

Engineering Costs – Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring and Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle Costs.

Cash Flow & Rate of Return Analysis- Cash Flow and Cash Flow Diagrams, Time Value of Money, Debt repayment, Nominal & Effective Interest; Cash Flow– Calculations, Treatment of Salvage Value, Annual Cash Flow Analysis, Internal Rate of Return, Calculating Rate of Return, Future Worth Analysis, Benefit-Cost Ratio Analysis, Cost Volume Profit Analysis.

Section B

Inflation And Price Change – Types of Index, Price Change with Indexes, Use of Price Indexes In Engineering Economic Analysis, Effect Of Inflation & Deflation, Present Worth Analysis, Effect of Inflation on economic evaluations; Uncertainty In Future Events - Estimates and Their Use in Economic Analysis, Range Of Estimates, Probability, Joint Probability Distributions, Expected Value, Economic Decision Trees.

Depreciation - Basic Concepts, Depreciation Calculation Fundamentals, Basic methods of computing depreciation - Straight-Line Depreciation and Declining Balance Depreciation, Evaluations of depreciation methods.

Section C

Replacement Analysis - Replacement Analysis Decision Map, Replacement due to deterioration (with and without time value of money), obsolescence, inadequacy, replacement of items that fail suddenly and completely; Individual and Group Replacement policies; Economic Life of cyclic replacements.

Accounting – Basic Accounting concepts and conventions, corporate financial statements- Trading account, Balance Sheet, Income Statement; Financial Ratios

Books Recommended:

1. James L.Riggs,David D. Bedworth, Sabah U. Randhawa : Economics for Engineers 4e , Tata McGraw-Hill
2. Donald Newnan, Ted Eschembach, Jerome Lavelle: Engineering Economics Analysis, OUP
3. John A. White, Kenneth E.Case,David B.Pratt : Principle of Engineering Economic Analysis, John Wiley
4. Sullivan and Wicks: Engineering Economy, Pearson Education
5. R.Paneer Seelvan: Engineering Economics, PHI
6. Michael R Lindeburg : Engineering Economics Analysis, Professional Pub

IPX-404 CAD/CAM & ROBOTICS [3 1 0 4]

Section A

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

Section B

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.

Discritization: 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

Section C

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 CNCMachines-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.

Section D

Dynamic modeling of Rigid Manipulators: Definition of a robot, types and technology levels of robots, classification of robots, parts of a robot, applications. Kinematics modeling of manipulator arms, Denavit Hartenberg notations, inverse kinematics, kinematics modeling of instantaneous motions, inverse kinematics, Newton-Euler formulation for deriving the dynamics, Lagrangian formulation of manipulator dynamics, inverse dynamics, trajectory planning.

Conventional Sensors and Actuators for Robots: Linear and rotary encoders, resolvers, dynamic modeling of servo motors and stepper motors.

Control of Robots: Open loop control and closed loop control of robot manipulators, open loop control by computed torque method, closed loop control for disturbance rejection and trajectory execution, individual joint PID control of single link manipulators.

Books Recommended:

1. CAD/CAMTheory and practices,2/e-Ibrahim Zeid (McGraw Hill)
2. Finite Element Analysis- J N Reddy, (McGraw Hill)
3. JJ Craige, Introduction to Robotics, Pearson Education, New Delhi.
4. P. N. Rao "CAD/Cam principles and operations", Tata McGraw Hill
5. Groover, Weiss, Nagel and Odrey, "Industrial Robotics", McGraw-Hill.

IPX-406 PROJECT MANAGEMENT [3 1 0 4]

Section A

Introduction: Concept & definition of a project, categories of projects, project life cycle phases, project visibility, roles & responsibilities of project manager. Generation & screening of project ideas, selection of a project, project rating index, financial aspects, project cash flows, social cost-benefit analysis.

Project Planning: The statement of work, project specifications, work breakdown structure. Contract planning, Organization planning, project vs. non-project organization, matrix form of organization. Selection of personnel. Controlling, directing, coordination and delegation.

Section B

Project Scheduling: Gantt chart, milestone char. Network scheduling terminology. Path enumeration, Activity on node & activity on arc network precedence diagrams: dummy activities, topological ordering, redundancy, cycles. Isolating critical path: multiple critical paths. Determination of float: total float, safety float, free float, and independent float. The CPM model.

The PERT Model: event orientation, uncertainty, the PERT assumptions, expected times for activities, variability of activity times, expected length of critical path, due date probability. Invoking central limit theorem. Time-cost trade-off and generation of the project cost curve in deterministic networks. Computerized project management. Other network-based techniques – minimal spanning tree technique, shortest route technique.

Section C

Time and cost considerations: cost versus time, straight-line approximation of variation of cost with reduction in time for activities, direct and indirect costs. Contracting the network: fixed project duration and corresponding total cost, optimum project duration and minimum project cost, project cost curve.

Controlling projects: cumulative costs for early and late start schedules, range of feasible budgets, graphic display of cost and time data, time and cost overrun or under run in projects, Cost Performance Index and Schedule Performance Index.

Limited resources scheduling: the complexity of the project scheduling with limited resources, heuristic programs, resource leveling and resource allocation in project scheduling.
Information requirements for projects, project management software based application.

Books Recommended:

1. Kerzner Harold, "Project *Management - A Systems Approach to Planning, Scheduling and Controlling*", CBS Publishers Delhi, Second edition (2002).
2. Weist Jerome D and Ferdinand K. Levy, "*A Management Guide to PERT/CPM with GERT/PDM/DCPM and other networks*", Prentice-Hall of India New Delhi, Second edition (2003)
3. Parsanna Chandra, "*Project Planning, Analysis, Selection, Implementation and Review*", Tata McGraw Hill, Fourth Edition (2002)
4. Srinath L.S., "*PERT & CPM Principles and Applications*", Affiliated East- West Press Pvt. Ltd., New Delhi, Third Edition (1993)
5. Ghattas R G and Sandra L Mckee, "*Practical Project Management*" Pearson Education Asia, First edition (2004)

IPX- 422 CAD/CAM ROBOTICS LABORATORY [0 0 2 1]

Creating component drawing and making sub assemblies of components using PRO-Engineer, UNIGRAPHICS /IDEAS/CATIA choosing from the following components.

1. Steam stop valve
2. Tail stock
3. Plummer block
4. Check valve
5. Flange Coupling
6. Universal Coupling
7. Stuffing Box
8. Connecting Rod

Programming on CNC lathe and milling, demonstrating linear interpolation, circular interpolation, canned cycles using MASTER CAM/DELCAM etc.

Demonstration of Programming Robotic manipulators

Departmental Elective Courses

IPX-601 OCCUPATIONAL HEALTH AND SAFETY [3 0 0 3]

Section A

Introduction: Environmental law: Legal control of Hazardous substances and processes, Environmental Issues and judicial trends. Health and safety law, common liabilities and work place injuries, Health and safety at work- the principle legal requirements, Health and safety and Industrial relation law.

Health and safety Management: Safety Management and policy, Investigation reporting and recording of accidents, Health and safety monitoring, Comprehensive exposure assessment, Principles of evaluating workers exposure, Risk assessment in the work place, Major incidents and procedures, Health and safety training and communication, the cost of accidents. Principles of accident prevention, safe system of work, Surveys and audits.

Section B

Occupational Health and Hygiene: The organization of working environment, temperature, lighting and ventilation, welfare amenity provision, cleaning and hygiene. Toxicology and health, Occupational disease and conditions: Occupational Audiometry, NIHL, Cardiovascular Disease, Physiological and psychological parameters. Occupational health practice, Noise and vibration, Dust and fumes, radiation and radiological protection, personal protection, Occupational hygiene practice, prevention and control strategies in occupational hygiene, manual handling, first aid, human factor and safety, stress, safety technology.

Section C

Assessment of Exposure: Measurement of noise and vibration exposure. Noise and vibration and control, Heat stress monitoring, dust exposure and respiratory health. Work Posture, Musculoskeletal disorders, Strain Index, Lifting Equation, Maximum acceptable weight limits, Occupational Audiometry. Cardiovascular health, Occupational determinants of heart rate variability, pulmonary functions and respiratory health.

Books Recommended:

1. Jeremy W. Stranks, "Handbook of Health and safety Practice" Pitman Publishing, 1994.
2. Dharmendra S Sengar, " Environmental law" Prentice Hall of India, New Delhi.
3. Malcolm J Crocker, "Noise and Noise Control" CRC Press.
4. Marek Malik, " Clinical Guide to cardiac Autonomic Tests" Kulwer Academic Publishers.
5. Marek Malik,"Hear rate variability" Futura Publishing Co. NY
6. Cyril M Harris, "Handbook of Noise control" McGraw-Hill Book Company, NY
7. Maryanne Maltby, "Occupational Audiometry" Butterworth-Heinemann Immprint of Elsevier.

IPX-602 MAINTENANCE AND RELIABILITY ENGINEERING [3 1 0 4]

Section A

Basic concepts of Reliability: Concept, Terms, objectives, applications, area of use, use of reliability in industry. Introduction to Probability Concepts

Basic Reliability Models: The Reliability function**,** mean time to failures, hazard rate function, bath tub curve, conditional reliability, probability density function, failure rate, failure density, hazard rate, uncertainty measures.

