ANNA UNIVERSITY CHENNAI :: CHENNAI 600 025

UNIVERSITY DEPARTMENTS

CURRICULUM – R 2009

B.E. (PART TIME) INDUSTRIAL ENGINEERING

SEMESTER I

CODE NO	COURSE TITLE	L	T	P	C
PTMA9111	Applied Mathematics	3	0	0	3
PTPH9111	Applied Physics	3	0	0	3
PTCY9111	Applied Chemistry	3	0	0	3
PTGE9112	Fundamentals of Computing	3	0	0	3
PTGE9151	Engineering Mechanics	3	0	0	3
	TOTAL	15	0	0	15

SEMESTER II

CODE NO	COURSE TITLE	L	T	P	C
PTPH9165	Material science	3	0	0	3
PTGE9261	Environmental science and Engineering	3	0	0	3
PTEC9161	Electronics Engineering	3	0	0	3
PTCE9213	Strength of Materials	3	0	0	3
PTME9211	Mechanics of Machines	3	0	0	3
	TOTAL	15	0	0	15

SEMESTER III

CODE NO	COURSE TITLE	L	T	P	C
PTMA9261	Probability and Statistics	3	0	0	3
PTIE9202	Operations Research -I	3	0	0	3
PTIE9201	Work system Design	3	0	0	3
PTME9305	Design of Machine elements	3	0	0	3
PRACTIAL					
PTIE9203	Work system Design Laboratory	0	0	3	2
	TOTAL	15	0	0	14

SEMESTER IV

CODE NO	COURSE TITLE	L	T	P	C
PTIE9302	Operations Research -II	3	0	0	3
PTIE9304	Applied Ergonomics	3	0	0	3
PTIE9305	Manufacturing Automation	3	0	0	3
PTIE9355	Production Planning and Control	3	0	0	3
PRACTIAL					
PTIE9357	Statistical Application and Optimization lab	0	0	3	2
	TOTAL	12	0	3	14

SEMESTER V

CODE NO	COURSE TITLE	L	T	P	C
PTIE9354	Facilities Layout and Material Handling	3	0	0	3
PTIE9251	Engineering Economy, Costing and Accounting	3	0	0	3
PTIE9033	Supply Chain Management	3	0	0	3
PTIE9303	Statistical Quality Control	3	0	0	3
PTGE9021	Professional Ethics in Engineering	3	0	0	3
	TOTAL	15	0	0	15

SEMESTER VI

CODE NO	COURSE TITLE	L	T	P	C
PTIE9402	Simulation Modeling and Analysis	3	0	0	3
PTGE9022	Total Quality Management	3	0	0	3
	Elective – I	3	0	0	3
	Elective –II	3	0	0	3
PTIE9356	Communication Skills and Production System Design Project	0	0	3	2
	TOTAL	12	0	3	14

SEMESTER VII

CODE NO	Course title	L	T	P	C
PTIE9401	Design of Experiments	3	0	0	3
PTIE9301	Principles of Management	3	0	0	3
	Elective – III	3	0	0	3
	Elective –IV	3	0	0	3
PTIE9451	Project Work	0	0	12	6
	TOTAL	12	0	12	18

TOTAL NUMBER OF CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE:105

LIST OF ELECTIVES

S.NO.	CODE NO	COURSE TITLE	L	T	P	C
1.	PTIE9021	Productivity Management and Re-engineering	3	0	0	3
2.	PTIE9022	Safety Engineering and Management	3	0	0	3
3.	PTIE9023	Human Resource Management	3	0	0	3
4.	PTIE9024	Information Systems Analysis and Design	3	0	0	3
5.	PTIE9026	Value Engineering and Project Management	3	0	0	3
6.	PTIE9027	Technology Management	3	0	0	3
7.	PTIE9028	Modeling of Manufacturing Systems	3	0	0	3
8.	PTIE9030	Decision Support and Intelligent Systems	3	0	0	3
9.	PTIE9032	Systems Engineering	3	0	0	3
10.	PTIE9034	Maintenance Engineering and Management	3	0	0	3
11.	PTIE9352	Principles of Computer Integrated Manufacturing Systems	3	0	0	3
12.	PTIE9353	Reliability Engineering	3	0	0	3
13.	PTIE9403	Operations Scheduling	3	0	0	3
14.	PTME9021	Energy Conservation Management	3	0	0	3
15.	PTME9029	Automobile Engineering	3	0	0	3
16.	PTME9301	Design of Jigs, Fixtures and Press Tools	3	0	0	3
17.	PTME9351	Finite Element Analysis	3	0	0	3
18.	PTMF9021	Product Design and Development	3	0	0	3
19.	PTMF9031	Robotics	3	0	0	3
20.	PTMF9035	Electronics Manufacturing Technology	3	0	0	3
21.	PTMF9402	Flexible Manufacturing Systems	3	0	0	3
22.	PTMG9071	Marketing Management	3	0	0	3
23.	PTMG9072	Entrepreneurship Development	3	0	0	3
24.	PTPT9071	Packaging Materials and Technology	3	0	0	3

PTMA 9111 **APPLIED MATHEMATICS** **L T P C**
(Common to all branches of B.E / B.Tech (PT) Programmes) **3 0 0 3**

UNIT I MATRICES 9
Characteristic equation – Eigenvalues and Eigenvectors of a real matrix – Properties of eigenvalues and eigenvectors – Cayley – Hamilton Theorem – Diagonalization of matrices - Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms .

UNIT II FUNCTIONS OF SEVERAL VARIABLES 9
Partial derivatives – Homogeneous functions and Euler's theorem – Total derivative – Differentiation of implicit functions – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables - Maxima and minima of functions of two variables.

UNIT III ANALYTIC FUNCTION 9
Analytic functions – Necessary and sufficient conditions for analyticity – Properties – Harmonic conjugates – Construction of analytic function – Conformal Mapping – Mapping by functions $w = a + z$, az, $1/z$, **-** Bilinear transformation.

UNIT IV COMPLEX INTEGRATION 9
Line Integral – Cauchy's theorem and integral formula – Taylor's and Laurent's Series – Singularities – Residues – Residue theorem – Application of Residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour with no pole on real axis.

UNIT V LAPLACE TRANSFORMS 9
Existence conditions – Transforms of elementary functions – Basic properties – Transforms of derivatives and integrals – Initial and Final value theorems – Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear ordinary differential equations with constant coefficients.

TOTAL: 45 PERIODS
TEXT BOOKS:
1. Grewal B.S., Higher Engineering Mathematics (40th Edition), Khanna Publishers, Delhi (2007).
2. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill Co. Ltd., New Delhi (2007).

