TEACHING SCHEME FOR B.TECH "INDUSTRIAL & PRODUCTION ENGINEERING" APPROVED FROM BOARD OF STUDIES OF DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING

w.e.f. January 2017 onwards

Total credits from 3rd sem to 8th sem: 144
Total credits from Ist and 2nd sem: 46
Total credits: 190

3RD SEMESTER

S No	Course Code	Course Title	Periods			Credits
			L	T	P	
1	IPX-201	Machine Drawing	1	0	6	4
2	IPX-203	Strength of Materials	3	1	0	4
3	IPX-205	Theory of Machines	3	1	0	4
4	IPX-207	Applied Thermodynamics	3	1	0	4
5	IPX-209	Statistics for Engineers	3	1	0	4
6	HMX-202	Entrepreneurial Development and Management	3	0	0	3
Laboratories						
7	IPX-221	Applied Thermodynamics Laboratory	0	0	2	1
8	IPX-223	Strength of Materials Lab	0	0	2	1
		Total	16	4	10	25

4TH SEMESTER

S No	Course Code	Course Title	Periods			Credits
			L	T	P	
1	IPX-202	Mechanical Measurements and Metrology	3	1	0	4
2	IPX-204	Materials Engineering	3	0	0	3
3	IPX-206	Production Planning and Control	3	1	0	4
4	IPX-208	Design of Machine Elements	3	0	2*	4
5	IPX-210	Manufacturing Technology	3	1	0	4
6	IPX-212	Heat & Mass Transfer	3	0	0	3
*Practice Session to be treated as tutorial						
Laboratories						
7	IPX-222	Mechanical Measurements and Metrology Laboratory	0	0	2	1
8	IPX-224	Manufacturing Technology Laboratory	0	0	2	1
9	IPX-226	Heat & Mass Transfer Laboratory	0	0	2	1
		Total	18	3	8	25

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w.e.f. January 2017 onwards

5TH SEMESTER

S No	Course Code	Course Title	Periods			Credits
			L	T	P	
1	IPX-301	Machine Tool Design	3	1	0	4
2	IPX-303	Work Study and Ergonomics	3	1	0	4
3	IPX-305	Quality Management	3	1	0	4
4	IPX-307	Operations Research	3	1	0	4
5	IPX-309	Automobile Engineering	3	0	0	3
6	IPX-XXX	Departmental Elective-1	3	0	0	3
Laboratories						
7	IPX-321	Machine Tool Design Lab.	0	0	2	1
8	IPX-323	Work Study and Ergonomics Lab.	0	0	2	1
9	HMX-312	Soft skills and Personal Interviews	0	0	2	Non credit
		Total	18	4	4	24

6TH SEMESTER

S No	Course Code	Course Title	Periods			Credits
			L	T	P	
1	HMX-306	Marketing Management	3	0	0	3
2	IPX-304	Fluid mechanics and machinery	3	1	0	4
3	IPX-306	Simulation of Production Systems	3	1	0	4
4	IPX-308	Facilities Planning and Design	3	1	0	4
5	IPX-310	Advanced Manufacturing Processes	3	1	0	4
6	IPX-XXX	Departmental Elective-2	3	0	0	3
Laboratories						
7	IPX-322	Fluid Mechanics and Machinery Laboratory	0	0	2	1
		Total	18	4	4	23

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w.e.f. January 2017 onwards

7TH SEMESTER

S No	Course Code	Course Title	Periods			Credits
			L	T	P	
1	IPX-401	Industrial Automation	3	1	0	4
2	IPX-403	Environmental Planning and Control	3	1	0	4
3	IPX-405	Materials Management	3	1	0	4
4		Open Elective-1	3	0	0	3
5	IPX-XXX	Departmental Elective-3	3	0	0	3
Laboratories						
6	IPX-421	Industrial Automation Lab	0	0	2	1
7	IPX-423	Practical Training				4*
8	IPX-425	Project (Phase-1)				2
		Total	15	2	4	25

8TH SEMESTER

S No	Course Code	Course Title	Periods			Credits
			L	T	P	
1	IPX-402	Engineering Economy	3	0	0	3
2	IPX-XXX	Departmental Elective-4	3	0	0	3
3	IPX-404	CAD/CAM & Robotics	3	1	0	4
4	IPX-406	Project Management	3	1	0	4
5		Open Elective - 2	3	0	0	3
Laboratories						
6	IPX-426	Project (Phase-2)				4
7	IPX-422	CAD/CAM & Robotics Lab.	0	0	2	1
		Total	15	2	0	22

TEACHING SCHEME FOR B.TECH "INDUSTRIAL & PRODUCTION ENGINEERING" APPROVED FROM BOARD OF STUDIES OF DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING
w.e.f. January 2017 onwards

List of Departmental Elective Courses

S No	Course Code	Course Title	L	T	P	C
1.	IPX-601	Occupational Health & Safety	3	0	0	3
2.	IPX-602	Maintenance and Reliability Engineering	3	0	0	3
3.	IPX-603	Supply Chain Management	3	0	0	3
4.	IPX-604	Finite Element Analysis	3	0	0	3
5.	IPX-605	Fracture Mechanics	3	0	0	3
6.	IPX-606	Technology Management	3	0	0	3
7.	IPX-607	Management Information Systems	3	0	0	3
8.	IPX-608	Composite Materials	3	0	0	3
9.	IPX-609	Change Management	3	0	0	3
10.	IPX-610	Smart Materials & Nano Technology	3	0	0	3
11.	IPX-611	Non-destructive Testing	3	0	0	3
12.	IPX-612	Mechatronics	3	0	0	3
13.	IPX-613	T.Q.M.	3	0	0	3
14.	IPX-614	Computer Integrated Manufacturing	3	0	0	3
15.	IPX-615	Vibration & Noise Control	3	0	0	3
16.	IPX-616	Design for Manufacturing	3	0	0	3
17.	IPX-617	Welding Engineering	3	0	0	3
18.	IPX-618	Advanced Mechanics of Materials	3	0	0	3
19.	IPX-619	Energy Conservation, Audit and Management	3	0	0	3
20.	IPX-620	Industrial Psychology	3	0	0	3
21.	IPX-621	I C Engines and Compressors	3	0	0	3
22.	IPX-622	Stochastic Modelling	3	0	0	3
23.	IPX-623	Advanced Optimization Techniques	3	0	0	3
24.	IPX-624	Processing of Non-Metals	3	0	0	3
25.	IPX-625	Micro-electro Mechanical Systems	3	0	0	3
26.	IPX-626	Human factors Engineering	3	0	0	3
27.	IPX-627	Surface Engineering	3	0	0	3

List of Open Elective Courses

Open Elective Courses to be offered by Department of Industrial and Production Engineering to other departments

S No	Course Code	Course Title	L	T	P	C
1.	IPX-629	Industrial Engineering	3	0	0	3
2.	IPX-630	Advanced Operations Research	3	0	0	3

Department of Industrial and Production Engineering shall offer two open elective courses (one each in 7^{th} and 8^{th} semester) out of courses at Sr. No. 1 and 2 as above or out of the **List of Departmental Core/Elective Courses.**

THIRD SEMESTER

IPX-201 MACHINE DRAWING [1 0 6 4]

Course Objectives
After completing this course the students should understand the 2D drawings of machine components so as to make 3D components. An ability to use drafting instruments in a manner acceptable to industry. To enable the students to draw and understand the assembly of various machine components.
Course Outcomes
CO 1: Identify the elements of a detail drawing and prepare Engineering Drawing using orthographic projections and sectional views.
CO 2: Practice of part drawings for simple machine components.
CO 3: Produce the assembly drawings using part drawings.
CO 4: An Ability to understand and apply the knowledge of machine drawing as a system of Communication in which ideas are expressed clearly and all information fully conveyed.
CO 5: Recognize to use modern engineering tools, software and equipment to analyze different drawings for Design & manufacturing.
CO 6: Recognition of the need for, and an ability to engage in self education and life-long learning.

DETAILED SYLLABUS

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*", Charotar Publishing House Pvt. Ltd.
4. Sidheshwar N, "*Machine Drawing*", Tata McGraw Hill Co. New Delhi
5. Tanta C L, "*Mechanical Drawing*" Dhanpat Rai and Sons, N.Delhi.

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

Course Objectives
The basic objective of this course deals with the study of behaviour of solid objects under various types of loading conditions. It aims to study methods to calculate the stresses and strains in structural members, such as beams, columns, and shafts bars, etc.
Course Outcomes
CO 1: Students shall able to apply the fundamental concepts of stress, strain and their analysis.
CO 2: Students shall able to analyse the response of material under various loading conditions like axial, transverse, torsional and their combination in real life problems.
CO 3: Students shall be able to identify different yield theories involved in the failure of materials which take into account various mechanical properties of material such as its yield strength, ultimate strength, Young's modulus, and Poisson's ratio for improvement in system performance.
CO 4: Students shall be able to calculate stresses in members like springs, beams, shafts etc.
CO 5: Students shall be able to apply various scientific tools to implement the concepts of stresses and strain in thick and thin pressure vessels.
CO 6: Students shall able to use various methods to calculate the deflection in beams.
CO 7: Students shall able to identify the conditions of stability of structures like columns and struts.

DETAILED SYLLABUS

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

Two dimensional system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stress, ellipse of stress and their applications, Two dimensional stress-strain system, principal strains and principal axis of strain, circle of strain and ellipse of strain, Relationship between elastic constants.

Bending Moment and Shear Force Diagrams: Definition shear force and bending moment, relation between load, shear force and bending moment, BM and SF diagrams for cantilevers, Simply supported and fixed beams with or without overhangs, calculation of maximum BM and SF and the point of contraflexure under Concentrated loads, Uniformity distributed loads over the whole span or part of span, combination of concentrated loads (two or three) and uniformly distributed loads, uniformly varying loads, application of moments.