Constant and time dependant failure models: Exponential, weibull, normal and lognormal distributions

Reliability of systems, Series and parallel-connected systems, Concept of redundancy, k out of n standby system, objectives, applications, redundant standby systems, system structure functions, minimal cuts and minimal paths, common mode failures, three state devices.

Determination of reliability (state dependant systems), Markov analysis, load sharing system, standby systems, degraded systems, Reliability allocation with redundancies

Section B

Failure Analysis: Introduction to failure mode and effect analysis, FMEA and FMECA, criticality analysis, Fault tree diagram, event tree.

Availability: concept and definitions, availability models, system availability.

Introduction to Maintenance: Objectives and importance of maintenance, Functions of Maintenance, maintainability vs. maintenance.

Section C

Types of maintenance: Corrective, Breakdown, Predictive, Replacement, Preventive and Proactive maintenance strategies, Preventive maintenances v/s. repair, Computerized Maintenance Management System, Reliability under preventive maintenance.

Design for Maintainability: Quantifiable measures of maintainability, maintainability management tasks during the product life cycle, life cycle costing, life cycle cost estimation models, spare parts management

Introduction to TPM and RCM

Books Recommended:

1. Clifton R H, "*Principles of Planned Maintenance*", McGraw Hill, New York, 2001.
2. Ebling CE, "An introduction to Reliability and .Maintainability Engineering" Tata Mc Graw Hill, Delhi, 2004.
3. Srinath L S "*Reliability Engineering*", Affiliated East-West Press Limited, New Delhi, 2002.
4. Dhillon B S, "*Engineering Maintainability*", Prentice Hall of India, New Delhi, 2000.
5. Wireman Terry, "*Preventive Maintenance*", Reston Publishing Company, Reston Virginia, 1998.

IPX-603 SUPPLY CHAIN MANAGEMENT [3 0 0 3]

Section A

Understanding supply chain: Objectives of supply chain, stages of supply chain, supply chain process cycles, customer order cycle, replenishment cycle, manufacturing cycle, procurement cycle, push/pull view of supply chain processes, importance of supply chain flows, examples of supply chain.

Supply chain performance: supply chain strategies, achieving strategic fit, product life cycle, the minimize local cost view, the minimize functional cost view, the maximize company profit view, the maximize supply chain surplus view.

Supply chain drivers and obstacles: Four drivers of supply chain – inventory, transportation, facilities, and information, a framework for structuring drivers, role of each driver in supply chain, obstacles to achieve strategic fit.

Section B

Network Design: Factors influencing distribution in network design, distribution networks in practice, framework for network design decisions, models for facility location and capacity allocation, making network design decisions in practice, impact of uncertainty on network design, discounted cash flow analysis, representation of uncertainty, evaluating networks using decision trees, illustration through practical examples.

Aggregate Planning in Supply Chains: Role of aggregate planning in a supply chain, aggregate planning strategies, aggregate planning using linear programming and problem solving using solver, practical problems concerning aggregate planning.

Managing economies of scale in a supply chain: Role of cycle inventory in a supply chain, economies of scale to exploit fixed costs, economies of scale to exploit quantity discounts, short term discounting, estimating cycle inventory related costs, determining appropriate level of safety inventory.

Section C

Transportation in a supply chain: Facilities affecting transportation decisions, modes of transportation and their performance characteristics, design options for a transport network, tradeoffs in transportation decision, tailored transportation, routing and scheduling in transportation, making transportation decisions in practice.

Sourcing Decisions in Supply Chains: Role of sourcing in supply chains, supplier assessment, design collaboration, sourcing planning and analysis, market sourcing decisions in practice

Coordination in a supply chain: Lack of supply chain coordination and the Bullwhip effect, effect of lack of coordination on performance, obstacles to coordination, managerial levers to achieve coordination, achieving coordination in practice.

Books Recommended:

1. Chopra Sunil, Meindl Peter, "*Supply Chain Management – Strategy, planning and Operation's"*, Pearson Education, Asia (2007).
2. Christopher Martin, "*Logistics and Supply Chain Management*", Pearson Education Asia, (2004).
3. Kapoor K K, Kansal Purva, "*Marketing logistics: A Supply Chain Approach*", Pearson Education Asia (2003).
4. Benjamin S Blanchard, *Logistics Engineering and Management*, Pearson Education, Asia (2005)
5. Buffa, "*Modern Production/Operations Management*", Wiley Eastern Ltd. (2000)

IPX-604 FINITE ELEMENT ANALYSIS [3 0 0 3]

Section A

Basic concepts: Variational and Residual methods-Introduction - Different approaches in Finite Element Method - Direct Stiffness approach, simple examples Variational approach, Elements of variational calculus – Euler's-Lagrange equation, Rayliegh Ritz method , Weighted Residual methods, Point Collation method, Sub domain Collation method, Galerkins method - Steps involved in FEM.

Section B

Elements and Interpolation Functions: Elements and coordinate system –Interpolation Polynomials - Linear elements Shape function - Analysis of simply supported beam - Element and Global matrices - Two dimensional elements, triangular and rectangular elements - Local and Natural Co-ordinate systems.

Finite Element Solution of Field Problems: Field problems – Finite element formation of field problems - Classification of partial differential equations - Quasiharmonic equation - Steady state problems - Eigen value problems - Propogation problems - Examples, Torsional problem – Fluid flow and Heat transfer problems - Acoustic vibrations – Application in manufacturing problems – metal cutting and metal forming.

Section C

Finite Element Solution of Structural Problems: Solid mechanic problems – Finite element formulation of solid mechanic problems - Axial force member - element matrices for axial force members - Truss element analysis of pinned truss - Two dimensional elasticity problems.
Higher Order Elements and Numerical Methods: Numerical method and computer implementation – Numerical method in FEM and Computer implimentation. Evaluation of shape functions - One dimensional & triangular elements, Quadrilateral elements, Isoparametric elements - Numerical Integration, Gauss Legendre quadrature - Solution of finite element equations - Cholesky decomposition, Skyline storage - Computer implementation- Use of FEM software.

Books Recommended:

1. Larry J Segerlind ," Applied Finite Element Analysis", John Wiley, 1984
2. Bathe, K.J., "Finite Element Procedures", Prentice Hall, 1994.
3. Huebner,K.H. and Thornton, E.A., "The Finite Element Method for Engineers", John Wiley, 1982.
4. Reddy,J.N., "Introduction to Finite Element Method", McGraw Hill, 1993
5. Zienkiewich . O.C., and Taylor . R.L., "The Finite Element Method", McGraw Hill,1991.
6. S.S.Rao, "Finite element method ", 1995.

IPX-605 FRACTURE MECHANICS [3 0 0 3]

Section A

Introduction to Fracture Mechanics: Stress-Strain Curve, Elements of dislocation theory, Historical perspective, Stress Concentration effect of flaws, Fracture Mechanics approach to design, Effect of material properties on fracture, Cleavage, Brittle and Ductile fracture, ductile brittle transition, modes of fracture failure, Fatigue and stress corrosion cack growth, Damage tolerance

Linear Elastic Fracture Mechanics: An atomic view of fracture, Griffith Energy Balance, Energy release rate, instability and the R Curves, compliance, tearing modulus, Stress and Displacement field in isotropic elastic materials, Airy stress function, Westergard approach for different modes of fracture, Stress analysis of crack, Stress intensity factor (SIF), relation between K and global behaviour, Effect of finite size,

Section B

Elastic-Plastic Fracture Mechanics: Crack tip deformation and plastic zone size, plane stress vs plane strain, effective crack length, Irwin plastic zone correction, Dugdale approach, effect of plate thickness

J Contour Integral- Relevance and scope, J as a path-independent line integral, J as a stress intensity parameter, Stress-Strain relations, J-Controlled fracture, Laboratory measurement of J, Crack Tip Opening Displacement (CTOD), Relationship between CTOD, K and G, Equivalence between CTOD and J, Determination CTOD from strip yield model, HRR Singularity

Section C

Fatigue Fracture: Introduction to fatigue, factors affecting fatigue performance, fatigue loading, constant and variable amplitude loading, some characteristics of fatigue crack, Paris Law

Experimental and Finite Element Estimates of Fracture Mechanics: Experimental determination of J-Integral, Critical Stress intensity factor and CTOD, Photoelasticity techniques, strain gage measurements, Fatigue crack initiation and propagation testingPreprocessing in Finite Element Method, Element selection and meshing of crack, Load application, constraints, preprocessing checks, processing the model, postprocessing

Books Recommended:

1. Anderson T.L., Fracture Mechanics Fundamentals and Applications, CRC Press, Second edition, 1994
2. Kumar Prashant, Elements of Fracture Mechanics, Wheelers Publishing Co. Ltd India, Second edition, 2010
3. Hertzberg Richard W., Deformation and Fracture Mechanics of Engineering Materials, Wiley India, Fourth Edition, 1996
4. Broek David, Elementary Engineering Fracture Mechanics, Kluwer Academic Publishers, Fourth revised reprint edition, 1999
5. Barsom John M. and Rolfe Stanley T., Fracture and Fatigue Control in Structures: Aplications of Fracture Mechanics, ASTM USA, Third Edition, 1999
6. Sanford R.J., Principles of Fracture Mechanics, Printice Hall, Printice Hall USA, 2003
7. Gdoutos E.E., Rodopoulos C.A. and Yates J.R., Problems in Fracture Mechanics A Solution Guide, Kluwer Academic Publishers The Netherlands, 2003

IPX-606 TECHNOLOGY MANAGEMENT [3 0 0 3]

Section A

Productivity Engineering: Productivity concept and definition, productivity and economic development, impact of productivity in macro-economic context, productivity and production, productivity and profitability, productivity and quality, productivity and technology, external environment and productivity, total, partial and total factor productivity.
Measurement of productivity: factors affecting the productivity of any nation, GDP and GNP, productivity at firm level, measurement approaches, total productivity model, product oriented model, computer algorithms for measuring total and partial productivity. Productivity measurement of services.