REFERENCES:
1. Glyn James, Advanced Modern Engineering Mathematics, Pearson Education (2007).
2. Veerarajan, T., Engineering Mathematics (For First Year), Tata McGraw-Hill Pub. Pvt Ltd., New Delhi (2006).

PTPH9111   **APPLIED PHYSICS**   **L T P C**
                                                                       3 0 0 3

UNIT I   ULTRASONICS   9
Introduction – Production – magnetostriction effect - magnetostriction generator-piezoelectric effect - piezoelectric generator- Detection of ultrasonic waves properties – Cavitations - Velocity measurement – acoustic grating - Industrial applications – drilling, welding, soldering and cleaning – SONAR - Non Destructive Testing – pulse echo system through transmission and reflection modes - A, B and C –scan displays, Medical applications - Sonograms

UNIT II   LASERS   9
Introduction – Principle of Spontaneous emission and stimulated emission. Population inversion, pumping. Einstein's A and B coefficients - derivation. Types of lasers – He-Ne, CO_2, Nd-YAG, Semiconductor lasers- homojunction and heterojunction (Qualitative)- Industrial Applications - Lasers in welding, heat treatment and cutting – Medical applications - Holography (construction and reconstruction).

UNIT III   FIBER OPTICS & APPLICATIONS   9
Principle and propagation of light in optical fibres – Numerical aperture and Acceptance angle - Types of optical fibres (material, refractive index, mode) – Double crucible technique of fibre drawing - Splicing, Loss in optical fibre – attenuation, dispersion, bending - Fibre optical communication system (Block diagram) - Light sources - Detectors - Fibre optic sensors – temperature and displacement - Endoscope.

UNIT IV   QUANTUM PHYSICS   9
Black body radiation – Planck's theory (derivation) – Deduction of Wien's displacement law and Rayleigh – Jeans' Law from Planck's theory – Compton effect - Theory and experimental verification – Matter waves – Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one-dimensional box - Electron microscope - Scanning electron microscope - Transmission electron microscope.

UNIT V   CRYSTAL PHYSICS   9
Lattice – Unit cell – Bravais lattice – Lattice planes – Miller indices – 'd' spacing in cubic lattice – Calculation of number of atoms per unit cell – Atomic radius – Coordination number – Packing factor for SC, BCC, FCC and HCP structures – NaCl, ZnS, diamond and graphite structures – Polymorphism and allotropy - Crystal defects – point, line and surface defects- Burger vector.

                                                              TOTAL: 45 PERIODS

TEXT BOOKS:
1. Palanisamy, P.K., 'Engineering Physics' Scitech publications, Chennai, (2008).
2. Arumugam M. ' Engineering Physics', Anuradha Publications, Kumbakonam,(2007)
3. Sankar B.N and Pillai S.O. 'A text book of Engineering Physics', New Age International Publishers, New Delhi, 2007.

REFERENCES:
1. R. K. Gaur and S.C. Gupta, 'Engineering Physics' Dhanpat Rai Publications, New Delhi (2003)
2. M.N. Avadhanulu and PG Kshirsagar, 'A Text book of Engineering Physics', S.Chand and company, Ltd., New Delhi, 2005.
3. Serway and Jewett, 'Physics for Scientists and Engineers with Modern Physics', 6th Edition, Thomson Brooks/Cole, Indian reprint (2007)

PTCY9111 **APPLIED CHEMISTRY** **L T P C**
3 0 0 3

UNIT I WATER TREATMENT AND POLLUTION CONTROL 9
Treatment of water –impurities and disadvantages of hard water-Domestic and Industrial treatment - zeolite and ion exchange processes-Portable water-Boiler feed water – conditioning of boiler feed water. Scale and sludge formation –prevention –caustic embrittlement-boiler corrosion–priming and foaming Sewage treatment–Primary, secondary and tertiary treatment–significance of DO, BOD and COD-desalination – reverse osmosis. Control of water,air and land pollution.

UNIT II FUELS 9
Classification of fuels-Proximate and ultimate analysis of coal- coke manufacture-Otto Hoffman by product method-cracking-thermal and catalytic (fixed bed and fluidized bed)-petroleum-refining-factions-composition and uses synthetic petrol-fischer drops methods- Bergius process- knocking-octane number and cetane number-Preparation, composition and uses of producer gas , water gas and natural gas. Flue gas analysis-Orsat apparatus- gross and net calorific values- calculation of minimum requirement of air(simple calculations)- Explosive range –spontaneous ignition temperature

UNIT III THERMODYNAMICS AND SURFACE CHEMISTRY 9
Second law of thermodynamics-entropy and its significance- criteria for spontaneity- free energy-Gibbs, Helmholts and Gibbs-Helmholts equation-applications and problems – Adsorption –types of adsorption- adsorption of gases on solids- adsorption isotherm-Freundlich and Langmuir isotherms-adsorption of solutes from solutions- applications

UNIT IV ELECTROCHEMISTRY - CORROSION AND CATALYSIS 9
Reversible and irreversible cells-electrode potentials-types of electrodes-cell reactions-Nernst equations- electrochemical and galvanic series-fuel cells and solar cells-corrosion-chemical and electrochemical-factors affecting corrosion-sacrifical anode-impressed current cathodic protection-surface treatment and protective coating-Catalysis –classification-characteristics of catalysis – auto catalysis- enzyme catalysis

UNIT V POLYMERS-COMPOSITES AND NANOCHEMISTY 9
Polymers-definition-classification-thermoplastics and thermosetting plastics differences Preparation, properties and uses of polystyrene, bakelite, PET, polyurethane, Teflon, ureafromaldehyde, polycarbonates-Elastomers-Preparation, properties of Buna-S, nitrile, neoperene and butyl rubber, silicon rubber. Composites - FRP. Nanochemistry-introduction to nanochemistry- preparation and properties of nonmaterial-nano rods, nano wires-nanotubes-carbon nanotubes and their applications.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Dhara S S A text book of Engineering Chemistry, S.Chand & Co Ltd, New Delhi,2002
2. Jain. P.C and Monica Jain, Engineering Chemistry,Dhanpet Rai & Sons, New Delhi 2001.

REFERENCES:
1. Puri B R.,Sharma L R and Madhan S. Pathania, Principles of Physical Chemistry, Shoban Lal Nagin Chand & Co. Jalandar-2000.
2. G.B. Sergeev, Nanochemistry.Elsevier Science, New York,2006
3. V.R.Gowarikar, N.V.Viswanathan and Jayadev Sreedhar, Polymer Science, Wiley Eastern Limited, Madras (2006).

PTGE9112　　　　　**FUNDAMENTALS OF COMPUTING**　　　　　**L T P C**
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UNIT I　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　**9**
Computer systems – Exploring computers – Inside the system – processing data – CPUs – Types of storage devices - Operating systems basics – networking basics.