Bending of Beams: Symmetric member in pure bending, stress and deformations in the elastic range, deformations in transverse cross section, bending of members made of several materials, stress concentrations, plastic deformations, residual stresses, eccentric axial loading in a plane of symmetry, unsymmetric bending, general case of eccentric axial loading, bending of curved members, deflection of beams

Torsion: Stresses and deformation in circular shaft, Stresses in elastic range, Angle of twist, statically indeterminate shafts, design of transmission shafts, stress concentration and plastic deformations in circular shafts, circular shafts of an elastoplastic material, residual stresses in circular shafts, torsion of noncircular member, thin walled hollow shafts

Thin and Thick cylinders and Spheres: Derivation of formulae and calculations of hoop stress longitudinal stress in a cylinder, and sphere subjected to internal pressures increase in Diameter and volume Derivation of 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

Strain Energy: Definitions, expressions for strain energy stored in a body when load is applied: gradually, suddenly and with impact, strain energy of beams in bending, beam deflections, strain energy of shafts in twisting, energy methods in determining spring deflection, Castigliano's & Maxwell's theorems

Columns and Struts: Column under axial load, concept of instability and buckling, slenderness ratio, derivation of Euler's formulae for the elastic buckling load, Eulers, Rankine, Gordom's formulae Johnson's empirical formula for axial loading columns and their applications, eccentric compression of a short strut of rectangular & circular sections

Books Recommended:

1. Beer P F and Johnston (Jr) E R, "Mechanics of Materials", SI Version, Tata McGraw Hill, India.
2. Riley William F. Sturges Leroy D. and Morris Don H.,"Mechanics of Materials", Wiley Publishers India.
3. Popov E P, "Engineering Mechanics of Solids", SI Version 2nd Edition, Prentice Hall of India, New Delhi.
4. Timoshenko S P and Young D H, "Elements of Strength of Materials", 5th Edition, East West Press, New Delhi.

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

Course Objectives
To introduce the approaches and mathematical models used in kinematic and dynamic analysis of machinery. To give basic knowledge on kinematic and dynamic design of machinery and give basic knowledge on mechanical vibrations.
Course Outcomes
CO 1: The students will be able to determine velocities & accelerations of various planar mechanisms.
CO 2: Students will be able to establish static force relationships and inertia forces and their effect that exist in machines.
CO 3: Students will be able to analyse the dynamics of flywheel and their motion.
CO 4: Students will be able to analyse the process of rotating masses under critical speeds with respect to machine dynamics.
CO 5: Understanding of Cam and follower will enable the students to design and operate the inlet and exhaust valves of internal combustion engines, automatic attachment of machineries, and feed mechanism of automatic lathes etc.
CO 6: Understanding of governors will enable the students to determine the supply of working fluid to the engine with the varying load conditions.
CO 7: Students will be able to develop various mechanisms for power transmission.

DETAILED SYLLABUS

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]

Course Objectives
To make the students aware about the theoretical as well as practical concepts of boilers, turbines and compressors. It helps the students to understand the working and industrial application of the equipment.
Course Outcomes
CO 1: Students will be able to practice the basic concepts and working cycles for steam engines.
CO 2: Student will be able to design the blades and impeller for impulse and reaction turbines.
CO 3: Student will be able to identify and make different types of condensers, cooling water calculations etc.
CO 4: The student will be able to recommend a particular boiler as per the specified requirement.
CO 5: Student shall be able to analyze single stage and multistage reciprocating air compressors using appropriate modern scientific tools.
CO 6: Recognise the different types of SI and CI Engines and analyse their combustion process and performance for optimization of various parameters

DETAILED SYLLABUS

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]

Course Objectives
To train the students about various tools and techniques of data analysis so that they can apply the same for analysis of real life data encountered in their jobs.
Course Outcomes
CO1. Student shall be able to demonstrate the capability of data collection and analysis for performance analysis.
CO2. Student shall be able to calculate central tendency and dispersion from the data.
CO3. Student shall be able to various theoretical probability distributions and apply the same in real life situations.
CO4. Student shall be able to perform correlation and regression analysis, to establish the relation betweer dependent and independent variables.
CO5. Student shall be able to the method to apply advance statistical tests like chi-square test, F- test, T-test etc. And use them to find the significance of variance.

DETAILED SYLLABUS

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", Sixth 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]

Course Objectives
The main objective of the course is to inculcate the entrepreneurial skills among technocrat and make them job providers.
Course Outcomes
CO1. Student shall be able to recognise the basic traits of entrepreneurs and find the factors affecting them.
CO2. Students shall be able train the budding entrepreneurs through optimization of resources and strategic feasibility.
CO3.Students shall be able to optimize the manpower planning, recruitment and selection process while establishing new ventures.
CO4. Students shall understand the marketing management strategies and implement them as per requirements.
CO5.Students shall learn the steps of preparation of feasibility report.
CO6. Students will be able to lead teams for effective governance at all level.

DETAILED SYLLABUS

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]

Course Objectives
To understand the working and calculation of various parameters of 4-stroke petrol engine, single cylinder speed diesel engine, two stage Air Compressor. To understand the vapour compression cycle and determine the thermal conductivity of a solid insulating material. To calculate the various performance parameters of boiler and heat exchanger.
Course Outcomes
CO1. Student shall be able to Conduct a load test on a single cylinder, 4-stroke petrol and diesel engine and study its performance under various –loads using various engineering methods.
CO2. Student shall be able to Find the volumetric efficiency and isothermal efficiency of two stages Air Compressor using acquired engineering knowledge.
CO3. Student shall be able to find vapour compression refrigeration test rig and design way to improve its performance.
CO4. Student shall be able determine the thermal conductivity of a solid insulating material and select the best insulating material.
CO5. Student shall be able to select the parallel flow and counter flow heat exchanger as per requirement using advanced analysis.
CO6. Student shall be able to understand the working and the construction of different types of boilers and select the appropriate as per requirement.

LIST OF EXPERIMENTS

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]

Course Objectives
These objectives are formulated to demonstrate the basic principles in the area of strength and mechanics of materials to the undergraduate students through a series of experiments. The CO is given below: *1. Analyze and design structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behavior of materials.* *2. Students test steel and aluminium samples in single shear, double shear and impact loading and determining the hardness of material by different methods like Rockwell, Vicker's, and tests like Izod and Charpy* *3. Utilize appropriate materials in design considering engineering properties, sustainability, cost and weight.* *4. Perform engineering work in accordance with ethical and economic constraints related to the design of structures and machine parts.*
Course Outcomes
CO1. Students will be able to determine various mechanical properties of material like Young's modulus, tensile strength and percentage elongation for steel, aluminium, brass and cast iron specimens on universal testing machine and shall be able to plot the stress strain diagram.
CO2. Students will be able to perform the compression test for cast iron specimen on universal testing machine.
CO3.Students will be able to measure the total energy absorbed during sudden loading of the ductile specimen on Charpy and Izod setup. So as to recommend the material for various applications.
CO4.Students will be able to determine the stiffness of the cantilever beam and Spring under compressive and tensile loading and analyze the loading patterns.
CO5.Students will be able to plot and study the S-N curve for steel, aluminium and fibre reinforced composite material at 25%, 50%, 60% and 75% of ultimate tensile strength of the specimen.
CO6.Students will be able to determine the deflection for mild steel specimen and verify the beam formula for specimen in bending.
CO7.Students will be able determine Brinell hardness and Rockwell hardness on various specimen and recommend the appropriate material for various application.
CO8. Students will be able to analyse the behaviour of steel and aluminium specimen under torsion.

LIST OF EXPERIMENTS

1. Determination of Young's modulus, tensile strength and percentage elongation for steel, aluminium, brass and cast iron specimens on UTM.
2. To perform the compression test for cast iron specimen on UTM.
3. To perform the shear test on UTM
4. To investigate the stress concentration factor for specimens with different radius and type of edge notches using Photoelasticity
5. To determine deflection of beam for a steel Cantilever beam with flat bar cross section, instrumented with 3 strain gages.
6. To determine the deflection for mild steel specimen and verify the beam formula for specimen in bending.
7. To perform torsion test and determine the modulus of rigidity, the shear stress at the limit of proportionality, general characteristics of the torque, angle of twist relationship
8. To determine compound stress and strain in a thin pressure vessel
9. To verify Maxwell's Reciprocal Theorem for strain energy.
10. To measure the total energy absorbed in fracturing of the ductile specimen on Charpy and Izod setup.
11. Testing of specimens for Brinell hardness and Rockwell hardness.

FOURTH SEMESTER

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

Course Objective
The main objective of this course is to make students familiar with the mechanical measuring systems, and the standard measurement methods. It further aims to make them to understand the basic measurement systems in the real time engineering applications.
Course Outcomes
CO 1: Selecting suitable mechanical measuring instruments for basic and special requirement in the industries.
CO 2: Calibrating and analyzing the characteristics of measuring instruments.
CO 3: Designing the fits and tolerances to improve the existing performance.
CO 4: Determine error and analysing uncertainty in the measurements.
CO 5: Work in quality control and quality assurances divisions in industries.

DETAILED SYLLABUS

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, piezo-electric transducers, photoelectric transducers, strain gauges, use of various transducers.
Measuring Standards: Classification of standards, basic standards used worldwide, airy points for minimum deflection.
Length and Angle Measurement: Slip gauges, angle gauges, spirit level, bevel protector, sine bar.
Interchangeability: Meaning of interchangeability, types of interchangeability, and advantages of interchangeability.

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]

Course Objectives
The primary objective of this interdisciplinary course is to present the fundamentals of material science and metallurgical engineering with various heat treatment process. The students will be exposed with the basics of development, production and use of metallic materials with reference to Physical metallurgy
Course Outcomes
CO 1: The students shall be able to demonstrate the capability in selecting and identifying the materials based on their requirement of mechanical and metallurgical properties
CO 2: Students will able to understand and analyze the phenomenon like diffusion among metals
CO 3: Students will able to improve the performance of various materials in terms of their composition and change in properties and can identify what type of heat treatment processes may be required under various conditions.
CO 4: Students will be able to understand and investigate the homogeneous and heterogeneous solidification takes place in alloys with mathematical meaning
CO 5: Students will be able to make use of Phase diagrams and TTT Diagrams to understand and investigate the change in properties of steel and cast iron under varying composition rates.
CO 6: Students will be able to predict the properties on the basis of structure and texture identification of components like austenite, ferrite, martensite, bainite, pearlite, etc.