Section B

Productivity evaluation: Productivity evaluation and planning, methodologies for evaluation, the productivity evaluation tree, short-term and long-term productivity planning.
Technology management: Need for managing the technology, importance of technology and its management, role of technology in economic development, technological change in modern society. Technology planning, technology forecasting, applications of technology forecasting and it's impact on business, technology life cycle and it's importance.

Section C

Technology transfer: Technology transfer at macro and micro level, need for technology transfer, modes of technology transfer, technology adaptation, factors affecting technology adaptation, technology absorption, technology diffusion, technology transfer agreements, negotiations in technology transfer, cultural differences, introduction to re-engineering, characteristics of technology in developing countries, role of R & D department in technology adaptation & development, implementation of acquired technology,

Books Recommended:

1. Sumanth D J, "*Productivity Engineering & Management*", McGraw Hill (1995).
2. Sink S, "*Productivity Management, Planning, Measurement & Evaluation*", John Wiley, 1990
3. Smith E A, "*Productivity Manual*", Gulf Publisher, 1989.
4. Fredrick Betz, "*Technology Management*", McGraw Hill, 1990.
5. Coombs Rod & Richards Albert, "*Technological Collaborations*", Edward Elgar Publishing, Ltd, 1996.

IPX-607 MANAGEMENT INFORMATION SYSTEMS [3 0 0 3]

Section A

Managing the digital firm: Concepts, need and scope of Information system in business organization, the competitive business environment and the emerging digital firm, transformation of business enterprise, major business functions, approaches to the development of an organization's information system; technical approach, behavioral approach, socio – technical approach, new
options for organization design, the Network revolution, Internet and its functions, World Wide Web, LAN etc., positive & negative impacts of information systems.

Information systems in the enterprise: Organizational levels, subsystems of information system; operational level, knowledge level, management level and strategic level information systems, transaction processing systems, office systems, knowledge work systems, MIS, DSS, ESS, relationship of systems to one another, systems from a functional perspective, life cycle of information system.

Managing data resources: Components of computer based information system (CBIS), file organization terms & concepts, problems with traditional file environment, Database Management
System (DBMS), types of Databases, Relational DBMS, hierarchical & network DBMS, Object oriented databases. Datamining.

Section B

Logical database design: Entity relationship diagram, properties of tables, update anomaly, insertion anomaly, deletion anomaly, inconsistency anomaly, repeating groups, primary key and concatenated key, Normalisation, 1NF to 2NF to 3 NF steps.

Artificial intelligence: Expert system, features of an expert system, heuristic and algorithm,
human expertise vs. artificial expertise, knowledge representation: rule-based methods frame based methods, tasks and stages of expert system development and difficulties in developing an expert system.

Section C

Computer simulation: concept of simulation, when is simulation an appropriate tool, when simulation is not appropriate, advantages and disadvantages of simulation, areas of application, systems & system environment, components of a system, discrete & continuous systems, model of
a system, types of models, steps in a simulation study, simulation application examples, selecting simulation software.

Books Recommended:

1. Laudon Kenneth C and Laudon Jane P, "*Management Information Systems*", Pearson Education Asia, Eighth Edition (2004)
2. Donald A Waterman, "*A Guide to Expert Systems*", Pearson Education Asia, Third Indian Reprint (2002)
3. Banks Jerry…[et al.], "*Discrete Event System Simulation*", Pearson Education Asia, Third Edition (2001)
4. Davis & Olson, "*Management Information Systems*", McGraw Hill International Editions.
5. Parker & Case, "*Management Information Systems*", McGraw Hill International Editions.

IPX-608 COMPOSITE MATERIALS [3 0 0 3]

Section A

INTRODUCTION: Introduction to Composites, Classifying composite materials, commonly used fiber and matrix constituents, Composite Construction, Properties of Unidirectional Long Fiber Composites, Short Fiber Composites

STRESS STRAIN RELATIONS: Concepts in solid mechanics, Hooke's law for orthotropic and anisotropic materials, Linear Elasticity for Anisotropic Materials, Rotations of Stresses, Strains, Residual Stresses.

Section B

ANALYSIS OF LAMINATED COMPOSITES: Governing equations for anisotropic and orthotropic plates. Angle-ply and cross ply laminates. Static, dynamic and stability analysis for simpler cases of composite plates, Interlaminar stresses

FAILURE AND FRACTURE OF COMPOSITES: Netting Analysis, Failure Criterion, Maximum Stress, Maximum Strain, Fracture Mechanics of Composites, Sandwich Construction

Section C

APPLICATIONS AND DESIGN: Metal and Ceramic Matrix Composites, Applications of Composites, Composite Joints, Design with Composites, Review, Environmental Issues

Books Recommended:

1. Daniel and Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press, 2005.
2. Jones R.M., "Mechanics of composite materials", McGraw-Hill, Kogakusha Ltd., Tokyo, 1975.
3. Agarwal.B.D. and Broutman.L.J., "Analysis and Performance of fiber composites", John-Wiley and Sons, 1980.
4. Michael W.Hyer, "Stress Analysis of Fiber-Reinforced Composite Materials", McGraw Hill, 1999.
5. Mukhopadhyay.M, " Mechanics of Composite Materials and Structures", University Press, India, 2004.

IPX-609 CHANGE MANAGEMENT [3 0 0 3]

Section A

Problematizing organizations: Stakeholders, environment, structure, systems, culture and people, types of change- linear and nonlinear, incremental and radical, slow and fast, systems perspective of change, framework for conceptualizing change.

Section B

Organizational change- people, process and technology issues, restructuring of organizations, creative destruction, role of information technology in organizational change.

Reengineering and restructuring, self-regulating evolutionary and revolutionary changes, challenges of continuous and incremental changes, drivers of change, change agents, change process, total change.

Section C

Competitiveness: various measures of competitiveness, relationship between change and competitiveness, SWOT analysis, SAP-LAP analysis, tinkering and kludging, Matrix of change,
Delphi study, implementing change: various issues and theories, impact of change, Case studies.

Books Recommended:

1 Johnson A Edosomwan, *"Organizational Transformation and Process Reengineering"*, Kogan Page Limited, London, 2000.
2 Sushil, "*Flexibility in Management*", Vikas Publishing House, New Delhi, 2001.
3 Bernard Burnes, "*Managing Change*", Pitman Publishing Company, London, 1999.
4 John Storey, "*Human Resourse and Change Management*", Blackwell Publishers, UK, 1999.
5 Stephen P Robbins, "*Organizational Behaviour*", Pearson Education, New Delhi, 2002.

IPX-610 SMART MATERIALS AND NANO TECHNOLOGY [3 0 0 3]

Section A

Introduction to Smart materials: Materials for both actuation and sensing: Piezoelectric Materials, Magnetostrictive Materials, Materials for actuation: Shape Memory alloys Magnetic shape memory material, Electro/Magneto rheological fluids; Materials for sensing: Optical fibre; Composite smart materials and micromodelling related issues; Intelligent system with integrated sensors & actuators; Self-sensing actuators; Placement of Smart Actuators/Sensors - Vibration damping.

Section B

Introduction to Nanotechnology: Characteristic scale for quantum phenomena, nanoparticles, nano-clusters, nanotubes, nanowires and nanodots. Drexler-Smalley debate - realistic projections. Electronic structure: quantum wells quantum dots, quantum wires. Nano clusters, clusters of rare gases, clusters of alkali metals.

Section C

Processing of Nano Materials: Si processing methods: Cleaning /etching, oxidation-oxides, Gettering, doping, epitaxy. Top-down techniques: Photolithography, other optical lithography's (EUV, X-ray, LIL), particle beam lithography's (e-beam, FIB, shadow mask evaporation), probe lithography's. Molecular-beam epitaxy, chemical beam epitaxy, metal-organic CVD (MOCVD). Bottom-up techniques: self-assembly, self-assembled monolayer, directed assembly, layer-by-layer assembly.

Books Recommended:

1. Michelle Addington , Daniel L. Schodek "Smart Materials and Technologies in Architecture" John Wiley, 2008
2. Vijay K. Varadan, Ahsan Hariz, Olaf Reinhold "Smart Materials, Structures, & Integrated Systems", Springer, 1997
3. Bhushan, Bharat , "Handbook of Nano Technology" Springer, 2007
4. Di Ventra, Massimiliano; Evoy, Stephane; Heflin, James R. "Introduction to Nanoscale Science and Technology", Wiley, 2006
5. Mark J. Schulz , Ajit D. Kelkar , "Nanoengineering of Structural, Functional and Smart Materials" CRC Press, 2005

IPX-611 NON-DESTRUCTIVE TESTING [3 0 0 3]

Section A

Radiography: Principle of radiography, types of radiography, equipments for neutron radiography, x-ray radiography, equipments for x-ray radiography, advantages and applications of fluoroscopy and photo fluoroscopy

Electromagnetic methods: Principle of electromagnetic testing, mathematical analysis, flaw detection in conductors, various types' of instruments used and advantages of various electromagnetic methods for crack detection etc.