UNIT II　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　**9**
The internet and the WWW – Internet services – connecting to the internet - Working with applications software – productivity software – graphics and multimedia – Data base Management systems – Creating computer program.

UNIT III　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　**9**
C programming fundamentals – compilation process – variables – Data types – Expressions – looping – decisions.

UNIT IV　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　**9**
Arrays - Working with functions – structures – character strings – pre processor.

UNIT V　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　**9**
Pointers – Dynamic memory allocation – linked list - Applications

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Peter Norton,   "Introduction to Computers", Sixth Edition, Tata McGraw Hill, 2007.
2. Stephen G. Kochan, "Programming in C", Third Edition, Pearson Education, 2007.

REFERENCES:
1. B.W.Kernighan and D.M.Ritchie, "The C Programming language", Second Edition,
2. Pearson Education, 2006
3. Ashok N. Kamthane, "Computer programming", Pearson Education, 2007.
4. Kenneth A. Reek, "Pointers on C", Pearson Education, 2007.
5. R.G.Dromey, "How to solve it by Computer", Pearson Education, 2007.

PTGE9151　　　　　**ENGINEERING MECHANICS**　　　　　**L T P C**
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AIM:
To introduce the basic principles which help to understand motion and/or forces involved in engineering applications

OBJECTIVE:
At the end of this course the student should be able to understand the vectorial and scalar representation of forces and moments, static equilibrium of particles and rigid bodies both in two dimensions and also in three dimensions. Further, he should understand the principle of work and energy. He should be able to comprehend the effect of friction on equilibrium. The student should be able to understand the laws of motion, the kinematics of motion and the interrelationship. The student should also be able to write the dynamic equilibrium equation. All these should be achieved both conceptually and through solved examples.

UNIT I   BASICS & STATICS   9
Introduction - Units and Dimensions - Laws of Mechanics – Lame's theorem, Parallelogram and triangular Law of forces – Vectors – Vectorial representation of forces and moments – Vector operations on forces, dot product and cross product - Coplanar Forces – Resolution and Composition of forces – Equilibrium of a forces – Forces in space - Equilibrium in space - Equivalent systems of forces – Principle of transmissibility – Single equivalent force

UNIT II   EQUILIBRIUM OF RIGID BODIES   9
Free body diagram – Types of supports and their reactions – requirements of stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem - Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions – Examples

UNIT III   PROPERTIES OF SURFACES AND SOLIDS   9
Determination of Areas and Volumes – First moment of area and the Centroid of standard sections – T section, I section, Angle section, Hollow section – second and product moments of plane area – Rectangle, triangle, circle - T section, I section, Angle section, Hollow section – Parallel axis theorem and perpendicular axis theorem – Polar moment of inertia – Principal moments of inertia of plane areas – Principal axes of inertia - Mass moment of inertia – Derivation of mass moment of inertia for rectangular solids, prism, rods, sphere from first principle – Relation to area moments of inertia.

UNIT IV   DYNAMICS OF PARTICLES   9
Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion – Newton's law – Work Energy Equation of particles – Impulse and Momentum

UNIT V   CONTACT FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS 9
Frictional force – Laws of Coloumb friction – simple contact friction – Rolling friction – Belt friction Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion – Impact of elastic bodies

TOTAL: 45 PERIODS

TEXT BOOK:
1. Beer,F.P and Johnson Jr. E.R, "Vector Mechanics for Engineers", Vol. 1 Statics and Vol. 2 Dynamics, McGraw-Hill International Edition, 2007.

REFERENCES:
1. Irving H. Shames, Engineering Mechanics - Statics and Dynamics, IV Edition – PHI / Pearson Education Asia Pvt. Ltd., 2003
2. Hibbeller, R.C., Engineering Mechanics, Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., 2000.
3. Ashok Gupta, Interactive Engineering Mechanics – Statics – A Virtual Tutor (CDROM), Pearson Education Asia Pvt., Ltd., 2002
4. J.L. Meriam & L.G. Karige, Engineering Mechanics Vol. I & Vol. II, V edition, John Wiley & Sons, 2006.
5. P. Boresi & J. Schmidt, Engineering Mechanics Statics & Dynamics, Micro Print Pvt. Ltec., Chennai, 2004

PTPH9165   **MATERIALS SCIENCE**   **L T P C**
                                                                          3 0 0 3

OBJECTIVE:
The objective of this course is to introduce the essential principles of materials science for   mechanical and related engineering applications.

UNIT I   MECHANICAL PROPERTIES   9
Introduction to mechanical properties - tensile test – plastic deformation mechanisms – slip and twinning – role of dislocations in slip – strengthening methods – strain hardening – refinement of the grain size – solid solution strengthening – precipitation hardening – creep resistance – creep curves – mechanisms of creep – creep-resistant materials – fracture – the Griffith criterion – critical stress intensity factor and its determination – fatigue failure – fatigue tests – methods of increasing fatigue life – hardness – Rockwell and Brinell hardness - Knoop and Vickers microhardness.

UNIT II   PHASE DIAGRAMS   9
Solid solutions – Hume Rothery's rules – free energy of solid solution – intermediate phases – The phase rule – single component system – one-component system of iron – binary phase diagrams – isomorphous systems – the tie-line rule – the lever rule – application to isomorphous system - eutectic phase diagram – peritectic phase diagram – other invariant reactions – microstructural change during cooling.

UNIT III   FERROUS ALLOYS AND HEAT TREATMENT   9
The iron-carbon equilibrium diagram – phases, invariant reactions – microstructure of slowly cooled steels – eutectoid steel, hypo and hypereutectoid steels – effect of alloying elements on the Fe-C system – diffusion in solids – Fick's law – phase transformations – pearlitic transformations – T-T-T-diagram for eutectoid steel- bainitic and martensitic transformations – tempering of martensite – heat treatment of steels – annealing – normalizing – quenching and tempering – case hardening – induction, flame and laser hardening - carburizing, cyaniding, carbonitriding and nitriding.

UNIT IV   ENGINEERING ALLOYS   9
Steel specifications – Low Carbon Steels – Mild Steels – Medium Carbon Steels – High Strength Structural Steels – Tool Materials - Stainless Steels - High Temperature Alloys -Cast Irons – The Light Alloys – Copper and its Alloys – Bearing Alloys – Titanium alloys.

UNIT V   ELECTRONIC MATERIALS   9
Classification of solids – energy bands – concept of Fermi level – conductor, semiconductor, insulator – Semiconductors: intrinsic, extrinsic – carrier concentration expression (qualitative) – compound semiconductors (qualitative) – dielectric materials – polarisation mechanisms – dielectric breakdown – magnetic materials – ferromagnetic materials & hysterisis – ferrites – superconducting materials, properties, types and applications.