DETAILED SYLLABUS

Crystal Structure and Dislocations: various types of crystal structure and its types, Point, line and volume imperfections.

Dislocation and strengthening mechanism: Nature of dislocations: edge and screw type, dislocation characteristics slip system and plastic deformation, energy of screw dislocation, burger vector notation, stress fields around dislocations, deformation by twinning, stacking faults, strengthening by grain size reduction, solid solution strengthening, strain hardening, recovery, recrystallization, and grain growth. Super critical and ultra-super critical materials.

Diffusion: Atomic mechanism of diffusion, interstitial and substitution diffusion, atomic mobility, diffusion path, Fick's first law and second Law of diffusion, steady and non-steady state diffusion, temperature dependence of diffusivity, formula for depth of penetration

Solidification: Thermodynamics of solidification, Nucleation in pure metals, homogeneous and heterogeneous nucleation, growth of pure solid, solidification of ingots, freezing, metallic glass, equilibrium and non-equilibrium solidification

Phase Diagrams: Gibb's Phase rule, lever rule, Theory of alloy Phases: Hume-Rothery rules, Unary systems, Binary Isomorophous phase diagrams, Phase Diagrams of Binary Eutectic and off-eutectic composition, peritectic and eutectoid alloys, Iron-carbon phase diagram and microstructures of plain carbon steel and cast iron

Phase Transformations: Diffusional and diffusion-less transformation, Microstructural transformation, different types of energies involved (bulk Gibb's free energy, strain energy and interfacial energy), first order transformation its nucleation and growth, undercooling of system, critical size of nucleus, nucleation barrier, melting point of nano-crystal and its melting behaviour, atomic perspective of nucleation and nucleation barrier, heterogeneous versus homogeneous nucleation rates, growth transformation rate, TTT Diagrams, eutectoid transformations, CCT Curves, pearlite, bainite and martensite transformation, glass transition.

Heat Treatment: Mechanism of annealing, normalizing, tempering, hardening and case hardening, Introduction to chemical heat treatment, mechanism and methods of carburizing, nitriding, cyaniding, introduction to flame hardening.

Recommended Books:

1. Phase Transformations in Metals and Alloys, David A. Porter, Kenneth E. Easterling and Mohamed Y. Sherif, Third Edition, CRC Press
2. Physical Metallurgy, William F. Hosford, Second Edition, CRC Press,
3. Materials Science and Engineering An Introduction, William Callister, Wiley student edition
4. Alloy Phase Equalibria, A. Prince, Elsevier Publishing Company, Amsterdam, 1966.

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

Course Objectives
The objective of the course is to enable the students to study basic strategies of production planning and its controlling methods. It also includes resource planning, shop floor planning.
Course Outcomes
CO1: Student shall be able to forecast the appropriate requirement of resources for various production processes and other shop floor activities.
CO2: The students will be able to design an appropriate strategy for resource planning through appropriate MRP tool.
CO3: The students will be able to improve the productivity of shop floor through design of appropriate production systems such as mass production, batch production etc within existing conditions.
CO 4: The students will be able to identify the bottlenecks of shop floor and remove the same by appropriate design and analysis.
CO5: The students will be able to apply scientific tools such as MRP, JIT and learning curves etc. for optimizing production systems.
CO 6: The student will be able to communicate/sell his decisions effectively in front of his/her peers and groups.

DETAILED SYLLABUS

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 Selvam 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]

Course Objectives
The basics of machine design, including the design process, engineering mechanics and materials, failure prevention under static and variable loading, and characteristics of the principal types of mechanical elements.
Course Outcomes
CO 1: The student will be able to apply his/her knowledge for design of various mechanical components and mechanisms.
CO 2: The student will be able to apply the concepts of theory of failure, factor of safety, types of various loading conditions in objects with simple shapes.
CO 3: The student will be able to make use of the design principles so as to improve the performance of various components like spring, shaft, bearing etc. for various power transmission drives.
CO 4: The student will be able to identify the shortcomings of existing systems and redesign the same through appropriate design technique within realistic limits and constraints.
CO 5: The student will be able to use various scientific tools and software for optimizing the design of machines and their components.

DETAILED SYLLABUS

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]

Course Objectives
The main objective of this course is to emphasize the importance manufacturing sciences in the day-to-day life, and to study the basic manufacturing processes and tools used. The course is delineated particularly to understand the conventional manufacturing processes like casting, metal forming, and welding process.
Course Outcomes
CO1: The student will be having the capability of selecting suitable manufacturing processes to manufacture the products optimally.
CO 2: The student will be able to recommend the appropriate design of gating systems, forming processes, welding process and NDT technique.
CO 3: The student will be able to develop simplified manufacturing processes with the aim of reduction of cost and manpower.
CO 4: The student will be able to identify/control the appropriate process parameters, and possible defects of manufacturing processes so as to remove them.
CO 5: The student will be able to make use of the software and CAD/CAM tools meant for optimizing manufacturing processes.

DETAILED SYLLABUS

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, CO_2 moulding, continuous casting-squeeze casting-electro slag casting. Fettling and finishing, defects in Castings.

Foundry melting furnaces: Selection of furnace-crucibles oil fired furnaces, electric furnaces cupola, calculation of cupola charges, hot blast, cupola-Degasifications, inoculation-pouring equipment, Inspection of castings. Need-Areas for mechanization-Typical layout-sand reclamation techniques-material handling, pollution control in Foundry, Computers in casting process.

Section B

Forming: Metallurgical aspects of metal forming slip, twining mechanics of plastic deformation effects of temperature, strain rate-microstructure and friction in metal forming, yield criteria and their significance-classification of metal forming processes. Principle classification equipment, tooling processes, parameters and calculation of forces during forging and rolling processes, Ring compression tests, Post forming heat treatment, Defects (cause and remedy) applications. Classification of extrusion processes, tool, equipment and principle of these processes, influence of friction, Extrusion force calculation, Defects and analysis: Rod/wire drawing-tool, equipment and principle of processes defects, Tube drawing and sinking processes Mannessmann processes of seamless pipe manufacturing.

Classification of Forming Processes: Classification conventional and HERF processes, Presses types and selection of presses, formability of sheet metals, Principle, process parameters,

equipment and application of the following processes. Deep drawing, spinning, stretch forming, plate bending, press brake forming, Explosive forming, electro hydraulic forming, magnetic pulse forming. Super plastic forming, electro forming-fine blanking, P/M forging-Isothermal forging-high speed, hot forging high velocity extrusion.

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 characteristics safety aspects in welding-automation of

welding, seam tracking, vision and arc sensing-welding robots. Defects in welding-causes and remedies-destructive testing methods

Non Destructive Testing of weldments: Testing of pipe, plate, boiler, drum, tank-case studies weld thermal cycle-residual stresses-distortion-relieving of stresses, weldability of cast iron, steel, stainless steel, aluminium alloys-effect of gases in welding-fatigue failure in weldments.

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]

Course Objectives
To understand the fundamentals of heat transfer mechanisms in fluids and solids and their applications in various heat transfer equipment in process industries.
Course Outcomes
CO 1: The student will be able to apply the concepts of conduction, convection and radiation to formulate engineering and natural thermal systems.
CO 2: The student will be able to calculate the rate of heat transfer/mass transfer for the design of appropriate items like pipes, cylinders, flat sufaces etc.
CO 3: The student will be able to introduce modification in the existing industrial components within realistic constraints.
CO 4: The student will be able to identify the root causes of low effectiveness of various equipments on shop floor and take the appropriate measures to correct them.
CO 5: The student will be able to make use of scientific tools related to thermal systems for various applications.
CO 6: The student will be able to understand the environmental concern of heat and mass transfer.

DETAILED SYLLABUS

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.

Heat Exchanger: Types of heat exchangers; fouling factors; overall heat transfer coefficient; Logarithmic mean temperature difference (LMTD) method; Effectiveness-NTU method.

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

Books Recommended:

1. Holman J P, "Heat Transfer", McGraw Hill Book Co. (1992).
2. Yunus A. Cenegel, "Heat & Mass Transfer: A practical Approach", McGraw Hill Book Co. (2007).
3. Incropera F P and DeWitt D P, "Introduction to Heat Transfer," 2nd Ed John Wiley New York (1996).
4. Geankopolis C J, "Transport Processes and Separation Process Principles", Prentice Hallof India, 4th Edition, Eastern Economy Edition (2004)
5. Kern D Q, "Process Heat Transfer", McGraw Hill Book Co. (1997).
6. 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]

Course Objectives
These objectives are formulated to demonstrate the basic principles in the area of Metrology and Measurement laboratory to the undergraduate students through a series of experiments. The CO are given below: *1. Identify and classify different measuring tools related to experiments* *2. Identify, define, and explain accuracy, precision, and some additional terminology* *3. Conduct, Analyse, interpret, and present measurement data from measurements experiments* *4. Identify sources of variability, error, and uncertainties* *5. Demonstrate excellent laboratory skills and techniques including the proper use of relevant instruments and related technology* *6. Enhance the ability to apply knowledge of mathematics, statics, physics and engineering sciences.*
Course Outcomes
CO1. The student shall be measuring the various parameters like length, height, angle, displacement, flatness etc., by using various instruments like vernier calipers, micrometer, dial indicator, etc.
CO2. The student shall be able to measure the threads, gear tooth profiles and surface roughness using appropriate instruments and analyze the data.
CO3. The student shall be able to recognize various types of governors and gyroscopes, and improve their performance as per requirement.
CO4. The student shall be able to determine the balancing forces, inertial forces of rotating and reciprocating components in real life problems.
CO5: The student shall be able to check alignment of various components in various mechanisms using advanced scientific tools.