Section B

Ultrasonic methods: Principle of ultrasonic testing, generation of ultrasonic waves, equipment details for ultrasonic checking, methods of wave propagation, methods of flaw detection, various methods of ultrasonic testing, advantages of ultrasonic methods for flaw detection and crack location

Holography: Principle of holography, method of holographic recording, method of holographic reconstruction, advantages of this technique and applications of holographic methods for non-destructive testing.

Section C

Liquid penetrant testing: Principle of liquid penetrates testing, types of dyes and penetrants used in this testing technique and application of liquids for detecting sub-surface defects.

Magnetic particle testing: Principles of magnetic particle testing, details of equipments used and methods of crack detection by magnetic particle testing Hardness testing: Brinnel hardness testing, Rockwell hardness tests, shore hardness testing, Vicker hardness testing and theory behind various hardness testing methods.

Books Recommended:

1. Malhotra, "*Handbook on Non-destructive Testing of Concrete*", Publisher: CRC Press, 2002.
2. Mix, Paul E, "*Introduction To Nondestructive Testing: A Training Guide*", John Wiley and Sons Ltd, 1999.
3. Blitz and Jack, "*Electrical and Magnetic Methods of Nondestructive Testing*", Institute of Physics Publishing, 2001.
4. Achenbach, J D, "*Evaluation of Materials and Structures by Quantitative Ultrasonics*", Springer-Verlag Vienna, 2001.
5. Henrique L M, "*Non Destructive Testing and Evaluation for Manufacturing and Construction*", Hemisphere Publishers, New York, 2001.

IPX-612 MECHATRONICS [3 0 0 3]

Section A

Introduction to Mechatronics: What is mechatronics, Mechatronic systems, measurement systems, Control systems, micrpoprocessor based controllers, multi discipline scenario.
Signal Conditioning: Signal conditioning process, Operational amplifier (inverting amplifier, non-inverting amplifier, summing, integrating amplifier), protection, filtering, data acquisition, multiplexer, analog to digital converter (ADC), digital to analog converter (DAC). Oscillators to generator sinusoidal, square, triangular and impulse waveforms, 555 timer, sample and hold, analog to digital and digital to analog converters, multiplexing. Interfacing input output ports, serial and parallel interfacing requirements, buffers, handshaking, polling and interrupts.
Transducers & Sensors:
Position Sensors: Limit switch, photoelectric switches, proximity sensors, pneumatic limit
valves and backpressure sensors, pressure switches, resolvers, incremental & absolute encoders, decoders & relays.
Displacement: Potentiometer sensors, LVDT, capacitive displacement sensors. Velocity sensors:Tachogenerator, use of encoders

Section B

Digital circuits:Digital logic, number systems, logic gates, Boolean algebra, application of logic gates, sequential logic, flip flop, D flip flop, JK flip flop, Master slave flip flop.
Microprocessor and Microcontroller:
Microcontroller: Comparison between microprocessor and micro controller, organization of a microcontroller system, architecture of MCS 51 controller, pin diagram of 8051, addressing modes, instruction types and set, Applications.
Programmable Logic Controllers(PLC): Introduction, definition and history of PLC, PLC system and components of PLC input output module, PLC advantages and disadvantages.
Ladder diagram & PLC programming fundamentals: Basic components and other symbols, fundamentals of ladder diagram, machine control terminology, update – sole ladder – update, physical components Vs. program components, light control example, internal relays, disagreement circuit, majority circuit, oscillator, holding (sealed or latches) contacts, always ON always OFF contacts, Nesting of ladders.

Section C

PLC programming: PLC input instructions, outputs, coils, indicators, operational procedures, contact and coil input output, programming example, fail safe circuits, simple industrial applications.
PLC Functions: PLC timer functions – Introduction, timer functions, industrial applications, industrial process timing applications PLC control functions – PLC counters and its industrial applications
Mechatronics systems: Traditional Vs Mechatronic Design, Case studies of Mechatronic systems designs, like piece counting system, pick and place manipulator, simple assembly task involving a few parts, part loading / unloading system, automatic tool and pallet changers etc

Books Recommended:

1. Mechatronics – W. Bolton, Pearson education
2. Mechatronics – Mahalik, TATA McGraw Hill
3. Microprocessor 8085 – Gaokar
4. Mechatronics – Appu Kuttam, Oxford publications
5. Automated Manufacturing systems, S. Brain Morris, McGRaw Hill
6. Introduction to PLC programming, NIIT, P

IPX-613 T. Q. M. [3 0 0 3]

Section A

Basic concepts: Various approaches to understanding quality. Quality & competitiveness. The strategy of detection, prevention as a strategy, development of prevention, the economic benefits of prevention.

Managing Quality: importance of quality and its historical evolution; Philosophies of Quality Gurus; continual improvement, customer satisfaction, process improvement and total organizational involvement; technical and philosophical issues surrounding quality management; use of QM initiatives, tools, and techniques in an organization.

QC Tools: Check sheets, Stratification, Histogram, Pareto charts, Cause & Effect Diagrams and Scatter Diagrams. Numericals. Quality circles: Objectives, Structure, roles & responsibilities of Facilitators, Team Leader etc. Steps in formation of Quality Circles. Poka –Yoke (mistake proofing). Seven new QC Tools: Affinity diagram, Relations Diagram, Matrix diagram, Tree diagram, Process Decision Program Chart (PDPC), Arrow diagram & Matrix data analysis.

Taguchi's Loss - Function Approach: Definition, understanding & applications. Goal post view of Quality vs. Taguchi's loss- function approach. Loss functions for "Nominal the best", "Smaller the better" and "Larger the better" cases. Average Loss for a sample for "Nominal the best" case. Numericals.

Section B

Focusing on the Customers: Customer satisfaction & Loyalty, customer satisfaction index, creating satisfied customers, customer segmentation, gathering & analyzing customer information, and customer relationship management.

Quality Function Deployment (QFD) approach: Introduction, the QFD team, benefits of QFD, the voice of the customer, organization of information, house of quality, what's, how's, building house of quality, QFD process.

Quality costs: Prevention, appraisal, internal failure & external failure costs.

Benchmarking: Introduction, definition, reasons to benchmark, benchmarking process, deciding what to benchmark, understanding current performance, planning, studying others, learning from the data, using the findings, pitfalls & criticism of benchmarking.

Section C

Principles of Six sigma (6σ): introduction, comparison of 3σ / 6σ yield levels, CTQ: Critical to Quality, CTQP: CTQ Performance, CTQS: CTQ Specifications, theme selection (activity focusing). 6σ methodology**:** DMAIC & DMADV. Various formulae to measure different metrics related to Six Sigma defects, yield calculations, Case Study & Numericals.

Kano's Model: Requirements Categories, Categorizing the Requirements, Prioritizing the Requirements, Product Assessment, Setting up targets

Quality Audit: process audit & product audit, internal audit, second party, third party audit, pre-assessment, compliance audit. Procedure of auditing: Audit planning, audit execution, audit reporting, close out of corrective action. Minor & major non-conformities.

Books Recommended:

1. Evans & Lindsay, "The Management & Control of Quality", Thompson South-Western, 6th Edition, 2005.
2. Sower, Savoie & Renick, "Introduction to Quality Management and Engineering", Pearson Education Asia, 1999.
3. Besterfield Dale H [et…al.], "Total Quality Management", Pearson Education Asia, Second Edition, 2001.
4. Jankiraman & Gopal, "Total Quality Management: Text & Cases", PHI Learning New Delhi, 2010.
5. S M Sundara Raju, "Total Quality Management: A Primer" Tata McGraw Hill, New Delhi.
6. Subir Chowdhry, "The Power of Six Sigma", Pearson Education Asia, 2001.

IPX-614 COMPUTER INTEGRATED MANUFACTURING [3 0 0 3]

Section A

Introduction: Scope, islands of automation, architecture of CIM, information flow in CIM, elements of CIM, benefits, limitations, obstacles in implementation.

CAD/CAM/CAE: Product Design and CAD, application of computers in design, CAM – manufacturing planning and control, scope of CAD / CAM and CIM, concurrent engineering, design for manufacturing and assembly.

Group Technology: Concept, design and manufacturing attributes, part families, composite part, methods of grouping, PFA, classification and coding system- OPITZ, Relevance of GT in CIM, GT and CAD, benefits and limitations of GT.

Computer Aided Process Planning and Control: need, retrieval and generative type CAPP, role of CAPP in CIM. **(2)**

Section B

Flexible Manufacturing Systems: Concept, flexible & rigid manufacturing manufacturing cell and FMS structure, types, components of FMS, Distributed Numerical
Control (DNC), Building Blocks of FMS, Flexible Assembly System.

Computer Aided Production Planning and Control: Computer integrated production management system, aggregate planning, master production schedule, shop floor control, materials requirement planning, capacity planning, manufacturing resource planning and enterprise resource planning.