                                                          TOTAL: 45 PERIODS
TEXT BOOKS:
1. Raghavan, V., Materials Science and Engineering, Printice Hall of India, 2007.
2. Palanisamy, P.K., Applied Materials Science, SCITECH, 2003.

REFERENCES:
1. Callister, W.D., Materials Science and Engineering an Introduction, John Wiley, 2003.
2. Raghavan, V., Physical Metallurgy, Pritice Hall of India, 2003.

PTGE9261   ENVIRONMENTAL SCIENCE AND ENGINEERING   L T P C
3 0 0 3

AIM:
The aim of this course is to create awareness in every engineering graduate about the importance of environment, the effect of technology on the environment and ecological balance and make them sensitive to the environment problems in every professional endeavour that they participates.

OBJECTIVE:
At the end of this course the student is expected to understand what constitutes the environment, what are precious resources in the environment, how to conserve these resources, what is the role of a human being in maintaining a clean environment and useful environment for the future generations and how to maintain ecological balance and preserve bio-diversity. The role of government and non-government organization in environment managements.

UNIT I   ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY   14
Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.
Field study of common plants, insects, birds
Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II   ENVIRONMENTAL POLLUTION   8
Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards (h) e-waste – soil waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides.
Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III   NATURAL RESOURCES   10
Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.

Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health – Case studies.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education (2004).
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, (2006).

REFERENCES:
1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press (2005)

| PTEC9161 | ELECTRONICS ENGINEERING | L T P C |
| | | 3 0 0 3 |

UNIT I SEMICONDUCTORS AND RECTIFIERS 9

Classification of solids based on energy band theory – Intrinsic semiconductors – Extrinsic semiconductors – P-type and N-type – P-N junction – VI Characteristics of PN junction diode – Zener effect – Zener diode - Zener diode characteristics – Zener diode as a regulator – Half and Full wave rectifiers.

UNIT II TRANSISTOR AND AMPLIFIERS 9

Bipolar junction transistors – CB, CE, CC configurations and characteristics – Biasing circuits – Fixed bias, Voltage divider bias – Concept of feedback – Negative feedback – Voltage series feedback amplifier – Current series feedback amplifier – Principles of Tuned amplifiers.

UNIT III   POWER AND CONTROL ELECTRONIC DEVICES   9
FET – Configuration and characteristics – FET amplifier – SCR, Diac, Triac, UJT – Characteristics and simple applications.

UNIT IV   SIGNAL GENERATORS AND LINEAR ICS   9
Sinusoidal oscillators – Positive feedback – RC phase shift, Hartley, Colpitts, Wein bridge oscillators – Multivibrators – Operational amplifier – Adder, multipliers, integrator and differentiators.

UNIT V   DIGITAL ELECTRONICS   9
Boolean algebra – Decoder , Encoder – Multiplexer , Demultiplexer – Half and full adders – Flip flops – Digital to Analog and analog to digital converters.

TOTAL: 45 PERIODS

TEXT BOOK:
1. Malvino, 'Electronic Principles', McGraw Book Co., 1993.

REFERENCES:
1. Grob. B and Schultz. M.E., 'Basic Electronics', Tata Mcgraw Hill, 2003.
2. Thomas L. Floyd, 'Electronic Devices', Pearson Education, 2002.
3. Thomas L. Floyd, 'Digital Fundamentals', Pearson Education, 2003.

PTCE9213   **STRENGTH OF MATERIALS**   **L T P C**
                                                            3 0 0 3

AIM:
To understand the stresses and strains for different types loads for various applications.

OBJECTIVES:
- To understand the stresses developed in beams under transverse load
- To understand the shear stress developed due to tensional load
- To understand the stresses induced in cylinders and spheres due to internal pressure.

UNIT I   STRESS, STRAIN AND DEFORMATION OF SOLIDS   8
Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic Constants – Volumetric strains – Stresses on inclined planes – Principal stresses and principal planes – Mohr's circle of stress.

UNIT II   TRANSEVERSE LOADING ON BEAMS AND STRESSES IN BEAMS   11
Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending – bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution.

UNIT III   TORSION   8
Torsion formulation Stresses and deformation in circular and hollows shafts – Stepped shafts – deflection in Shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs.

UNIT IV DEFLECTION OF BEAMS 10

Double Integration method – Macaulay's method – Area moment theorems for computation of slopes and deflections in beams – Conjugate beam and strain energy method – Maxwell's reciprocal theorems.

UNIT V THIN CYLINDERS, SPHERES AND THICK CYLINDERS 9

Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses – deformation in thin cylinders –spherical shells subjected to internal pressure – deformations in spherical shells - Lame's theory – application of theories of failure

TOTAL : 45 PERIODS

TEXTBOOKS:
1. Rajput.R.K. "Strength of Materials" S.Chand & co Ltd. New Delhi 1996
2. Jindal U.C. "Strength of Materials" Asian Books Pvt Ltd, New Delhi 2007

REFERENCES:
1. Egor. P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 1997
2. Subramanian R. "Strength Of Materials" Oxford University Press, Oxford Higher Education Series ,2007
3. Hibbeler , R.C, Mechanics Of Materials", Pearson Education, Low Price Edition,2007
4. Bansal, R.K. Strength Of Materials, Lakshmi Publications(P)Ltd, New Delhi
5. Ferdinand P Been, Russell Johnson,J.R. & John J Dewole Mechanics Of Materials, Tata Mcgraw Hill Publishing Co Ltd, New Delhi, 2006

PTME 9211   **MECHANICS OF MACHINES**   **L T P C**
                                                                3 0 0 3

OBJECTIVES:
- To understand the principles in the formation of mechanisms and their kinematics.
- To understand the effect of friction in different machine elements.
- To analyse the forces and toques acting on simple mechanical systems
- To understand the importance of balancing and vibration.

UNIT I KINEMATIC OF MECHANICS 10

Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slide crank chain – kinematics analysis in simple mechanisms – velocity and acceleration polygons – Analytical methods – computer approach – cams – classifications – displacement diagrams - layout of plate cam profiles – derivatives of followers motion – circular arc and tangent cams.

UNIT II GEARS and GEAR TRAINS 9

Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth action interference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – epicyclic gear trains – automotive transmission gear trains.

UNIT III FRICTION 8

Sliding and Rolling Friction angle – friction in threads – Friction Drives – Friction clutches – Belt and rope drives – brakes – Tractive resistance.

UNIT IV   FORCE ANALYSIS   9
Applied and Constrained Forces – Free body diagrams – static Equilibrium conditions – Two, Three and four members – Static Force analysis in simple machine members – Dynamic Force Analysis – Inertia Forces and Inertia Torque – D'Alembert's principle – superposition principle – dynamic Force Analysis in simple machine members.