LIST OF EXPERIMENTS

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 maker's microscope.
12. To measure the elements of screw thread using profile projector.

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

Course Objectives
The objective of this Lab Course is to provide practical hands on experience to the students for various basic manufacturing processes, their tools and techniques for Machining, Foundry and Welding etc. so as to prepare them for using basic machines for producing components in the workshop.
Course Outcomes
CO1. The student shall be able to make use of various tools meant for Foundry, Machining and Welding Operations.
CO2. The student shall be able to design moulds of simple objects like flange, gear V- grooved pulley etc. and various parts of moulds such as cope, drag, riser, etc.
CO3. The student shall be able to evaluate accuracy of arc welding in butt joint, Lap Joint, T fillet etc. and select appropriate parameters for improvement of weld quality.
CO4. The student shall be able to identify various defects and shortcomings during gas welding operation, TIG and MIG welding Jobs, Spot welding etc. and give solution to eliminate the defects in real life situations.
CO5. The student shall be able to perform Die design and manufacturing for forming operations.

LIST OF EXPERIMENTS

1. To prepare the pattern, core, mold and cast few engineering components.
2. To Design and prepare a die/punch set for some sheet metal operations.
3. To perform the welding (TIG, MIG etc.) and observing the effect of various process parameters on the quality of weld.
4. To Design and manufacture a Chuck Key, V-Block and a gear by using various operations like turning, milling, drilling, grinding etc.

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

Course Objectives
This course will help to understand the phenomena of heat and mass transfer, to develop methodologies for solving a wide variety of practical engineering problems, and to provide useful information concerning the performance and design of particular systems and processes. Help to understand the thermal systems w.r.t the design, fabrication, and experimentation.
Course Outcomes
CO1. –Students will be able to apply theoretical knowledge for Analyzing problems involving steady state heat conduction in simple geometries.
CO2. Students will be able to improve the performance of systems for better heat transfer.
CO3. Students will be able to design systems and evaluate heat transfer coefficients for natural convection and forced convection for ducts.
CO4. Students will be able to identify, analyze and solve problems related with different heat exchangers.
CO5 Students will be able to design set ups for research activities in the laboratory

LIST OF EXPERIMENTS

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.

FIFTH SEMESTER

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

Course Objectives
The course has been designed with the objectives of making the students understand theory of metal cutting, machining parameters, machine tools and various machining operations, selection of jigs and fixtures and economy of machining processes.
Course Outcomes
CO 1: The student will be able to apply the fundamental principles of metal cutting processes and machine tools.
CO 2: The student will be able to design the various jig and fixture for industrial requirement through creative thinking.
CO 3: The student will be able to improve the performance of manufacturing processes by selecting /optimizing various machining parameters.
CO 4: The student will be able to identify and solve real life problems for developing appropriate processes related with machine tool.
CO 5: The student shall have sufficient knowledge for applying modern scientific tools and able to understand the latest technologies in metal cutting.
CO 6: The student will be able to guide the team of skilled and semi-skilled workers on the shop floor for effectively maintaining the machine.

DETAILED SYLLABUS

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]

Course Objectives
To provide basic understanding to the students about the concept and significance of work study and ergonomics. To impart thorough knowledge to the students about various techniques of work-study for improving the productivity of an organisation. To inculcate the skill among the students for analysing and improving existing methods of working on the shop floor of an organisation. To impart through knowledge and skills to students with respect to allowances, rating, calculation of basic and standard time for manual operations in an organisation. To provide the knowledge to the students about various wages and incentives schemes. To inculcate analysing skills among the students with respect to work place design, working postures and lifting tasks. To provide thorough knowledge about assessment about occupational exposure to heat stress, noise, vibrations and RSPM.
Course Outcomes
CO 1: Students will be able to calculate the basic work content of a specific job for employees of an organization. Thereby they will be able to calculate the production capacity of man power of an organization.
CO 2: Students will be able to analyze and calculate the level of risk in a job causing stress, fatigue and musculoskeletal disorders and design appropriate work systems.
CO 3: Students will be able to rate a worker engaged on a live job and calculate basic, allowed and standard time for the same.
CO 4: Students will be able to analyze the existing methods of working for a particular job and develop an improved method through questioning technique.
CO 5: Students will be able to devise appropriate wage and incentive plan for the employees of an organization
CO 6: Students will be able to provide appropriate allowances for the jobs under analysis.
CO 7: Students will be able to assess the occupational environmental factors like heat stress, noise, and vibration and RSPM level in the industry.

DETAILED SYLLABUS

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]

Course Objectives
This course will present the theory and methods of quality monitoring including process capability, control charts, acceptance sampling etc. to give the participants the necessary tools for the development of efficient statistical methods for the assurance of quality in manufacturing & service environments. It is of major concern that the participants learn to assess the efficiency of various methods under consideration in relation to the specific areas of application.
Course Outcomes
CO 1: To develop an ability to apply the basic concepts of quality monitoring and ISO 9000.
CO 2: Formulate an (the) adequate statistical control problem for a production or similar process &use alternative statistical methods for solving the process control problem.
CO 3: Student shall be able to demonstrate improvement in formation of defectives by comparing alternative process control methods concretely (numerically) & in general.
CO 4: Use attribute sampling methods & assess economics of inspection for choosing an inspection strategy (No Inspection, Sampling Inspection & 100% Inspection).
CO 5: Estimate and test quality measures in general by means of modern and relevant statistical tools.

DETAILED SYLLABUS

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]

Course Objectives
The course aims at building capabilities in the students for analyzing different situations in the industrial/ business scenario involving limited resources and finding the optimal solution within constraints.
Course Outcomes
CO 1: Analyze any real life system with limited constraints and depict it in a model form.
CO 2: Convert the problem into a mathematical model.
CO 3: Solve the mathematical model manually as well as using soft resources/software such as solver, TORA etc.
CO 4: Understand variety of problems such as assignment, transportation, travelling salesman etc.
CO 5: Solve the problems mentioned in point 4 using linear programming approach using software.
CO 6: Understand different queuing situations and find the optimal solutions using models for different situations.
CO 7: Simulate different real life probabilistic situations using Monte Carlo simulation technique.

DETAILED SYLLABUS

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]

Course Objectives
To make the students gain knowledge about the working of various components of auto mobiles.
Course Outcomes
CO 1: Student will be able to understand the theory and the construction of clutches, brakes, cams.
CO 2: Student will be able to understand the mechanisms for transmission of power from engine to wheels.
CO 3: Student will be able to understand the design of the tyres for the given set of condition.
CO 4: Student will be able to understand the importance of noise level, Engine emission norms, vibrations and safety in automobiles.
CO 5. Student will be able to understand the alternative fuels, energy conservations and hybrid systems and other advancements.

DETAILED SYLLABUS

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]

Course Objectives
The main objectives of this lab course is to make the students practice on machine tools so that they can identify, manipulate and control various process parameters during machining processes in manufacturing industry.
Course Outcomes
CO1. Students will become familiar with fundamental principles of metal cutting.
CO2. Students will be able to identify various process parameters and their influence on surface properties of various metals.
CO3. Students will be able to recommend appropriate speed, feed and depth of cut for various processes on lathe machine.
CO4. Students will be able to position, hold and locate work material and cutting tools.
CO5. Shall be able to control various parameters on EDM for better material removal rate and better surface finish.

LIST OF EXPERIMENTS

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]

Course Objectives
To inculcate the skill among the students for analysing and improving existing methods of working on the shop floor of an organisation. To impart through time study skill among the students through applying various allowances, rating practices, and calculate the standard time for manual operations in an organisation. To inculcate the analysing skills among the students w.r.t. work place design, working postures and lifting tasks. To provide thorough knowledge about assessment about exposure to occupational hazards like: heat stress, noise, vibrations and RSPM. To impart skill for conducting hearing conservation and respiratory health prevention in the industry.
Course Outcomes
CO1. Students will be able to calculate the basic work content of a specific job for employees of an organisation. Thereby they will be able to calculate the production capacity of man power of an organisation.
CO2. Students shall be able to analyse the existing methods of working for a particular job and develop an improved method.
CO3. Students shall be able to rate a worker engaged on a live job and calculate basic, allowed and standard time for the same.
CO4. Students shall be able to provide appropriate allowances for the jobs under analysis.
CO5. Students shall be able to analyze and calculate the level of risk of the job causing stress, fatigue and musculoskeletal disorders among the employees of an organization.
CO6. Students shall be able to assess the occupational environmental factors like heat stress, noise, vibration and RSPM level in the industry.

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]

Course Objectives
This objective of the course is to introduce the students with various aspects of marketing, including strategic marketing planning, marketing research, product planning and development, promotion planning, distribution and pricing. The students should be able to participate in different steps of management i.e. research, planning, organization, implementation and control of marketing.
Course Outcomes
CO 1 Students shall be able to calculate the cost and selling price of a product.
CO 2 Students shall be able to design appropriate promotional strategies to motivate consumers, traders and sales force.
CO 3 Students shall be able to analyze and improve the marketing performance of an organization.
CO 4 Students shall work to identify and solve the consumer problems.
CO 5 Students will use marketing research to gauge and address various marketing issues.
CO 6 Students shall be able to motivate and lead the sales team towards achievement of organizational sales and other marketing objectives.
CO 7 Students will practice the societal marketing concept to minimize the long term ill effects of their products and offerings on society.

DETAILED SYLLABUS

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]

Course Objectives
Fluid mechanics describes all the physical laws that govern the flow of fluid and gases and helps us to recognize the causes and effects of fluid flow through the determination of characteristic parameters like pressure field, velocity field in a fluid flow along with different properties of fluid like density, viscosity and mainly an interrelation between these two and in different situation not only the flow of fluid but also the case when fluid is at rest.
Course Outcomes
CO 1: Understand the behaviour of fluids at rest as well as in motion and utilizing the principles develop in previous mechanics courses.
CO 2: Develop the principles and equations for pressure flow and momentum analysis.
CO 3: Provide the students with the analysis and design principles for water distribution and pressure flow system design (pressure flow, pumps and network analysis).
CO 4: Illustrate and develop the equations and design principles for open channel flow, including sanitary and storm sewer design and flood control hydraulics.
CO 5: Introduce the varied flow principles and their application. Discuss the use of software-based solutions etc.
CO 6: Students will understand the working of different types of turbines and be able to design their parts such as blades, casing, draft tube etc.