Computer Aided Quality Control: Objectives, non contact inspection methods, equipment; contact type inspection: Co-ordinate Measuring Machines (CMM), construction, working principle and applications, Inspection robots.

Production Support Machines and Systems in CIM: Industrial robots for load/unload, automated material handling, automatic guided vehicles, automated storage and retrieval system.

Section C

Data Acquisition and Database Management Systems: (a) Data acquisition system,type of data, automatic data identification methods, bar code technology, machine vision.(b) Data and database management system, database design requirements, types of DBMS models- hierarchical, network and relational models and their applications.

Communication in CIMS: Role of communication in CIMS, requirements of shop floor communication, types and components of communication systems in CIM, Networking concepts, network topology, access methods, ISO-OSI reference model for protocols, MAP/TOP, TCP/IP.

Planning and Implementation of CIMS: Planning for CIMS, need for planning, Phases of CIM implementation, incremental implementation and one time implementation, CIM benchmarking, Economic and social justification of CIM.

Books Recommended:

1. Automation, Production systems and Computer Integrated Manufacturing, 3/e - M.P. Groover (PHI or Pearson Education)
2. Computer Integrated Design and Manufacturing - Bedworth, Henderson & Wolfe, (McGraw Hill)
3. Performance Modeling of Automated Manufacturing Systems, 2/e - Viswanadham, N. & Narahari, Y. (EEE) (PHI)
4. Principles of Computer Integrated Manufacturing - S. Kant Vajpayee, (PHI)
5. CAD / CAM Principles and Applications - P.N. Rao (Tata McGraw Hill)
6 CIM Handbook - Teicholtz & Orr (McGraw Hill)
7. CAD/CAM/CIM, 3/e – Radhakrishnan, Subramanayam & Raju (New Age International)
8. Computer Integrated Manufacturing, 2/e - James A. Rehg, H. W. Kraebber, (Pearson Education)
9. MAP/TOP Networking : Foundation of CIM – Vincent Jones (McGraw Hill)

IPX-615 VIBRATION AND NOISE CONTROL [3 0 0 3]

Section A

Vibration concepts: Vibration of SDOF free, forced, damped and undamped vibration analysis.
Energy based method of analysis: Lagrange's Equation and Hamilton's principal. Lumped parameter and distributed parameter modeling of mechanical vibratory systems.

Applications of numerical procedures to determine natural frequencies and mode shapes.

Section B

Finite Element Method for dynamic analysis. Distributed parameter models of rods, bars and beams.

Experimental and theoretical routes to vibration engineering. Introduction to Modal testing, Vibration Testing. Spatial, Modal and Response models of vibrating systems.

Design of vibration isolators. Auxiliary mass systems including tuned & untuned dampers for vibration control. Signal processing for noise and vibration.

Section C

Acoustics Concepts: Wave approach to sound, wave equation in two and three dimensions. Noise measurement and instrumentation standards. Sound pressure, power and intensity. Noise radiation from vibrating bodies. Various source models. Various types of sound fields. Sound Absorption and transmission. Some case studies

Books Recommended:

1. Mechanical Vibrations (2nd Edition) H Benaroya, Marcel Dekker, New York, 2004
2. Mechanical Vibration, (4th Edition) S S Rao, Pearson Education, Delhi, 2004.
3. Theory and Practice of Mechanical Vibration, (2nd Edition) J S Rao and K Gupta, New Age International Publishers, New Delhi, 1999.
4. Advanced Theory of Vibration, J S Rao, Wiley Eastern Ltd. New Delhi, 1992
5. Inman D.J., "*Engineering Vibration*" 2nd Edition, Prentice Hall, 2001, ISBN 013726142X
6. Vibration: Fundamentals and Practice, (2nd Edition) de Silva, CRC Taylor & Francis, FL USA, 2007.
7. Fundamentals of Acoustics (4th Edition), Kinsler, Frey, Coppens & Sanders, John Wiley & Sons Inc, Delhi, 2000.

IPX-616 DESIGN FOR MANUFACTURING [3 0 0 3]

Section A

DFMN Approach and Process: Methodologies and tools, design axioms, design for assembly and evaluation, minimum part assessment taquchi method, robustness assessment, manufacturing process rules, designer's tool kit, Computer Aided group process rules, designer's tool kit,
Computer Aided group Technology, failure mode effective analysis, Value Analysis. Design for minimum number of parts, development of modular design, minimising part variations, design of parts to be multi-functional, multi-use, ease of fabrication, Poka Yoka principles.

Section B

Geometric Analysis: Process capability, feature tolerance, geometric tolerance, surface finish, review of relationship between attainable tolerence grades and difference machining processes. Analysis of tapers, screw threads, applying probability to tolerences.
Form Design of Castings And Weldments: Redesign of castings based on parting line considerations, minimising core requirements, redesigning cast members using weldments, use of welding symbols.
Mechanical Assembly: Selective assembly, deciding the number of groups, control of axial play, examples, grouped datum systems - different types, geometric analysis and applications-design features to facilitate automated assembly.

Section C

True Position Theory: Virtual size concept, floating and fixed fasterners, projected tolerance zone, assembly with gasket, zero true position tolerance, functional gauges, paper layout gauging, examples. Operation sequence for typical shaft type of components. Prepration of process drawings for different operations, tolerence worksheets and centrality analysis, examples. Automatic assembly Transfer systems: Automatic Feeding and orienting –vibratory feeders, automatic feeding and orienting mechanical feeders, Feed tracks, parts placement mechanisms
Performance and Economics of Assembly
Design for manual Assembly: Product design for high speed automatic assembly and robot assembly, printer circuit board assembly. Feasibility study for assembly automation.

Books Recommended:

1. Biren Prasad, "*Concurrent Engineering Fundamentals - VOL II*", Prentice Hall, 1997.
2. Ulrich Karl.T, Eppinger Stephen D, "*Product design and development*", McGraw Hill, 1994.
3. Carter Donald E., "*Concurrent Engineering*", Addision Wesley, 1992.
4. Bralla James G., "*Hand Book of Product Design for Manufacturing*", McGraw Hill, 1986.
5. Beitz Paul, "*Engineering Design*", Springer Verlag, 1992.

IPX-617 WELDING ENGINEERING [3 0 0 3]

Section A

Introduction to joining technology, General survey and classification of welding processes, Safety and hazards in welding,
Power sources for arc welding, Physics of the welding arc and arc characteristics, Metal transfer & its importance in arc welding, Various forces acting on a molten droplet and melting rates,

Section B

Welding consumables: fluxes, gases and filler materials, SMAW, SAW, GTAW and related processes, GMAW and variants, PAW, Gas welding, Soldering, Brazing and diffusion bonding,

Section C

Thermal cutting of metals, Surfacing and spraying of metals, Resistance welding processes: spot, seam, butt, flash, projection, percussion etc, Thermit welding, Electro-slag and electro-gas welding, Solid-state and radiant energy welding processes such as EBW; LBW; USW, Explosive welding; Friction welding etc, Welding of plastics,
Advances, challenges and bottlenecks in welding.

Books Recommendation:

1. Cary Hobart B. (1980), Modern Welding Technology. Prentice Hall, New Jersey.
2. Ador (2005), "Modern Arc Welding Technology", Oxford and IBH Publishing Co. Pvt. Ltd.
3. Houldcroft P.T. (1977), Welding Process Technology, Cambridge University Press, pp. 107-119.
4. Jeffus Larry (2004), "Welding principles and applications", Fifth Edition, Thomson Delmar Learning, Singapore.
5. Lancaster J. F. (1984), "The physics of welding", International Institute of Welding, Pergamon press.
6. Little Richard L. (2004), "Welding and welding technology", Tata McGraw-Hill publishing co. ltd. 25th reprint.

IPX-618 ADVANCED MECHANICS OF MATERIALS [3 0 0 3]

Section A

Analysis of stresses: 3D state of stress at a point; principal stresses; invariants; 3D Mohr's circle; octahedral stresses; hydrostatic and pure shear stresses. Differential equations of equilibrium in rectangular and polar coordinates. Boundary conditions. Saint-Venant's principle, Principle of superposition.

Analysis of strains: 3D strain components in rectangular and polar coordinates; state of strain at a point; principal strains; strain deviators and invariants. Compatibility conditions in rectangular and polar coordinates. Constitutive relations.

Boundary value problems: Stress formulation and displacement formulation; Beltrami-Michell equations and Navier's equations. Methods of solution and uniqueness of solution.

Plane problems: Plane stress and plane strain elastic problems, Airy stress function, 2D problems in rectangular and polar coordinates.

Section B

Axisymmetric problems: Cantilever beam with end load; uniformly loaded beam; thick and thin walled cylinders; rotating discs and cylinders; plate with a circular hole. Curved beams.

Torsion of non-circular bars: Torsion of prismatic bar of circular cross section, Saint-Venant's semi-inverse method, Linear elastic solutions, Prandtl's stress function method. Unsymmetrical bending, shear centre and shear flow.

Energy methods: Castigliano's Theorem, Principle of virtual work; minimum potential energy; statically indeterminate systems, Rayleigh and Rayleigh-Ritz technique for beams

Section C

Elastic stability: Analysis of beams and Columns, buckling of plates and columns.

Yield and Fracture criteria: Different failure theories; stress space and strain space; yield surfaces.