UNIT V   BALANCING AND VIBRATION   9
Static and Dynamic balancing – Balancing of revolving and reciprocating masses – Balancing machines – free vibrations – Equations of motion – natural Frequency – Damped Vibration – bending critical speed of simple shaft – Torsional vibration – Forced vibration – harmonic Forcing – Vibration solation.

                                                              TOTAL: 45 PERIODS

TEXT BOOKS:
1. Ambekar A.G., "Mechanism and Machine Theory" Prentice Hall of India, New Delhi, 2007
2. Shigley J.E., Pennock G.R and Uicker J.J., "Theory of Machines and Mechanisms", Oxford University Press, 2003

REFERENCES:
1. Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 1984.
2. Ghosh.A, and A.K.Mallick, "Theory and Machine", Affiliated East-West Pvt. Ltd., New Delhi, 1988.
3. Rao.J.S. and Dukkipatti R.V. "Mechanisms and Machines", Wiley-Eastern Ltd., New Delhi, 1992.
4. John Hannah and Stephens R.C., "Mechanics of Machines", Viva Low Prices Student Edition, 1999.
5. V.Ramamurthi, Mechanisms of Machine, Narosa Publishing House, 2002.
6. Robert L.Norton, Design of Machinery, McGraw-Hill, 2004.

STANDARDS:
IS 2458:2001, Vocabulary of Gear Terms – Definitions related to Geometry.
IS 3756 : 2002, Method of Gear Correction – Addendum modification for External cylindrical gears with parallel axes.
IS 5267 : 2002 Vocabulary of Gear Terms – Definitions Related to Worm Gear Geometry.
IS 12328 : Part 1 : 1988 Bevel Gear Systems Part -1 Straight Bevel Gears.
IS12328 : 1988 Bevel Systems Part – 2 Spiral Bevel Gears.

PTMA 9261   **PROBABILITY AND STATISTICS**   **L T P C**
                                                              3 0 0 3

AIM:
This course aims at providing the required skill to apply the statistical tools in engineering problems.

OBJECTIVES:
- The students will have a fundamental knowledge of the concepts of probability.
- Have knowledge of standard distributions which can describe real life phenomenon.
- Have the notion of sampling distributions and statistical techniques used in management problems.

UNIT I   RANDOM VARIABLES   9

Discrete and Continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma, Weibull and Normal distributions - Functions of a random variable.

UNIT II   TWO-DIMENSIONAL RANDOM VARIABLES   9

Joint distributions – Marginal and Conditional distributions – Covariance – Correlation and Linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III   TESTING OF HYPOTHESIS   9

Sampling distributions - Tests for single mean, proportion, Difference of means (large and small samples) – Tests for single variance and equality of variances – χ^2-test for goodness of fit – Independence of   attributes – Non-parametric tests: Test for Randomness and Rank-sum test (Wilcoxon test).

UNIT IV   DESIGN OF EXPERIMENTS   9

Completely randomized design – Randomized block design – Latin square design - 2^2 - factorial design.

UNIT V   STATISTICAL QUALITY CONTROL   9

Control charts for measurements ($\overline{X}$ and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits -   Acceptance sampling.

                                                              TOTAL: 45 PERIODS

TEXT BOOKS:
1. Milton, J. S. and Arnold, J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th edition, (2007).
2. Johnson, R.A. and Gupta, C.B., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 7th edition, (2007).

REFERENCES:
1. Devore, J.L., "Probability and Statistics for Engineering and the Sciences", Thomson Brooks/Cole, International Student Edition, 7th edition, (2008).
2. Walpole, R.E., Myers, R.H., Myers, S.L. and Ye, K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia , 8th edition, (2007).
3. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists, 3rd edition, Elsevier, (2004).
4. Spiegel, M.R., Schiller, J. and Srinivasan, R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill edition, (2004).

PTIE9202　　　　　　**OPERATIONS RESEARCH – I**　　　　　　**L T P C**
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　3 0 0 3

OBJECTIVE:
To learn the basics of deterministic optimization tools

UNIT I　　　　LINEAR PROGRAMMING　　　　　　　　　　　　　10
Introduction - Formulation of linear programming models – Assumptions-Graphical solution procedure – solving LPP using simplex algorithm – Degeneracy, Alternative Optima, Unbounded identification-　LP Applications- Data Envelopment Analysis- Revised Simplex Method

UNIT II　　　　ADVANCES IN LPP - I　　　　　　　　　　　　　10
Duality theory　- Interpretation of dual variables- Primal Dual Relationships – Role of duality in sensitivity analysis - Dual simplex method – Graphical based and Simplex based Sensitivity analysis –- Transportation problems, transportation simplex method– Assignment problems, Hungarian method- LP formulation of transportation and Assignment networks- Traveling sales man problem

UNIT III　　　　ADVANCES IN LPP – II　　　　　　　　　　　　10
Integer Linear programming formulations, graphical solution of the LP relaxation, Graphical solution to all integer problem, applications involving 0-1 variables, introduction to cutting plane and branch & bound methods – Multi objective optimization - Goal programming problem formulation.

UNIT IV　　　　NETWORK MODELS　　　　　　　　　　　　　　9
Maximal flow problem – Shortest route problem – Minimal spanning tree problem - Project networks, CPM, PERT, Crashing of networks, L P model for crashing – project costing and control.

UNIT V　　　　DYNAMIC PROGRAMMING　　　　　　　　　　　6
Elements of dynamic programming – stage and state, characteristics of DP problems, recursive relationship, Bellman's principle of optimality – computational procedure for shortest route problem, knapsack problem, production and inventory control problem.

　　　　　　　　　　　　　　　　　　　　　　　　TOTAL : 45 PERIODS
TEXT BOOKS:
1. Hillier and Lieberman Introduction to Operations Research, TMH, 2000
2. R.Panneerselvam, Operations Research,PHI,2006

REFERENCES:
1. Philips, Ravindran and Solberg, Operations Research, John Wiley,2002
2. Hamdy A Taha, Operations Research – An Introduction, Prentice Hall India,2003
3. Ronald L Rardin, Optimisation in Operations Research, Pearson, 2003.
4. David R. Anderson, et al , An Introduction to Management Science – Quantitative approaches to Decision Making, Thomson,2003.

PTIE9201   **WORK SYSTEM DESIGN**   **L T P C**
                                                                           3 0 0 3

OBJECTIVE:
To impart knowledge in the area of Method study and Time study so that students can implement these principles and techniques to improve productivity in manufacturing and Service sectors.

UNIT I   PRODUCTIVITY   9
Total time for a job or operation, total work content and ineffective time, – Production and Productivity - Productivity and standard of living, Factors affecting Productivity, Productivity measurement Models.

UNIT II   METHODS ENGINEERING   9
Methods Engineering-Steps -Tools and techniques, Motion study.