DETAILED SYLLABUS

Section A

Introduction of Fluid Properties: Engineering units of measurement, mass, density, specific weight, volume and gravity, surface tension, capillarity, viscosity, compressibility and bulk modulus of elasticity, pressure and vapour pressure.

Fluid Statics: Pressure at a point, pressure variation in static fluid, absolute and gauge pressure, Manometers, Hydrostatic forces on plane and curved surfaces (Problems on gravity dams); Buoyant force, Stability of floating and submerged bodies- Metacentre.

Kinematics of Flow: Types of flow – Ideal & real, steady & unsteady, uniform & non-uniform, one, two and three dimensional flow, path lines, streak-lines, streamlines and stream tubes, continuity equation for one and three dimensional flow, Rotational and irrotational flow, Laminar and Turbulent Flow, Circulation, Velocity potential, Stream function, Flow nets.

Section B

Dynamics of Flow: Euler's equation of motion along a streamline and derivation of Bernoulli's equation and its application Fluid measurements: Velocity Measurements (Pitot tube), Flow Measurement (Venturi-meter, Orifice meter, Nozzles, Mouth pieces, Rotameter)**,** Energy correction factor, Linear momentum equation for steady flow, Momentum correction factor.

Dimensional Analysis and Similitude and Modelling: Dimensional analysis, dimensional homogeneity, use of Buckingham-pi theorem, calculation of dimensionless numbers, similarity laws, specific model investigations.

Laminar and Turbulent Flow: Introduction to laminar and turbulent flow, Reynolds experiment and Reynolds number, relation between shear and pressure gradient, laminar flow through circular 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 Wiesbach's Equation, Drag force on flat plate, Rough and smooth boundary.

Section C

Impact of jet: Forces on fixed and moving vanes and other applications

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

Books Recommended:

1. White Frank M., Fluid Mechanics, McGraw Hill Companies, Third edition, 2005
2. CengelYunis 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]

Course Objectives
This subject provides students with the basic system concept and definitions of system; the practical concepts of different types of distribution and their relevance to represent real life data; techniques to model and to simulate various systems; and the ability to analyze a system, to make use of the information to improve the performance and to learn how the system would perform in its working environment.
Course Outcomes
CO1: The students will be able to apply the knowledge of probability concepts to understand system concept
CO2: The students will be able understand the behaviour of a system and apply functional modeling methods to design the activities of a system.
CO 3: The students will be able to simulate the operation of a system and make improvements in the working of system according to the simulation results.
CO 4: The students will be able to apply modern simulation technology methods for problem solving under different types of real life complex problems of business and industry.

DETAILED SYLLABUS

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]

Course Objectives
The main objective of this course is to enable the students to be trained with planning/production and plant layouts, studying about strategies of material handling and equipments, and selection of site locations. It also aims to explore the layout planning by computer applications following different algorithms.
Course Outcomes
CO 1: The students will be able to select appropriate location for establishing industrial plants by applying the concepts of location selection.
CO 2: The students will be able to plan and design plant and production layouts through basic strategies and with computer applications.
CO 3: The students will be able to identify and analyse the problems in the existing layout/ material handling system and shall be able to the optimize the layout/ material handling system
CO 4: The students will be able to develop algorithms for new planning layouts for typical applications in the industries and Suggesting appropriate material handling strategies in the industries.

DETAILED SYLLABUS

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]

Course Objectives
The objective of the course is to provide the students the knowledge of modern manufacturing processes such as Ultrasonic machining, Abrasive machining processes, Electrochemical machining, Electro discharge machining & their modifications into hybrid processes. Also to introduce them to advanced topics such as Laser beam welding/machining, Electron beam welding/machining & state of art in various research areas.
Course Outcomes
CO1. Students will be able to categorize different material removal, joining processes as per the requirements of material being used to manufacture end product.
CO2. Students will be able to select material processing technique with the aim of cost reduction, reducing material wastage & machining time.
CO3. Students will be able to identify the process parameters affecting the product quality in various advanced machining of metals/ non-metals, ceramics and composites.
CO4. Students will be able to combine & develop novel hybrid techniques from the state of art techniques available.
CO5. Students will be able to perform process analysis taking into account the various responses considered in a process.

DETAILED SYLLABUS

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, working principal of Plasma arc machining.

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. "Advanced Machining Processes" V.K. Jain, Allied Publishers Pvt. Ltd.
2. "Modern Machining Processes" P.C Pandey & H.S. Shan, McGraw Hill Education.
3. "Materials and Processes in Manufacturing" (8th Edition), E. P. DeGarmo, J. T Black, R. A. Kohser, Prentice Hall of India, New Delhi.
4. "Manufacturing Science" A. Ghosh, and A. K. Mallik, Affiliated East-West Press Pvt. Ltd. New Delhi.
5. "Nontraditional Manufacturing Processes", G.F. Benedict, Marcel Dekker, Inc. New York.
6. Rao P N, "Manufacturing Technology", Tata McGraw Hill Publilishing Company.
7. Mishra P K,"Non Conventional Machining", Narosa Publishers.
8. Singh K K "Unconventional Manufacturing Processes" Dhanpat Rai & Company, New Delhi.

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

Course Objectives
1. To compare the results of analytical models introduced in lecture to the actual behavior of real fluid flows *2. To discuss and practice standard measurement techniques of fluid mechanics and their applications.* *3. To understand important concepts about fluid machines dedicated to energy conversion systems and criteria for design.*
Course Outcomes
CO1. Students will be able to apply the practical knowledge of fundamentals of Mechanics for verifying basic principles of fluid flow.
CO2. Students will be able to design systems by applying knowledge learnt in this course for problems related with fluid flow.
CO3. Students will be able to improve the performance of the existing systems through different fluid flow measurement parameters such as velocity, fluid pressure etc.
CO4. Students will be able to solve real life problems concerning fluid flow

LIST OF EXPERIMENTS

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.

SEVENTH SEMESTER

IPX-401 INDUSTRIAL AUTOMATION [3 1 0 4]

Course Objectives
This course provides theoretical and practical aspects of implementing automation in industry. This course offers learning of pneumatics/ hydraulics systems, electrical controls and Programmable logic controllers.
Course Outcomes
CO 1: Students should be able to design and implement automated systems using pneumatics.
CO 2: Students should be able to provide hydraulic solutions for designing automated systems.
CO 3: Students should be able to devise Assembly automated systems using feeders, orienters and escapement devices
CO 4: Students should be able to design and implement electro-pneumatic/hydraulic solutions for automated systems.
CO 5: Students should be able to apply PLC programming and implement it on PLC kits.

DETAILED SYLLABUS

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]

Course Objectives
To emphasize the functioning of natural and human-generated environmental systems for design and implementation of environmental planning and its control measures in manufacturing and service industries in order to address the climate change/environmental issues more effectively and efficiently.
Course Outcomes
CO1: The students will be able to analyze the complex and dynamic interactions between humans and their environment / ecosystem.
CO2: The students will be able to apply professional techniques and procedures for effective environmental planning and its management.
CO 3: The knowledge and awareness of environmental legislations will make the students to contribute to the development of environmental management system design (ISO 14000) at various levels (Company, Municipality, national and international).
CO4: The students will be able to understand the need for environment impact assessment for various projects and will be able to implement the same in the real life situation.

DETAILED SYLLABUS

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.

IPX-405 MATERIALS MANAGEMENT [3 1 0 4]

Course Objectives
To train the students for working as materials managers by providing them knowledge about effective and efficient purchase, different inventory policies and models, effective and efficient stores management, modern techniques like JIT and MRP.
Course Outcomes
CO1. Develop an ability to perform the role of a materials manager in an organization.
CO2. Shall be able to manage the activities of materials manager like purchasing, inventory analysis, storage etc.in a scientific manner.
CO3. Shall be able to improve due date performance through use of MRP techniques with in capacity constraints.
CO4. Shall be able to analyze the inventory situation of a company and suggest improvements.
CO5. Shall be able to practice material planning through modern materials management tools like JIT, DBR etc.
CO6. To lead the teams for effective decision making and coordinate to effect purchase at minimum cost.
CO7. Understand ethical issues in purchasing and negotiations.

DETAILED SYLLABUS

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.
2. Narsimhan, Mcleavey & Billington, "*Production Planning & Inventory Control*", Prentice Hall of India.
3. Dobler Donald W., Burt David N., "*Purchasing and Supply Management*", Tata McGraw Hill.
4. Menon K S, "*Purchasing and Inventory Control*", Wheeler Publishing New Delhi.
5. Krajewski L J and Ritzman L P, "*Operations Management*", Pearson Education Asia.

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

Course Objectives
1. To expose students to fundamental concepts of hydraulic and pneumatic systems. *2. They will learn about electro pneumatic, electro hydraulic circuits and PLC ladder logic* *3. Students will be given basic training on using Robotic arm.*
Course Outcomes
CO1. Students will be able to design systems for industrial problems using pneumatic and hydraulic principles of automation.
CO2. Students will be able to make electrical circuits for control of hydraulic and pneumatic actuators.
CO3. Students will have knowledge about various types of industrial sensors and integrating it in the circuits along with actuators.
CO4. Students should be able to program PLC for industrial automation problems.
CO5. Students will be able to program Robot using a teach pendant.

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 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.