Experimental and FE Techniques: Experimental and Finite Element Techniques: Stress analysis using Photoelasticity and strain gages, Tensile and compression test, Fatigue test. Preprocessing in Finite Element Method, Element selection and mesh, Load application, constraints, preprocessing checks, processing the model, postprocessing

Books Recommendation:

1. Budynas Richard G., Advanced Strength and Applied Stress Analysis, Tata McGraw Hill Publishers, Second Edition, 2011
2. Srinath L.S., Advanced Mechanics of Solids, Tata McGraw Hill Publishers, Third Edition, 2009
3. Boresi Arthur P. and Schmidt Richard J., Advanced Mechanics of Materials, Wiley India Publishers, Sixth Edition, 2012.
4. Bruhna, Otto, " Advanced Mechanics of Solids", Springer.
5. William B. Bickford," Advanced Mechanics of Materials", Wesley.

IPX-619 ENERGY CONSERVATION AUDIT AND MANAGEMENT [3 0 0 3]

Section A

Energy Scenario : Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, Indian energy scenario, Sectoral energy consumption (domestic, industrial and other sectors), energy needs of growing economy, energy intensity, long term energyscenario, energy pricing, Energy security, energy conservation and its importance, energy strategy for the future, Energy Conservation Act 2001 and its features.

Basics of Energy its various forms and conservation : Electricity basics – Direct Current and Alternative Currents, electricity tariff, Thermal Basics-fuels, thermal energy contents of fuel, temperature and pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity and heat transfer.

Section B

Evaluation of thermal performance – calculation of heat loss – heat gain, estimation of annual heating & cooling loads, factors that influence thermal performance, analysis of existing buildings setting up an energy management programme and use management – electricity saving techniques

Energy Management & Audit: Definition, energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs,
3.1 Bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments and metering

Financial Management : Investment-need, appraisal and criteria, financial analysis techniques simple payback period, return on investment, net present value, internal rate of return, cash flows, risk and sensitivity analysis; financing options, energy performance contracts and role of Energy Service Companies (ESCOs)

Section C

Energy Monitoring and Targeting: Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques – energy consumption, production, cumulative sum of differences (CUSUM). Energy Management Information Systems (EMIS)

Energy Efficiency in Thermal Utilities and systems: Energy efficiency in thermal utilities like boilers, furnaces, pumps and fans , compressors, cogeneration (steam and gas turbines), heat exchangers ,lighting system, Motors belts and drives, refrigeration system.

Heat Recovery and Co-generation:- Heat recovery from ventilation, air co-generation of heat and electricity, heat recovery and bottoming cycles.

Books Recommendation:

1. W. F. Kenny, Energy Conservation In Process Industry.
2. Amlan Chakrabarti, Energy Engineering and Management, Prentice hall India 2011
3. CB Smith, Energy Management Principles , Pergamon Press, New York
4. Hand outs New Delhi, Bureau of energy efficiency
5. W. C. Turner, John Wiley and sons, Energy Management Hand Book.

IPX-620 INDUSTRIAL PSYCHOLOGY [3 0 0 3]

Section A

Introduction to Industrial Psychology – Definitions & Scope**.** Major influences on industrial Psychology-Scientific management and human relations schools, Taylorism and scientific management, Hawthorne Experiments

Individual in Workplace

Motivation and Job satisfaction , stress management. Organizational culture, Leadership & group dynamics. Work Environment & Engineering Psychology-fatigue. Boredom, accidents and safety. Job Analysis, Recruitment and Selection, test of special abilities and personality assessment, attitudes, morale and adjustment, Reliability & Validity of recruitment tests.

Section B

Performance Management : Training & Development.

Basic motivation concepts and their applications, Understanding work teams, communication, conflict management and negotiations, Organizational culture, Organizational change and factors contributing to the development, Case studies and problem solving sessions

Section C

Managerial psychology : The functions performed by effective managers, The manager as a decision-maker, Psychological models of managerial decision-making, The manager as a motivator: major models of work motivation. Managerial motivation. Goal-setting, intrinsic motivation and self-efficacy in work settings. The manager as a communication link : superior-subordinate communication. Determinants of and barriers to effective communication at the managerial level, The manager as a conflict-resolver: major psychological approaches to conflict management, resolution and handling, The manager as a reward allocator. Basic principles of distributive and procedural fairness from a managerial perspective.

Books Recommendation:

1. Miner J.B. (1992) Industrial/Organizational Psychology. N Y : McGraw Hill.
2. Blum & Naylor (1982) Industrial Psychology. Its Theoretical & Social Foundations CBS Publication.
3. Aamodt, M.G. (2007) Industrial/Organizational Psychology : An Applied Approach (5^{th} edition) Wadsworth/Thompson : Belmont, C.A.
4. Aswathappa K. (2008). Human Resource Management (fifth edition) New Delhi : Tata McGraw Hill.
5. Arnold & Randall, " Work Psychology", Pearson.

IPX-621 I C ENGINES AND COMPRESSORS [3 0 0 3]

Section A

Introduction to I.C Engines: Engine classification, Air standard cycles, Otto cycle, Diesel cycle, Dual cycle, Comparison of Otto, Diesel and Dual cycles, Stirling cycle, Ericsson cycles, Actual cycle analysis, Two and four stroke engines, SI and CI engines, Valve timing diagram, Rotary engines, stratified charge engine. Fuels: Fuels for SI and CI engine , Important qualities of SI and CI engine fuels, Rating of SI engine and CI engine fuels, Dopes, Additives, Gaseous fuels, LPG, CNG, Biogas, Producer gas, Alternative fuels for IC engines.
Testing and Performance: Performance parameters, Basic measurements, Blow by measurement, Testing of SI and CI engines.

Section B

SI Engines: Combustion in SI engine, Flame speed, Ignition delay, Abnormal combustion and it's control, combustion chamber design for SI engines, Carburetion, Mixture requirements, Carburetor types, Theory of carburetor, MPFI, Ignition system requirements, Magneto and battery ignition systems, ignition timing and spark plug, Electronic ignition.

CI Engine: Combustion in CI engines, Ignition delay, Knock and it's control, Combustion chamber design of CI engines. Fuel injection in CI engines, Requirements, Types of injection systems, Fuel pumps, Fuel injectors, Injection timings. Scavenging in two Stroke engines, pollution and it's control.

Section C

Engine Cooling: Different cooling systems, Radiators and cooling fans, Lubrication: Engine friction, Lubrication principle, Type of lubrication, Lubrication oils, Crankcase ventilation, Supercharging: Effect of altitude on power output, Types of supercharging, Compressors: Classification, Reciprocating compressors, Single and Multi stage compressors, Intercooling, Volumetric efficiency, Rotary compressors, Classification, Centrifugal compressor , Axial compressors, Surging and stalling, Roots blower, Vaned compressor.

Books Recommendation:

1. Fundamentals of Internal Combustion Engine by Gill, Smith,Ziurs, Oxford & IBH Publishing CO.
2. IC Engines, by Rogowsky, International Book Co.
3. A Course in International Combustion Engines, by Mathur & Sharma, Dhanpat Rai & Sons.
4. I.C Engine Analysis & Practice by E.F Obert.
5. I.C Engine, by Ganeshan, Tata Mc Graw Hill Publishers.
6. I.C Engine, by R. Yadav, Central Publishing House, Allahabad
7. Reciprocating and Rotary Compressors, by Chlumsky, SNTI Publications, Czechoslovakia
8. Turbines, Compressors and Fans, by S.M.Yahya, Tata Mc Graw Hill Pub.

IPX-622 STOCHASTIC MODELLING [3 0 0 3]

Section A

Introduction: Probability, Random Variables; Discrete Random Variables, Continuous Random Variables. Multivariate Random Variables; Multivariate Discrete Random Variables, Multivariate Continuous Random Variables. Conditional Probability Mass Function, Conditional Probability Density Function, Computing Probability by Conditioning

Introduction of Stochastic Process; Discrete-Time Markov Chains, Transient Distributions, Occupancy times, Limiting Behaviour. Cost Models: Expected Total Cost Over a Finite Horizon, Long-Run Expected Cost Per Unit Time

Section B

Continuous Time Markov Models: Continuous Time Stochastic Processes, Continuous Time Markov Chains, Exponential Random Variables, Poisson Processes, Transient Analysis: Uniformization. Occupancy Times, Limiting Behaviour. Cost Models: Expected Total Cost, Long-Run Cost Rates.

Introduction of Generalized Markov Models, Renewal Process, Cumulative Process. Semi-Markov Process: Long- Tetm Analysis, Mean Inter-Visit Times, Occupancy Distributions.

Introduction of Queuing Systems: Single Station Queues Results, Birth and Death Queues with Finite Capacity; M/M/l/K Queue, M/M/s/K Queue, M/M/K/K Queue. Birth and Death Queues with Infinite Capacity; M/M/l Queue, M/M/s Queue, M/M/∞ Queue. M/G/l Queue, G/M/l Queue. Networks of Queues: Jackson Networks, Stability, Limiting Behaviour.

Section C

Introduction of Optimal Design: Optimal Order Quantity, Optimal Leasing of Phone Lines, Optimal Number of Tellers, Optimal Replacement, Optimal Server Allocation.