UNIT III   WORK MEASUREMENT   9
Stop watch time study, performance rating, allowances, Development of Standard data, learning effect. Work measurement in Automated Processes. Computerised Labour standards.

UNIT IV   APPLIED WORK MEASUREMENT   9
Work sampling, Group Timing Technique (GTT), predetermined time systems, types, Methods Time Measurement (MTM), Wage incentive plans.

UNIT V   WORK DESIGN FOR OFFICE WORK   9
Organization and methods (O & M), Work measurement of office work, Work Analysis techniques applied to support staff, Form design and control.
                                                           TOTAL: 45 PERIODS

TEXT BOOK:
1. Barnes, R.M. Motion and Time Study, Design and measurement of work, John Wiley sons(Asia), Seventh edition,2002.

REFERENCES:
1. Benjamin W.Niebel, Andris Freivalds, Methods, standards & Work Design, McGraw hill, Eleventh edition, 2002.
2. ILO, Introduction to Work Study, Oxford and IBH publishing , 2001
3. Maynard H.B, Industrial Engineering Hand book,McGraw-Hill,2001

PTME9305   **DESIGN OF MACHINE ELEMENTS**   **L T P C**
                                                              3 1 0 4

AIM:
- To impart knowledge on design principles of various components in mechanical engineering application.

OBJECTIVES:
- To familiarize the various steps involved in the Design Process
- To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
- To learn to use standard practices and standard data
- To learn to use catalogues and standard machine components

UNIT I   STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS
9
Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties -- Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – Design of curved beams – crane hook and 'C' frame - Factor of safety - theories of failure – stress concentration – design for variable loading – Soderberg, Goodman and Gerber relations

UNIT II   DESIGN OF SHAFTS AND COUPLINGS   9
Design of solid and hollow shafts based on strength, rigidity and critical speed-Design of keys, key ways and splines-Design of crankshafts-Design of rigid and flexible couplings.

UNIT III   DESIGN OF TEMPORARY AND PERMANENT JOINTS   9
Threaded fastners - Design of bolted joints including eccentric loading, Knuckle joints, Cotter joints-Design of welded joints, riveted joints for structures-theory of bonded joints.

UNIT IV   DESIGN OF ENERGY STORING ELEMENTS   9
Design of various types of springs, optimization of helical springs-rubber springs-Design of flywheels considering stresses in rims and arms for engines and punching machines.

UNIT V   DESIGN OF BEARINGS AND MISCELLANEOUS ELEMENTS   9
Sliding contact and rolling contact bearings -- Design of hydrodynamic journal bearings, McKee's Eqn., Sommerfield Number, Raimondi & Boyd graphs, -- Selection of Rolling Contact bearings -- Design of Seals and Gaskets -- Design of Connecting Rod.

TOTAL: 45 PERIODS

Note: (Use of P S G Design Data Book is permitted in the University examination)

TEXT BOOKS:
1. Shigley J.E and Mischke C. R., "Mechanical Engineering Design", Sixth Edition, Tata McGraw-Hill , 2003.
2. Bhandari V.B, "Design of Machine Elements", Second Edition, Tata McGraw-Hill Book Co, 2007.

REFERENCES:
1. Sundararajamoorthy T. V, Shanmugam .N, "Machine Design", Anuradha Publications, Chennai, 2003.
2. Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.
3. Ugural A.C, "Mechanical Design – An Integral Approach, McGraw-Hill Book Co, 2004.
4. Spotts M.F., Shoup T.E "Design and Machine Elements" Pearson Education, 2004.

STANDARDS:
1. IS 10260 : Part 1 : 1982 Terms, definitions and classification of Plain bearings Part 1 : Construction.
2. IS 10260 : Part 1 : 1982 Terms, definitions and classification of Plain bearings Part 2 : Friction and Wear.
3. IS 10260 : Part 1 : 1982 Terms, definitions and classification of Plain bearings Part 3 : Lubrication.

PTIE9203   **WORK DESIGN LABORATORY**   **L T P C**
                                                                    0 0 3 2

OBJECTIVES:
To understand the theory better and apply in practice, practical training is given in the following areas:

1. Graphic tools for method study
2. Peg board experiment
3. Stop watch time study
4. Performance rating exercise
5. Work sampling
6. MTM practice

TOTAL: 45 PERIODS

PTIE9302   **OPERATIONS RESEARCH – II**   **L T P C**
                                                                    3 0 0 3

OBJECTIVE:
To impart knowledge on some probabilistic optimization techniques

UNIT I   DETERMINISTIC INVENTORY MODELS   9
Purchase model with no shortages – manufacturing model with no shortage – Purchase model with shortage – Manufacturing model with shortages –model with price breaks

UNIT II   PROBABILISTIC INVENTORY MODELS   9
Probabilistic inventory model – Reorder point model – multi product-Selective Inventory control.

UNIT III   QUEUING THEORY   9
Queuing theory terminology – Single server, multi server, Limited queue capacity – applications – Markov chains

UNIT IV   DECISION THEORY   12
Decision making under certainty – Decision making under risk – Decision making under uncertainty – Decision tree analysis – MCDM – AHP. Game Theory - Two person zero sum games, pure and mixed strategies – graphical solution – solving by LP.

UNIT V   REPLACEMENT MODELS   6
Replacement models – Money value, present worth factor and discount rate.

TOTAL: 45 PERIODS

TEXT BOOK:
1. Philips, Ravindran and Solberg, Operations Research, John Wiley,2002.

REFERENCES:

1. Hamdy A Taha, Operations Research – An Introduction, Prentice Hall India,2003
2. Ronald L Rardin, Optimisation in Operations Research, Pearson, 2003
3. David R. Anderson, et al , An Introduction to Management Science – Quantitative approaches to Decision Making, Thomson,2003

PTIE9304   **APPLIED ERGONOMICS**   **L T P C**
                                                             3 0 0 3

OBJECTIVE:
To explain the general principles that govern the interaction of humans and their working environment for improving worker performance and safety.

UNIT I   INTRODUCTION   3
Brief history of human factors Engineering/Ergonomics – Interdisciplinary nature.

UNIT II   HUMAN PERFORMANCE   10
Factors influencing performance – Information receiving and processing – Information theory and its application – Human response and errors – Signal detection theory – Biostatic and Biodynamic Mechanics.

UNIT III   PHYSIOLOGICAL ASPECTS OF HUMAN AT WORK   12
Metabolism – Physiological factors involved in muscular activity – Measurement of energy expenditure – Quantitative work load analysis – Physical work capacity and its evaluation – Physiological fatigue – Work and rest schedules – Physical fitness tests.

UNIT IV   WORK PLACE DESIGN   12
Problems of body size, Anthropometry measures, Work posture – Work space layout and work station design – Design of displays, controls and VDT work stations – Hand tool design, illumination.