IPX-425 PROJECT PHASE 1

Course Objectives
This course is intended to serve as an opportunity for seventh semester students to apply subjects they have learned thus far to a real-world engineering problem. These projects may be carried out within the institute or may be sponsored by business/industry and require some choices as to the specific engineering tools that will be used. Students work in teams under the supervision of a faculty member who leads the students through this problem-solving process. This course is intended to serve as a precursor to the PROJECT (PHASE - 2) scheduled in the eighth semester. Following tool selection, data gathering, and analysis, the students are required to reach a recommended solution for the project they undertake.
Course Outcomes
CO1. Select tools, gather data, build models, and analyse processes used in projects for business and industry.
CO2. Exhibit professional behaviour in dealing with external clients.
CO3. Demonstrate professional written and verbal presentation techniques.
CO4.Demonstrate competence in planning and scheduling methods
CO5. Use the acquired knowledge for developing novel and innovative prototypes for benefits of society at large.

IPX-423 PRACTICAL TRAINING

Course Objectives
Practical training is intended to serve as an opportunity for students to interact with the real time environment in the industries & apply their learnt principles in tackling the bottlenecks to optimal productivity in industries. Students work in teams under the supervision of an industry personnel who directs the students through this problem-solving process. This training is intended to serve as a precursor to the foray of students into engineering world out of academia scheduled after they graduate from the institute. It is an attempt to introduce the students to the state of art in various industries.
Course Outcomes
CO1. Find & select the bottlenecks to optimal productivity by gathering data, build models, and analyzing processes used in projects for business and industry.
CO2. Exhibit professional behaviour in dealing with clients & teams.
CO3. Demonstrate professional written and verbal presentation techniques.
CO4.Demonstrate competence in planning and scheduling operations.
CO5. Use the acquired knowledge for developing novel, innovative prototypes & solutions for benefits of society at large.

EIGHTH SEMESTER

IPX-402 ENGINEERING ECONOMY [3 0 0 3]

Course Objectives
This course will introduce various concepts and methods of economic analysis in engineering, including the time value of money and its effect on economic decisions, economic equivalence, economic measures of worth, cash flow analysis, equipment depreciation, effects of inflation, decision making under uncertainty, capital budgeting, replacement decisions, and benefit-cost analysis.
Course Outcomes
CO 1: The students will understand the basic concepts and terminology used in engineering economics.
CO 2: The students will be able to use the concepts of cash flows, time value of money in evaluation of investments and projects in real life
CO 3: The students will be able to compare and evaluate alternatives based on present, annual, rate of return, and benefit over cost analyses
CO 4: The students will be able to identify and analyse the impact of depreciation, taxation and other economic factors on feasibility of real life projects.
CO 5: The students will be able to recognize the economic impact of engineering solutions and Conduct sensitivity analysis on key compounding parameters, so as make financially prudent decisions in everyday life.

DETAILED SYLLABUS

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]

Course Objectives
This course provides students theoretical and practical exposure on CAD/CAM software. This course also discusses kinematic, dynamic and controls of Robotics manipulators.
Course Outcomes
CO 1: Students will be able to make 3D models using CAD software like Auto Cad, Pro Engineer.
CO 2: Students should be able to plan the process for manufacturing the part.
CO 3: Students should be able to identify appropriate tooling for manufacturing the part in integrated environment.
CO 4: Students should be able to create MPP and APT programs for manufacturing various parts on CNC machines.
CO 5: Students should be able to select and program Robots for different industrial applications.
CO 6: Students should be able to calculate and prepare programs on MATLAB / SciLab for kinematics, dynamics and controls of rigid manipulators.

DETAILED SYLLABUS

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 CNC Machines-Preventive Maintenance.

Rapid prototyping: - Introduction to rapid prototyping, need of RP in context of batch production, FMS and CIM and it's applications, Basic principles of RP, classification of different RP techniques, advantages of RP.

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/CAM Theory 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]

Course Objectives
With increasing technological and scientific advances, the efficient and effective planning and implementation of major projects is becoming increasingly complex and critical. This course is aimed at providing both basic and some advanced exposure to enable the manager of tomorrow to successfully complete sophisticated projects within the constraints of capital, time, and other resources.
Course Outcomes
CO 1: To develop an ability to apply the concepts of project, life cycle, and systems approach.
CO 2: To develop competency in project scoping, work definition, and work breakdown structure (WBS).
CO 3: To handle the complex tasks of time estimation and project scheduling, including PERT and CPM and tool like MS Project.
CO 4: To exhibit competencies in project costing, budgeting, and financial appraisal in real life problems.
CO 5: Shall be able to exercise project control and management through various tools of cost and schedule variance analysis.
CO 6: Shall be able to demonstrate leadership qualities required for effective governance of projects.

DETAILED SYLLABUS

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]

Course Objectives
1. To expose students for 3D modelling on one of the commercially available software. *2. To impart training to students on CNC lathe and CNC milling machine.* *3. To train students for operation of robotic arm.*
Course Outcomes
CO1. Students will be able to make 3D parts for commonly used mechanical components / products, create assembly and finally generate part prints.
CO2. Students will be able to create programs for various parts on CNC lathe and milling machine manually and using commercially available software
CO3. Students should be able to program robotic arm using teach pendant.

LIST OF EXPERIMENTS

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.

IPX-426 **Project Phase 2**

Course Objectives
This course is intended to serve as an opportunity for eight semester students to apply subjects they have learned thus far to a real-world engineering problem. These projects may be carried out within the institute or may be sponsored by business/industry and require some choices as to the specific engineering tools that will be used. Students work in teams under the supervision of a faculty member who leads the students through this problem-solving process. Following tool selection, data gathering, and analysis, the students are required to reach a recommended solution for the project they undertake.
Course Outcomes
CO1. Select tools, gather data, build models, and analyse processes used in projects for business and industry.
CO2. Exhibit professional behaviour in dealing with external clients.
CO3. Demonstrate professional written and verbal presentation techniques.
CO4.Demonstrate competence in planning and scheduling methods
CO5. Use the acquired knowledge for developing novel and innovative prototypes for benefits of society at large.
CO4.Demonstrate competence in planning and scheduling methods
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DEPARTMENTAL ELECTIVE COURSES

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

Course Objectives
The main objective of this course is to make the students aware of occupational health and safety issues in the industries, environmental laws, safety management laws and their applications. The course also outlines the conventional and advanced strategies for occupational protection, and occupational health assessment methods.
Course Outcomes
CO1. Students will understand the basic laws related to environmental and safety management in the industries.
CO2. Students will be able to formulate and implement new strategies for assuring health and safety issues in the industries.
CO3. Students will learn the compliance requirements for the industries as per the existing regulations such as Factory Act.
CO4. Students will be able to make appropriate decisions for w.r.t. factors affecting occupational health.
CO5. Students will be able to create awareness the humans during assessment of health hazards in their working environment.
CO6. Students will be able to contribute towards making efficient and more comfortable occupational Environment.

DETAILED SYLLABUS

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]

Course Objectives
This course is designed to introduce basic concepts of maintenance and reliability to the students, to introduce various methods of reliability analysis with real time problems with constraints and to make understanding the applications of Reliability and Maintenance analysis in different types of systems.
Course Outcomes
CO1.The students will be able to use statistical tools to characterise the reliability of an item and determine the reliability of a system, and will also understand the application of maintenance strategies in a manufacturing environment;
CO2. The students will be able to establish maintenance strategies according to system characteristics and design transition programs to implement these strategies.
CO3. The students will develop ability in formulating suitable maintenance strategies to enhance system reliability of a manufacturing system
CO4. Student will be able to apply concepts of TPM, RCM, & FMECA in managing the manufacturing organisation with highest possible levels of reliability/ availability.

DETAILED SYLLABUS

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]

Course Objectives
The objective of the course is to provide the student the knowledge of strategic importance of good supply chain design, planning, and operation for every firm. How good supply chain management can be a competitive advantage, what weaknesses in the supply chain can hurt the performance of a firm. The role of e-businesses in supply chain management. Various key Drivers of supply chain performance and how these drivers can be used in practical level. Knowledge of various distribution networks and their applications.
Course Outcomes
CO1. Students will be able to apply the knowledge of Linear Programming to find optimal solutions of Supply Chain & Logistics related problems.
CO2.Students will be able to Interpret and apply the concepts of logistics and supply chain management in improving other functional areas of business organizations.
CO3. Students will be able to understand different types of distribution networks and design a network for meeting a particular strategy of an organization
CO4. Students will have sufficient knowledge to develop models and solve problems by using tools such as Solver, Lingo Etc. and develop interest for research & higher education.
CO5. Students will be able to improve the performance of existing Supply Chains by developing a better decision support system
CO6. Students will be able to save resources for the organizations & make Supply Chains environmental friendly

DETAILED SYLLABUS

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]

Course Objectives
The basic objective of this course to equip the students with the Finite Element Analysis fundamentals and to introduce basic aspects of finite element technology, including domain discretization, polynomial interpolation, application of boundary conditions to enable students to formulate the design problems into FEA.
Course Outcomes
CO1. Students shall be able to demonstrate basic steps involved in FEA.
CO2. Students shall be able to formulate simple problems into finite elements.
CO3. Students shall be able to solve structural, thermal, fluid flow problems.
CO4. Students should be able to use professional-level finite element software students shall be able to solve engineering problems in Solid mechanics, fluid mechanics and heat transfer.
CO5. Students shall be able to derive element matrix equation by different methods by applying basic laws in mechanics and integration by parts.

DETAILED SYLLABUS

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 implementation. 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. S.S.Rao, "The Finite element method", Elsevier.
6. Zienkiewich . O.C., and Taylor . R.L., "The Finite Element Method", McGraw Hill,1991.