Introduction of Optimal Control: Discrete-Time Markov Decision Process: DTMDPs, Optimal Policies for DTMDPs, Optimal Inventory Control, Semi-Markov Decision Processes: SMDPs, Optimal Policies for SMDPs, Optimal Machine Operation.

Books Recommendation:

1. Guttorp, P. (1995). Stochastic Modelling in Scientific Applications, Chapman & Hall.
2. Bailey, N.T.J. (1964). The Elements of Stochastic Processes with Applications to the Natural Sciences, Wiley.
3. Karlin, S. and Taylor, H.M. (1975). A First Course in Stochastic Processes (2nd edn.), Academic Press.
4. Ross, S.M. (1983). Stochastic Processes, Wiley.
5. Basawa, I.V. and Prakasa Rao, B.L.S. (1980). Statistical Inference for Stochastic Processes, Academic Press.
6. Kulkarni V. G. (1995). Modeling and Analysis of Stochastic Systems, Chapman & Hall/CRC

IPX-623 ADVANCED OPTIMIZATION TECHNIQUES [3 0 0 3]

Section A

Lagrange multiplier methods; Kuhn-Tucker conditions; multi-criteria methods; Revised Simplex algorithm; Dantzig-Wolfe decomposition; Primal-Dual algorithm; Ford and Fulkerson Labeling algorithm; Dijkstra's algorithm; Polynomial-Time algorithm; Hungarian method for the Assignment problem, Nonbipartite Weighted Matching problem, Minimum Spanning Tree problem; Greedy algorithm; Branch-and-Bound for Integer Linear programming.

Section B

Definition of Heuristics; Heuristic methods for the optimization problems such as Travelling Salesman Problem, Capital Budgeting, Distribution, Location, Layout, Resource Allocation, Routing and Scheduling areas; Artificial Intelligence (AI) techniques (e.g., Genetic Algorithms, Simulated Annealing, Tabu Search, Ant Systems, etc.).

Books Recommendation:

1. M.J. Fryer & J.V. Greenman (1987) Optimisation Theory, Applications to OR and Economics, London, Arnold
2. W.L. Winston (2004) Operations Research: Applications and Algorithms (4th Ed.), ITP-Duxbury, Belmont
3. C. R. Reeves (1995) Modern Heuristic Techniques for Combinatorial Problems, Blackwell Scientific Publisher
4. H.P. Williams (1993) Model Solving in Mathematical Programming, (3rd edn.) Wiley
5. Glover and Kochenberger (2003) Handbook of Metaheuristics, Kluwer Academic Publishers.
6. El-Ghazali Talbi (2009) Metaheuristics: From Design to Implementation, Wiley
7. Christos H. Papadimitriou Kenneth Steiglitz: Combinatorial Optimization Algorithms and Complexity, Prentice Hall India
8. CH Papadimitriou, K. Steiglitz (1982); Combinatorial Optimization: Algorithms and Complexity. Prentice-Hall India

IPX-624 PROCESSING OF NON-METALS [3 0 0 3]

Section A

Introduction: Classification of engineering materials and processing techniques, structure and properties of nonmetals.

Glass:Glass structure and properties, glass melting and forming, glass annealing.

Section B

Ceramics: Classification of ceramics: crystal structures and properties, ceramic powder preparation, Synthesis of ceramic powders, fabrication of ceramic products from powders: pressing, casting, vapour phase techniques, sintering, finishing, machining. ceramic coatings.

Plastics: Structure and mechanical properties of plastics, thermoplastics and thermosets, Processing of Plastics: Extrusion. Injection moulding. Thermoforming. Compression moulding. Transfer moulding. General behavior of polymer melts, Machining of plastics.

Section C

Composites: Classification of composite materials, properties of composites, processing methods of polymeric matrix composites: hand lay-up, autoclaving, filament winding, pultrusion, compression molding, pre-pegging, sheet molding compounds etc., process capability and application areas of various techniques; Ceramic matrix composites, mechanical properties of ceramic matrix composites, different processing techniques for ceramic matrix composites, process capability and applications of various techniques; Secondary processing of composite materials, Need of secondary operations, different type of secondary operations, machining and drilling of non-metals, machining induced damage, different methods of reducing the damage on account of secondary processing.

Elastomers: Processing of Rubber/ Elastomers

Books Recommendation:

1. Manufacturing Processes for Engineering Materials : S. Kalpakjian, 3rd edition Addison - Wesley, 1997
2. Plastic Materials and Processing : A. Brent Strong, Prentice Hall, ISBN 0-13-021626-7
3. Composite Materials: Engineering and Science: F.L. Mathews and R.D. Rawlings, CRC press, 084930251X
4. Materials and Processes in Manufacturing, E. Paul DeGarmo, J. T. Black, Ronald A. Kohser, Wiley; 11 edition (August 30, 2011.
5. Evgney A. Levashow, " Russian Journal of Non-Ferrous Metals", Springer.

IPX-625 MICRO-ELECTRO MECHANICAL SYSTEMS (MEMES) [3 0 0 3]

Section A

Introduction, Development of MEMS Technology, Present, Future and Challenges, Fabrication Processes: Fundamentals of Material Science, Substrates: Single crystal substrates, Silicon on Insulator Substrate, Physical vapour deposition, Chemical vapour Deposition, Etching Processes, patterning, wafer bonding, annealing, chemical mechanical polishing, material doping, MEMS application in life sciences

Section B

Principal of Microsystems: Introduction, Microsensors and there types, Microactuation using different forces and materials, Microactuators and there types, Microaccelerometers, Microfluidics
Scaling Laws in Miniatuarization: Introduction to scaling, Scaling of physical systems scaling (geometric, mechanical, thermal, fludic, electrical, optical and chemical and biological), computational fabrication, and material issues
Materials and Microsystems: Introduction, Substrates and wafers, active substrate materials, Silicon as a substrate material, Silicon compounds, silicon piezoresistors, Gallium Arsenide, Quarta, Piezoelectric crystals, polymers, packaging materials

Section C

Microsystem Fabrication Process and Manufacturing: Introduction, Photolithography, Ion implantation, Diffusion, Oxidation, Chemical vapour deposition, physical vapour deposition, Chemical Mechanical Polishing, Material Doping, Deposition of epitaxy, Etching, Patterning, wafer-bonding and annealing. Micromanufacturing: Bulk micromachining, Surface micromachining, LIGA,
Packaging and Reliability: Packaging process steps, reliability models, MEMS failure mechanisms, Measurement Techniques for MEMS Operational, Reliability, and
Failure Analysis Testing

Books Recommendation:

1. Tai-Ran Hsu, MEMS & Microsystems Design and Manufacture, Fourth reprint edition, 2012
2. Allen James J, Micro Electromechanical System Design, First edition, Taylor and Farancis, FL (USA), 2005
3. Maluf Nadim and Williams Kirt, An Introduction to Microelectromechanical Systems Engineering, Second Edition, ARTECH House, MA (USA), 2004.
4. N. Maluf," An Introduction to Micro-electro Mechanical System Engineering", Artech. House.
5. S. Senturia," Micro system Design", Springer.

IPX-626 HUMAN FACTOR ENGINEERING [3 0 0 3]

Section A

Introduction: Introduction to Human Factors Engineering, What is field of human factors, the scope of human factors, the study of human factors as a science, Historical evolution of ergonomics, ergonomics and human factors engineering, Goals of human factors engineering. Introduction to research methods, an overview of research methods, experimental research methods Experimental design.

Visual Sensory Systems: The stimulus; light The receptor system; the eye ball and optic nerve, visual receptive system,, contrast sensitivity, reading, colour sensation, night vision, Bottom-up vs top down processing, depth perception, Visual search, detection, discrimination,.

Auditory, Tactile and Vestibular System: Auditory stimulus, Ear; the sensory transducer, the auditory experience, Alarms, criteria for alarms, designing for alarms, Sound localization, sound transmission problem, the speech signal, Speech Communications, hearing loss Noise reduction at the work place, the other senses; Touch, Vestibular senses.

Section B

Cognition: Information processing models, selective attention, Reception, Human Factor Guidelines in perception, Working Memory, Human factors Implications of working memory Limits, Long term memory, Organisation of information in ling term memory, episodic memory, Situation Awareness (SA), problem solving and troubleshooting, Metacognition and effort, Attention and Time sharing, mental effort and resource demand, task management and interruptions, Addressing time sharing overload.

Decision Making: Decision making models; normative and descriptive decision making models, Heuristics and biasness, Dependency of decision making on the decision context. Factors affecting decision making performance, improving human decision making.

Displays & Controls: classifications of displays, Thirteen principles of display design, Altering displays, labels, monitoring, multiple displays; display layouts, head up displays, configural displays, navigation displays and maps, Quantitative information displays. Controls; Principles of response selection, Discrete control activation, Positioning Control Devices, Verbal and symbolic inputs, Voice input, Continuous Control tracking, Control Order.

Section C

Engineering Anthropometry and Work place Design: Human Variability and Statistics, anthropometric data, Structural and Functional data, Use of anthropometric data in design, General; Principles for workplace design; clearance requirement of the largest users, reach requirements of the smallest users, special requirements of maintenance people, adjustability requirements, visibility and normal line of slight, component arrangement, Design of standing and seated work areas, work surface; height, depth & inclination.