UNIT V   OCCUPATIONAL HEALTH AND SAFETY   8
Industrial accidents, Personnel Protective devices, Safety Management practices – Effect of Environment – heat, cold & noise – NIOHS regulations and Factories Act

                                                     TOTAL: 45 PERIODS

TEXT BOOK:
1. Bridger, R.S., Introduction to Ergonomics, McGraw Hill, 1995.

REFERENCES:

1. Martin Helander, A guide to Ergonomics of Manufacturing, TMH, 2006.
2. Mecormik, T.J., Human Factors Engineering, TMH, 1990.
3. John Grimaldi, Safety Management, A.I.B.S., 5th Edition, Hazard Control Technology 2003
4. Philips, Chandler A, Human Factors Engineering, John Wiley and Sons, Inc. 2000.

PTIE9305   **MANUFACTURING AUTOMATION**   **L T P C**
                                                                   3 0 0 3

OBJECTIVE:
To give a brief exposure to automation principles and applications to production systems covering few types of automation**.**

UNIT I   **MANUFACTURING OPERATIONS**   **9**
Automation in production systems, principles and strategies, Product/production relationships, Production concepts and mathematical models, Costs of manufacturing operations.

UNIT II   **CONTROL TECHNOLOGIES**   **9**
Automated systems – elements, functions, levels, Continuous Vs discrete control, Computer process control, Sensors, Actuators, ADC, DAC, Programmable logic controllers – ladder logic diagrams.

UNIT III   **NUMERICAL CONTROL AND ROBOTICS**   **9**
NC - CNC – Part programming – DNC – Adaptive control – Robot anatomy – Specifications – End effectors – Industrial applications.

UNIT IV   **AUTOMATED HANDLING AND STORAGE**   **9**
Automated guided vehicle systems, AS/RS, Carousel storage, Automatic data capture - Bar code technology.

UNIT V   **COMPUTER-AIDED DESIGN**   **9**
Fundamentals of CAD – design process, manufacturing database – Computer graphics – functions, constructing the geometry, transformation, wire frame Vs solid modelling.

                                                   TOTAL: 45 PERIODS

REFERENCES:
1. Mikell P.Groover, Automation, "Production Systems and Computer Integrated Manufacturing" PHI, 2003.
2. Mikell P.Groover, Emory W. Zimmers, Jr., "CAD/CAM: Computer - Aided   Design and Manufacturing", PHI, 2007.

PTIE9355   **PRODUCTION PLANNING AND CONTROL**   **L T P C**
                                                                   3 0 0 3

OBJECTIVE:
To give an overview of techniques applicable to production planning, scheduling and control

UNIT I   **INTRODUCTION**   **5**
Introduction to Production Systems, Objectives and Scope of Operation Management, Operations Management Frame work, Relationship of operations with other Functional areas, Manufacturing Vs Service sector, Operations Decision making, Production Design Process and Process choices

UNIT II   **FORECASTING**   **10**
Need for Forecasting, Factors affecting Demand, Demand Patterns, Qualitative Forecasting Methods-Delphi techniques, Market Research, Nominal Group Technique

etc, Quantitative Forecasting methods–Moving Average Methods, Exponential Smoothing Methods, Regression methods, Monitoring and Control of Forecasts, Selection of forecasting methods, Forecasting Process.

UNIT III   AGGREGATE PLANNING   10
Role of Aggregate Planning, Inputs to Aggregate planning, Pure and Mixed strategies, Mathematical Models for Aggregate planning – Transportation Method, Linear programming Formulation, Linear Decision Rules, Master Production Schedule(MPS), Procedure for developing MPS, MRP terminology, process of MRP, Lot sizing in MRP

UNIT IV   CAPACITY MANAGEMENT   10
Types of Capacity, Measures of capacity, Factors affecting capacity, Capacity planning, Systematic approach to capacity planning, Long-term and short-term capacity decisions, Tools for capacity planning, Theory of Constraints,MRP–II, Capacity Requirement planning ,Basics of ERP.

UNIT V   PRODUCTION ACTIVITY CONTROL   10
Objectives and Activities of Production Activity Control, Flow-shop and Job shop production activity control.

TOTAL: 45 PERIODS

REFERENCES:
1. Lee J.Krajewski, Larry P.Ritzman, Operations Management Strategy and Analysis,   PHI, 6th Edition, 2003.
2. Norman Gaither, Greg Frazier, Operations Management, Thomson Learning, 9th Edition, 2002.
3. Pannerselvam,R.Production & operations Management, PHI, 2nd Edition, 2005
4. Seetharama .L.Narasimhan,Dennis W.McLeavey,Peter J.Billington, Production Planning and Inventory Control,PHI,second edition,2003.
5. B.Mahadevan, Operations Management:Theory and Practice,Pearson Education,2006.

PTIE9357   STATISTICAL APPLICATIONS AND OPTIMIZATION LAB   L T P C
                                                                     0 0 3 2
OBJECTIVES:
To give adequate exposure to applications of software packages in the areas of Applied Statistics, Operations Research and Reliability
I.   Basic Statistics
                1. Mean, Median, Mode, measures of dispersion

II.   Use of Spreadsheet
                2. Look up tables, Statistics

III.   Use of RELIASOFT
                3. Data analysis

IV.   Simple Operation Research Programs
                4. Initial Solution of TP, Inventory Price Break Models

V.   Optimization Package (TORA /LINDO)
                5.   LP Models
                6.   Transportation

7.   Assignment
8.   Maximal flow
9.   Minimal spanning tree
10. Shortest route
11. Network scheduling

TOTAL: 45 PERIODS

PTIE9354   **FACILITY LAYOUT AND MATERIAL HANDLING**   **L T P C**
                                                                3 0 0 3

OBJECTIVE:
To explain the basic principles in facilities planning, location, layout designs and material handling systems

UNIT I   **FACILITY LOCATION**   **12**
Introduction , Factors affecting location decisions , Location theory , Qualitative models , Semi-Quantitative models -Composite measure , Brown & Gibbs model , Break-Even analysis model, Single facility location problems – Median model, Gravity location model, Mini-Max model, Multi-facility location problems, Network and warehouse location problems.

UNIT II   **FACILITY LAYOUT DESIGN**   **9**
Need for Layout study , Factors influencing plant layout ,Objectives of a good facility layout, Classification of layout , Layout procedure – Nadler's ideal system approach, Immer's basic steps, Apple's layout procedure, Reed's layout procedure –Layout planning – Systematic Layout Planning – Information gathering, flow analysis and activity analysis, relationship diagram, space requirements and availability, designing the layout. Utilities planning

UNIT III   **COMPUTERISED LAYOUT PLANNING**   **9**
Concepts, Designing process layout – CRAFT, ALDEP, CORELAP – Trends in computerized layout, Algorithms and models for Group Technology - ROC and Bond Energy Algorithms.