IPX-605 FRACTURE MECHANICS [3 0 0 3]

Course Objectives
The objective of this course is to introduce the mathematical and physical principles of fracture mechanics and their applications to engineering design to develop the ability in students to compute the stress intensity factor, strain energy release rate, and the stress and strain fields around a crack tip for linear and nonlinear materials. It will also expand the students' knowledge on experimental methods to determine the fracture toughness and develop the students understanding on the design principle of materials and structures using fracture mechanics approaches.
Course Outcomes
CO 1: Correctly apply fracture mechanics to predict brittle fracture. Identify and describe the basic fracture and fatigue mechanisms
CO 2: Understand crack resistance and energy release rate for crack criticality.
CO 3: Application of Linear Elastic Fracture Mechanics on brittle materials.
CO 4: Students shall be able to identify the plane stress and plane strain conditions based on the shape and size of plastic zones. This concept made them capable to select the type of analysis subjected to plane stress and plane strain condition
CO 5: Correctly identify the cause of failure of a material based on fracture surface observations
CO 6: Understand the relationship between crack tip opening displacement, SIF and ERR and application of such parameters for ductile and brittle materials
CO 7: Understanding of experimental techniques to determine the critical values of parameters at crack tip

DETAILED SYLLABUS

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 testing, Preprocessing 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: Applications of Fracture Mechanics, ASTM USA, Third Edition, 1999

6. Sanford R.J., Principles of Fracture Mechanics, Prentice Hall, Prentice 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]

Course Objectives
After completion of this course the students will be exposed to the key concepts related with Productivity Engineering and Technology Management. Students will understand Productivity measurement and evaluation methods, identify weak productivity areas of organizations, and Productivity improvement techniques. Students will also be exposed to Technology Management and Technology Transfer concepts with a country and across the countries.
Course Outcomes
CO1. The students will be able to apply the knowledge to understand Productivity of an organization, evaluate it, and to find ways and means to improve it
CO2. Students will be able to design the systems for measuring total productivity/total factor productivity/partial productivity in manufacturing and service sectors
CO3. Students will be able to set the targets for meeting productivity levels and in turn improve the performance in different functional areas.
CO4. Students will be able to apply the knowledge and understand the role of technology in economic development
CO5. Students will be able to lead teams for effective governance and developing technology solutions either internally or through technology transfer from outside through Licensing or joint ventures.

DETAILED SYLLABUS

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]

Course Objectives
The course aims at making a student understand the importance of computer based information system, components' of such a system and peculiarities of different stages in development of an information system.
Course Outcomes
CO1. Students will be able to apply the concepts like data, information, normalization etc. in real life.
CO2. Students will be able to help in designing suitable information system for the specific needs of a functional area/organization as a whole
CO3. Students will be able to analyze the errors in the flow of information in an organization and suggest suitable system to rectify this problem.
CO4. Students will have sufficient knowledge of advanced tools like simulation and artificial intelligence and their role in decision making process.
CO5. Students will be able to work as team leaders/co-ordinators in the team created to develop and implement Computer based information system in an organization.

DETAILED SYLLABUS

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.
2. Donald A Waterman, "*A Guide to Expert Systems*", Pearson Education Asia.
3. Banks Jerry [et al.], "*Discrete Event System Simulation*", Pearson Education Asia.
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]

Course Objectives
The objective of this course is to develop ability to identify the properties of fibre and matrix materials used in commercial composites and some common manufacturing techniques, also to predict the elastic properties of both long and short fibre composites based on the constituent properties.
Course Outcomes
CO 1: Students will be able to understand the fundamentals of composite structures, select composite materials and basic design steps.
CO 2: Fiber and matrix composites and their reinforcements. Stability with reference to thermal change, fracture and compressive strength
CO 3: Predict elastic properties of long fibre and short fibre composites
CO 4: Predict hygro-thermal properties of long fibre composite materials. Design of a laminate for a given load condition
CO 5: Describe fundamental fabrication processes for polymer matrix, metal matrix, and ceramic matrix composites
CO 6: Demonstrate the ability to independently analyse and extend a given course subject, compose a report paper and effectively communicate the essentials through an oral presentation

DETAILED SYLLABUS

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.
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]

Course Objectives
The course has been framed with the main objective of introducing the concept of change and its management applicable to the organizations. The students shall be imparted with the knowledge of various types of changes, reengineering, restructuring and competitiveness.
Course Outcomes
CO1: The student shall be able to plan, organize and management change in the organization.
CO2: The student shall be able to trigger change by choosing the appropriate driver thro' creative thinking.
CO3: The student shall be able to identify obstacles to change management and make suitable strategy to remove them.
CO4: The student shall be able to identify and analyze stepped and radical changes in the organization.
CO5: The student shall be able to use scientific tools and theories to estimate competitiveness in an organization.
CO6: The student shall be able to act as change agent in an organization and design the appropriate strategy to make the change.

DETAILED SYLLABUS

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]

Course Objectives
1. First objective is that Students will be taught about smart materials.
2. Students shall be introduced to Nanotechnology.
3. Students will be exposed to technology for Processing of Nano Materials.
Course Outcomes
CO 1: Students will be able to understand the properties and application of various types of smart materials.
CO 2: To Identify sensing and actuating materials. Intelligent system with integrated sensors & actuators
CO 3: Characteristic scale for quantum phenomena, nanoparticles, nano-clusters, nanotubes, nanowires and nan dots
CO 4: Understanding electronic structure of Nano materials like quantum wells quantum dots, quantum wires
CO 5: Processing of nano materials. Understanding various Silicon processing methods.
CO 6: To understand Lithography, Photo lithography, optical lithography, particle beam lithography.
CO 7: Bottom-up techniques: self-assembly, self-assembled monolayer, directed assembly, layer-by-layer assembly.

DETAILED SYLLABUS

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]

Course Objectives
The main objectives of this course is to introduce the concept of non-destructive testing among the students and make them understand various types of non-traditional practices available for manufacturing industry
Course Outcomes
CO1: The student shall be able to select an appropriate NDT technique as per requirement.
CO2: The student shall be able to set various process parameters and control the NDT process for the desired output parameters.
CO3: The student shall be able to find the internal flaws in the material by NDT and take measures to eliminate them.
CO4: The student shall be able to solve various problems encountered like leakage, cracks, blowholes etc with the manufacturing process by analyzing the data.
CO5: the student shall be competent enough to make use of modern tools and softwares for analyzing and solving real life problems.
CO6: The student shall be able to introduce environmental friendly solutions to achieve organizational sustainability.

DETAILED SYLLABUS

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]

Course Objectives
This course provides student opportunity to learn about various sensors and microcontrollers. Using this they will be able to build automated solutions
Course Outcomes
CO1. Select and use appropriate Transducers & Sensors for automated solutions.
CO2. They should be able to design and implements digital logics using various gates.
CO3. Program and implement solutions using various Microcontrollers
CO4. Program and automated solutions using PLC.

DETAILED SYLLABUS

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

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

Course Objectives
The overall aim is for students to develop an understanding of total quality management principles, frameworks, tools and techniques for effective real life applications in both manufacturing and services.
Course outcomes
CO1. Students shall be able to apply the concept of quality, total quality management & determine the impact of quality on profitability.
CO2. Students shall be able to formulate Taguchi's Loss function; analyse & focus on customer requirements using Kano's model.
CO3. Students shall be able to measure the cost of poor quality, process effectiveness and efficiency to track performance quality, identify areas for improvement & carry out improvements.
CO4. Students shall be able to determine the voice of the customer & translate this voice into technical requirements for products/ services and make an assessment of the impact of quality on long-term business success of an organization.
CO5. Students shall be able to apply techniques like QC tools, six sigma etc. for investigating and analyzing quality related issues in the industry and suggest implementable solutions.

DETAILED SYLLABUS

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]

Course Objectives
1. Students will be introduced to CAD/CAM/CAE concepts. *2. Student will learn steps in upgrading from FMS to CIM.* *3. Students will learn about importance of data generation and management in CIMS.*
Course Outcomes
CO1. Students will be able to apply knowledge about Computer Aided Quality control and Process Planning Control.
CO2. Students will be able to Design Flexible manufacturing cell after carrying out Group technology study and finally creating FMS.
CO3. Students will be able to apply knowledge about various methods of communication in CIMS.
CO4. They will able apply data management and its importance for decision making in CIMS environment.

DETAILED SYLLABUS

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.

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]

Course Objectives
1. Students will be introduced to vibration concepts. *2. Students will learn Finite element method for dynamic analysis* *3. Students will be exposed to acoustic concepts.*
Course Outcomes
CO1. Students will understand the basic concepts of vibration and noise control and be able to design systems taking accordingly.
CO2. Students will be able to simulate vibrations generated by rods, bars and beams using finite element method.
CO3. Students will be able to perform Spatial, Modal and Response models of vibrating systems.
CO4. Students will be able to measure sound and vibrations using various sensors and will learn to control them.

DETAILED SYLLABUS

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.

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

Course Objectives
1. *Understand modern manufacturing operations, including their capabilities, limitations, and how to design for lowest cost.* 2. *Understand the designers' influence on manufacturing schedule and cost.* 3. *Analyze products and be able to improve their manufacturability and lower costs.* 4. *Understand the relationship between customer desires, functional requirements, product materials, product design, and manufacturing process selection.* 5. *Able to examine a product and determine how it was manufactured and why.* 6. *Understand the importance of human-factors in manufacturing and assembly, and how it relates to design.* 7. *Understand the use of value stream analysis to lower manufacturing costs.* 8. *Understand the advantages and disadvantages of discrete-event simulation.*
Course Outcomes
CO1: The student shall be able to design casting process and weldments for manufacturing industry.
CO2: The student shall be able to design components and assemblies after performing analysis and feasibility study.
CO3: The student shall be able to simplify the manufacturing process and modify design so as to reduce the cost for manufacturing relevant to manufacturing industry.
CO4: The student shall be able to review and select suitable manufacturing process for reducing part variations and specifications.
CO5: The student shall be able to assess the risks of manufacturing processes and take appropriate measures thro' latest scientific tools available.

DETAILED SYLLABUS

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]

Course Objectives
The main objectives of this course is to make the students familiar with various conventional and new techniques of welding for manufacturing industry.
Course Outcomes
CO1. Students will become more familiar with fundamental principles of joining technology.
CO2. Students will be able to identify hazards during welding and safety measures for the same.
CO3. They will be able to recommend an appropriate material as electrode of filler material for the parent metals to be joined.
CO4. They will be able to differentiate thermal cutting with welding and apply the same in industrial environment.
CO5. Students will be able to recommend appropriate flux during welding a particular metal.
CO6. Students shall be able to understand the advancements in welding techniques and bottlenecks encountered.