Biomechanics of Work: The musculoskeletal system, Biomechanical models, Low back problems, NOISH lifting guide, Manual material handling, Seated work and chair design, Upper extremities cumulative trauma disorders. Causes & prevention of CTD, hand tool design. Strain index method for DUE risk assessment. Work posture risk assessment using OWAS, Rapid Upper Limb Assessment and Rapid Entire Body Assessment tools..

Work Physiology: Muscle structure and metabolism, Circulatory and respiratory system, the respiratory system, Lung capacity, Lung capacity measurement using Spirometry. Measurement of workloads. Physical work capacity and whole body fatigue, causes and Control of whole body fatigue. Bio Energies. Stress and workloads. RSPM assessment.

Books Recommended:

1. Christopher D W, John D Lee. Gordon Becker, "*Human Factors Engineering*", PHI, 2011.
2. MI Khan, "*Industrial Ergonomics*", PHI, 2011.
3. Sanders Mark S and McCormick Ernert J, "*Human Factors in Engineering and Design*", McGraw-Hill Inc., 1993.
4. John B West, "*Respiratory Physiology*" Wolter Kulwer Lippincott Williams & Wilkins.
5. David J. Oborne,"Ergonomics at Work", John Willey & Sons.

IPX-627 SURFACE ENGINEERING [3 0 0 3]

Section A

Fundamentals of surface engineering

Introduction: Engineering components, surface dependent properties and failures, importance and scope of surface engineering; Surface and surface energy: Structure and types of interfaces, surface energy and related equations; Surface engineering: classification, definition, scope and general principles

Conventional surface engineering

Surface engineering by material removal: Cleaning, pickling, etching, grinding, polishing, buffing / puffing (techniques employed, its principle). Role and estimate of surface roughness; Surface engineering by material addition: From liquid bath - hot dipping (principle and its application with examples); Surface engineering by material addition: Electrodeposition / plating (theory and its scope of application);Surface modification of steel and ferrous components: Pack carburizing (principle and scope of application); Surface modification of ferrous and non ferrous components: Aluminizing, calorizing, diffusional coatings (principle and scope of application); Surface modification using liquid/molten bath: Cyaniding, liquid carburizing (diffusion from liquid state) (principle and scope of application); Surface modification using gaseous medium: Nitriding carbonitriding (diffusion from gaseous state) (principle and scope of application).

Section B

Advanced surface engineering practices

Surface engineering by energy beams: General classification, scope and principles, types and intensity/energy deposition profile; Surface engineering by energy beams: Laser assisted microstructural modification – surface melting, hardening, shocking and similar processes; Surface engineering by energy beams: Laser assisted compositional modification – surface alloying of steel and non-ferrous metals and alloys; Surface engineering by energy beams: Laser assisted compositional modification – surface cladding, composite surfacing and similar techniques; Surface engineering by energy beams: Electron beam assisted modification and joining; Surface engineering by energy beams: Ion beam assisted microstructure and compositional modification; Surface engineering by spray techniques: Flame spray (principle and scope of application); Surface engineering by spray techniques: Plasma coating (principle and scope of application); Surface engineering by spray techniques: HVOF, cold spray (principle and scope of application); Characterization of surface microstructure and properties (name of the techniques and brief operating principle).

Surface coatings and surface modifications

Evaporation - Thermal / Electron beam; Sputter deposition of thin films & coatings – DC & RF; Sputter deposition of thin films & coatings – Magnetron & Ion Beam; Hybrid / Modified PVD coating processes
Chemical vapor deposition and PECVD; Plasma and ion beam assisted surface modification; Surface modification by Ion implantation and Ion beam mixing

Section C

Characterization of coatings and surfaces

Measurement of coatings thickness; porosity & adhesion of surface coatings; Measurement of residual stress & stability; Surface microscopy & topography by scanning probe microscopy; Spectroscopic analysis of modified surfaces

Functional Coatings & Applications

Functional and nano-structured coatings and their applications in photovoltaics, bio- and chemical sensors; Surface passivation of semiconductors & effect on electrical properties; Surface engineering of polymers and composites; Thin film technology for multilayers & superlattices for electronic, optical and magnetic devices; Modeling

Books Recommended:

1. K.G. Budinski, Surface Engineering for Wear Resistances, Prentice Hall, Englewood Cliffs, 1988.
2. M. Ohring, The Materials Science of Thin Films, Academic Press Inc, 2005.
3. Peter Martin, " Introduction to Surface Engineering and Functionally Engineered Materials", John Willey
4. Mircea K. Bologa, " Surface Engineering and Applied Electrochemistry", Springer.
5. Devis, J.R.," Surface Engineering for Corrosion & Wear Resistance", 2001 Maney Publicsing.

IPX-628 ADVANCED MACHINING PROCESS [3 0 0 3]

Section A

Advanced Machining Processes
Introduction, Process principle, Material removal mechanism, Parametric analysis and applications of processes such as ultrasonic machining (USM), Abrasive jet maching (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

Section B

Advanced Casting Processes
Metal mould casting, Continuous casting, Squeeze casting, Vacuum mould casting, Evaporative pattern casting, Ceramic shell casting

Section C

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.

Books Recommended:

1. "Materials and Processes in Manufacturing" (8th Edition), E. P. DeGarmo, J. T Black, R. A. Kohser, Prentice Hall of India, New Delhi (ISBN 0-02- 978760).
2. "Manufacturing Science" A. Ghosh, and A. K. Mallik, Affiliated East-West Press Pvt. Ltd. New Delhi.
3. "Nontraditional Manufacturing Processes", G.F. Benedict, Marcel Dekker, Inc. New York (ISBN 0-8247-7352-7).
4. Vijay K. Jain, " Advanced Machining processes", Allied Publishers Pvt. Ltd.
5. Wit Grzesik, " Advanced Machining Processing of Metallic Materials", Elsevier.

Departmental Open Elective Courses

IPX-629 INDUSTRIAL ENGINEERING [3 0 0 3]

Section A

Work System Design: Definition, objectives, step-by-step procedure, charts and diagrams for recording data. principles of motion economy. Various techniques of work-measurement, work sampling, time study & its procedure. Rating, methods of rating, allowances and their types, standard time, numerical problems. Introduction to Ergonomics, man-machine system and its components.

Facilities planning and design: Plant layout, material handling and their interrelationship, objectives of a good plant layout, principles of a good layout, classical types of layouts.
Value engineering: Value analysis, methodology of value engineering.

Section B

Quality Control: Process control and product control, difference between SQC and SPC, chance and assignable causes of quality variation, Shewhart control charts. 100% inspection, no inspection and sampling inspection. Application of hyper geometric, binomial & Poisson distributions in acceptance inspection.

Inventory Management: Introduction, materials productivity and role of materials management techniques in improved materials productivity, Wilson's lot size model, inventory costs, hidden costs, composition of costs, estimation of inventory related costs, lead time, stock out point, number of time periods, calculating Economic Order Quantity (EOQ), sensitivity analysis of EOQ model.

Section C

Project Management: Gantt chart, milestone char. Network scheduling terminology. Path enumeration, Activity on node & activity on arc network precedence diagrams.

Reliability: Concept of reliability, objectives, applications, area of use, use of reliability in industry.

Books Recommended:

1. Krajewski L J and Ritzman L P, "*Operations Management*", Pearson Education Asia, Sixth Edition (2004)
2. Buffa, "*Modern Production/operations Management*", Wiley Eastern, New York (1999).
3. R Panneer Selvan, "*Production and Operation Management*", Prentice Hall India, New Delhi (2002).
4. Muhlemann Alan, Oakland John and Lockyer Keith, "*Production and Operations Management*", Macmillan India Publications Ltd. (2001)
5. Adam and Ebert "*Production and Operation Management*" Pearson Education Asia, Fifth Edition (2003)

IPX-630 ADVANCED OPERATIONS RESEARCH [3 0 0 3]

Section A

The simplex algorithm, post optimality analysis, duality in l.p., dual simplex method, revised simplex method.
Transportation algorithm and optimality, assignment model, Hungarian method. decision making under certainty, risk and uncertainty, game theory, two-person zero-sum game, mixed strategy.

Section B

Elements of queuing model, single channel infinite population model, finite queue length, pure birth and death model, multi channel queuing model.
Goal programming, problem formulation, the weighting method, primitive method.
Integer programming, problem formulation, branch-and-bound algorithm, zero-one implicit enumeration algorithm.

Section C

Non-linear programming, direct search method, gradient method.
Evolutionary algorithms, introduction to genetic algorithms, Binary coded GAs for constrained optimization, introduction to real coded GAs. Introduction to simulated annealing, ant colonies, particle swarm optimization.

Books Recommended:

1. Taha, H.A., Operations Research - An Introduction, Sixth Edition, Prentice Hall of India Private Limited, N. Delhi, 2004.
2. Hillier, F.S., Operations Research, First Indian Edition, CBS Publishers and Distributors, Delhi, 1994.
3. Wagner H.M., Principles of Operations Research, Second Edition, Prentice Hall of India Private Limited, New Delhi, 2003.
4. Deb K, Optimization for Engineering Design, Prentice Hall of India Pvt. Ltd., 2005.
5. Gupta P.K., and Hira, D.S., Operations Research, Third Edition, S. Chand and Company Ltd., New Delhi, 2005.