DETAILED SYLLABUS

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]

Course Objectives
This course deals with the study of behaviour of solid objects under various types of loading conditions. To impart the insights into the yielding & failure phenomenon of solids. To introduce students to finite element method used to analyze different material problems.
Course Outcomes
CO1. Students will be able to apply the concepts of three-dimensional stress and strain at a point as well as the stress-strain relationships for homogenous and isotropic materials.
CO2. Students will be able to calculate the stresses and strains in axially loaded members, torsion of noncircular cross section members, and members subject to non-symmetrical flexural loading.
CO3. Students will be able to calculate the stresses and strains associated with thick-wall cylindrical pressure vessels and rotating disks.
CO4. Students will be able to determine the stresses resulting from bending of curved beams and flat plates.
CO5. Students will be able to apply the theories of strength and fracture.
CO6. Students will be able to apply energy methods for the determination of the deflections and rotations.
CO7. Students will be able to design beams, cylinders and shafts for allowable stresses and loads.

DETAILED SYLLABUS

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, post processing

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]

Course Objectives
To impart basic knowledge to the students about current energy scenario, energy conservation, audit and management. To inculcate among the students systematic knowledge and skill about assessing the energy efficiency, energy auditing and energy management.
Course Outcomes
CO1. Students will be able to apply the knowledge of the subject to calculate the efficiency of various thermal utilities.
CO2. Students will be able to design suitable energy monitoring system to analyze and optimize the energy consumption in an organization.
CO3. Students will be able to improve the thermal efficiency by designing suitable systems for heat recovery and co-generation.
CO4. Students will be able to use the energy audit methods learnt to identify the areas deserving tighter control to save energy expenditure.
CO5. Students will be able to carry out the cost- benefit analysis of various investment alternatives for meeting the energy needs of the organization.
CO 6. Students will be able to guide the employees of the organization about the need and the methods of energy conservation.

DETAILED SYLLABUS

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, 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]

Course Objectives
The objective of this course is to inculcate the traits of performance management, organizational leadership, motivation and managerial psychology among the students.
Course Outcomes
CO1. Students will be able to learn and apply different scientific management techniques.
CO2 Students will be able to analyze the existing jobs and design suitable jobs to provide certain amount of challenge and job satisfaction
CO 3 Students will be able to analyze and resolve the real life conflicts
CO4 Student will have sufficient knowledge to undertake behavioural research projects in the organizations
CO5 Student will develop an ability to work in the work groups and communicate effectively
CO6 Students will be able to design suitable test procedures to test special abilities and personality traits of the different candidates

DETAILED SYLLABUS

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 (5th 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]

Course Objectives
1. *Understand the fundamentals of how the design and operation of internal combustion engines affect their performance, operation, fuel requirements, and environmental impact. Topics include fluid flow, thermodynamics, combustion, heat transfer and friction phenomena, and fuel properties, with reference to engine power, efficiency, and emissions.* 2. *Students examine the design features and operating characteristics of different types of internal combustion engines: spark-ignition, diesel, stratified-charge, and mixed-cycle engines.* 3. *Understand technical features for various types of compressors.* 4. *Select optimal type and size of equipment for a given industrial application.*
Course Outcomes
CO1. Student will be able to understand various air standard cycles.
CO2. Student will be able to calculate valve timing diagram for engines and test the performance engines.
CO3. Student will be able to understand the process of fuel combustion and calculate its values under different conditions.
CO4. Student will be able to analyze the effect of diesel and petrol vehicles on environment.
CO5. Student will be able to understand and design cooling system for IC engines.
CO6. Student will be able to calculate he performance parameters of rotary and reciprocating compressors.

DETAILED SYLLABUS

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]

Course Objectives
The objective of this course is to provide a sound foundation in probability with an emphasis on model building, covering inventory models, queuing models and Markov chains. The course provides the background for simple analytical derivation and numerical calculations for stochastic processes in discrete and continuous time.
Course Outcomes
CO1. Students shall be able to recognize when stochastic methods are likely to be appropriate and investigate the long-run behavior of simple stochastic processes in discrete & continuous time; namely, Markov chains.
CO2. Students shall be able to formulate and solve probabilistic problems using random variables.
CO3. Students shall be able improve the performance of systems such as inventory / production control using stochastic models.
CO4. Students shall be able to solve real life situations using queuing systems under different configurations.
CO5. Students shall be able develop skill in analysing systems and finally arriving at optimal solutions such as optimal leasing of phone lines, optimal number of tellers etc.

DETAILED SYLLABUS

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-Term 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]

Course Objectives
The course aims at building capabilities in the students for analyzing different situations in the industrial/ business scenario involving limited resources and finding the optimal solution within constraints by using advanced optimization tools.
Course Outcomes
CO1. The students will be able to analyze the real life systems with limited constraints
CO2.The students will be able to depict the systems in a mathematical model form.
CO3.The students will be to solve the mathematical model manually as well as using soft resources/software such as solver, TORA etc. under the given constraints
CO4. Understand variety of real industrial problems such as resource allocation, production planning, assignment, transportation, travelling salesman etc. and solve these problems using linear programming approach using software

DETAILED SYLLABUS

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]

Course Objectives
1. Students will be introduced to processing of glass and ceramics. *2. Students will learn about Rubbers and plastics.* *3. Finally they will learn about processing of composite materials.*
Course Outcomes
CO1: The student shall be able to prepare different plastics and composites in industrial environment.
CO2: The student shall be able to design various mechanical components after analysis of mechanical properties.
CO3: The student shall be able to improve the performance of components and assemblies by devising new materials within realistic constraints.
CO4: The student shall be able to identify the material properties and replace metals by non-metals within real life situations.
CO5: The student shall be able to analyze mechanical properties of metals and non-metals using scientific tools available.

DETAILED SYLLABUS

Section A

Introduction: Classification of engineering materials and processing techniques, structure and properties of non-metals.

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.
3. Composite Materials: Engineering and Science: F.L. Mathews and R.D. Rawlings, CRC press.
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]

Course Objectives
1. Students will be introduced to technology for development of micro electromechanical systems. *2. Students are taught Principal of Microsystems.* *3. Students are exposed to Microsystem Fabrication Process and Manufacturing.*
Course Outcomes
CO1. Students will explain MEMS Technology, Present, Future and Challenges.
CO2. Students will be able to explain micro sensors, micro-actuators, their types and applications.
CO3. Students will be able to explain about fabrication processes for producing micro-sensors and actuators. They will also be able to apply Reliability, and Failure Analysis Testing.

DETAILED SYLLABUS

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]

Course Objectives
To provide basic understanding to the students about the concept and significance of Human Factors Engineering, through imparting knowledge about visual, auditory and cognitive aspects of human factors. To inculcate the skill among the students for analysing human systems integration and improving overall decision making and the performance of the system. To inculcate analysing skills among the students with respect to work place design, working postures and lifting tasks. To provide thorough knowledge about assessment about occupational exposure to heat stress, noise, vibrations and RSPM.
Course Outcomes
CO1. Students will be able to apply the basic knowledge of effect of factors like visual, auditory and cognitive on performance to design suitable work systems.
CO2. The students will be able to analyze the factors affecting decision making and improve the same.
CO3. Students shall be able to analyse and calculate the level of risk in a job causing stress, fatigue and musculoskeletal disorders among the employees of an organisation and will design a suitable system to reduce the same.
CO4. Students shall be able to assess level of occupational environmental factors like heat stress, noise, vibration and RSPM in a company.

DETAILED SYLLABUS

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]

Course Objectives
To develop fundamental understanding and the role of materials to allow surface selection for mechanical contact surfaces.
Course Outcomes
CO1. Students will be able to understand failure micro mechanisms occurring for different service conditions.
CO2. Students will be able to relate the micro mechanism failure to optimize surface engineered microstructures.
CO3. Students will be able to identify appropriate testing approaches to evaluate service performance.
CO4. Students will be able to analyze real life surface failure problems and determine the correct surface engineering solution by applying contact mechanics.
CO5. Students will be able to analyze complex data and propose appropriate engineering solutions.

DETAILED SYLLABUS

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 Publishing.

DEPARTMENTAL OPEN ELECTIVE COURSES

IPX-629 INDUSTRIAL ENGINEERING [3 0 0 3]

Course Objectives
This course covers selected topics in the vast field of Industrial Engineering which is primarily concerned with the design and continuous improvement of systems by effectively integrating people, processes and technology. Quality and productivity improvement are critical issues.
Course Outcomes
CO1. Students shall be able to apply selected industrial engineering techniques for enhancing productivity in an organization.
CO2. Students shall be able to carry out work system design using principles of motion economy & ergonomics.
CO3. Students shall be able to manage projects& improve the performance of routine activities by application of appropriate industrial engineering tools.
CO4. Students shall be able to determine functions of a product/service & apply Value Engineering in real life problems.
CO5. The students will be able to optimize the inventory levels, carry out planning & design of Facilities at various levels.

DETAILED SYLLABUS

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]

Course Objectives
The objective of this course is to develop an ability in the students to understand and analyze managerial problems in industry so that they are able to use resources (capitals, materials, staffing, and machines) more effectively, formulate mathematical models for quantitative analysis of managerial problems in industry and develop skills in the use computer tools in solving real problems in industry.
Course Outcomes
CO1. Students shall be able to use variables for formulating complex mathematical models in management science, industrial engineering and transportation science.
CO2. Students will be able to use various software packages such as Lingo, Solver, and TORA for solving linear programming and integer programming models.
CO3. Students will be able to solve real life problems related with transportation and assignment problems, queuing theory etc.
CO4. Understand and apply different algorithms for solving goal or integer programming, nonlinear programming problems.
CO5. Understand genetic algorithms, Binary/Real coded GAs for constrained optimization, and simulated annealing, ant colonies, particle swarm optimization.

DETAILED SYLLABUS

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.