UNIT IV   **DESIGNING PRODUCT LAYOUT**   **6**
Line balancing - Objectives, Line balancing techniques – Largest Candidate rule-Kilbridge and Wester method- RPW method- COMSOAL.

UNITV   **MATERIAL HANDLING AND PACKAGING**   **9**
Objectives and benefits of Material handling, Relationship between layout and Material handling, Principles of material handling, Unit load concept, Classification of material handling equipments, Equipment selection, Packaging.

TOTAL: 45 PERIODS

TEXT BOOK:
1. Francis, R.L., and White, J.A.Facilities layout and Location, Prentice Hall of India, 2002.

REFERENCES:
1. Tompkins, White et al., Facilities planning, John Wiley & Sons, inc. 2003.
2. James, Apple, Material Handling System design, Ronald Press, 1980.
3. Krajewski, J. and Ritzman, Operations Management – Strategy and Analysis, Addison – Wesley publishing company inc. 5th Edition, 1999.
4. Pannerselvam,R.Production & operations Management, PHI, 2nd Edition, 2005

PTIE9251   ENGINEERING ECONOMY, COSTING AND ACCOUNTING   L T P C
3 0 0 3

OBJECTIVES:
- To impart knowledge in the areas of cost estimation, pricing of products, cost control methods and principles of accounting.
- After undergoing the course, the students will be able to estimate cost of products, analyze product cost and suggest cost reduction measure.

UNIT I   INTRODUCTION   6
Objectives of Managerial Economics, Firm, Cost Estimation, Costing, Cost Accounting, Factors Influencing Managerial Decisions & Theoretical Concepts, Classification and Elements of cost.

UNIT II   PRODUCTION ANALYSIS AND PRICING   9
Production Function-Least Cost Combination of Inputs-Factor Productivities & Return to Scale-Determinants of Price-Pricing under different objectives and Market Structures-Price Discrimination & Pricing methods in practice.

UNIT III   ESTIMATION   10
Estimation of Material, Labor and Overhead Cost, Allocation of Overheads. Estimation for different types of jobs.

UNIT IV   COSTING   10
Job Costing-Operating Costing-Process Costing- Standard Costing (Variance Analysis)

UNIT V   ACCOUNTING   10
Balance Sheet-Profit & Loss Statement-Evaluation of Investment decisions- Average Rate of Return-Payback Period-Net Present Value & IRR.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Jawaharlal, Cost Accounting, TMH, 1996
2. Ramachandran Aryasry & VV.Ramana Murthy, Engg Economics & Financial Accounting, TMH, NewDelhi, 2004.

REFERENCES:
1. James.C.Van Home, "Fundamentals of fincancial Management", PHI, NewDelhi, 2004.
2. V.L.Mote, Samuel Paul & G.S.Gupta, Managerial Economics-Concepts & Cases, TMH, Co, NewDelhi, 1989
3. T.P.Banga & S.C.Sharma, Mechancial Estimating and Costing, Khanna Publishers, 1984.

PTIE9033   **SUPPLY CHAIN MANAGEMENT**   **L T P C**
                                                                         3 0 0 3

OBJECTIVE:
To cover the basics of supply chain concepts, associated networks, tools and techniques required for evaluating various supply chain processes.

UNIT I   STRATEGIC FRAMEWORK   5
Objective, decision phases, process views, examples, strategic fit, supply chain drivers and metrics

UNITII   SUPPLY CHAIN NETWORKS   10
Distribution networks, Facility networks and design options, Factors influencing, Models for facility location and capacity allocation, Transportation networks and design options, Evaluating network design decisions

UNIT III   MANAGING DEMAND AND SUPPLY IN A SUPPLY CHAIN   10
Predictable variability in a supply chain, Economies of scale and uncertainty in a supply chain – Cycle and safety Inventory, Optimum level of product availability, Forward Buying, Multi-echelon cycle inventory

UNIT IV   SOURCING AND PRICING IN A SUPPLY CHAIN   10
Cross-Functional drivers, Role of sourcing in a supply chain, Logistics providers, Procurement process, Supplier selection, Design collaboration, Role of Pricing and Revenue Management in a supply chain

UNIT V   INFORMATION TECHNOLOGY AND COORDINATION IN A SUPPLY
                CHAIN   10
The role of IT in supply chain, The supply chain IT frame work, Customer Relationship Management, Supplier relationship management, Future of IT in supply chain, E-Business in supply chain, Bullwhip effect – Effect of lack of co-ordination in supply chain, Building strategic partnerships, CPFR

                                                          TOTAL: 45 PERIODS

TEXT BOOK:
1. Sunil Chopra and Peter meindl, "Supply Chain Management , Strategy, Planning, and operation", PHI, Third edition,2007.

REFERENCES:
1. Jeremy F.Shapiro, "Modeling the supply chain", Thomson Duxbury ,2002.
2. James B.Ayers, "Handbook of Supply chain management", St.Lucle press, 2000.

 PTIE9303   **STATISTICAL QUALITY CONTROL**   **L T P C**
                                                                         3 0 0 3
OBJECTIVE:
This course is concerned with the applications of statistical tools in measuring and controlling the quality of products/processes

UNIT I   QUALITY FUNDAMENTALS   5
Importance of quality, meaning of quality, quality dimensions, quality planning, quality control, SQC, Quality assurance, quality costs, economics of quality, quality and productivity, quality and reliability, quality loss function.

UNIT II   CONTROL CHARTS FOR VARIABLES   10
Process variation,– Statistical basis, 3 – sigma control limits, Rational sub-grouping, $\overline{X}$,R and S charts, Interpretation of charts, warning and modified control limits, operating characteristic curve for $\overline{X}$ – chart, SPC -process capability analysis – C_p, C_{PK}, C_{pm}, Machine capability, Gauge capability.

UNIT III   CONTROL CHARTS FOR ATTRIBUTES   10
P, np, C, U and ku charts, demerits control chart, Multi – variable chart, individual measurement charts – moving average and moving range charts, quality control in service sector.

UNIT IV   ACCEPTANCE SAMPLING   10
Need for Acceptance sampling, economics of sampling, sample selection, single and Double sampling – O.C. curves, Average outgoing quality (AOQ), Average sample number (ASN), Average total inspection (ATI), Multiple and sequential sampling, sampling plans – military standards, Dodge – Roming, IS 2500.

UNIT V   METROLOGY & INSPECTION   10
Fundamental methods of measurement, precision & accuracy, measurement devices - Linear and Angular - Coordinate Measuring Machine, Destructive and Non-Destructive Testing methods.

TOTAL: 45 PERIODS

TEXT BOOK:
1. Douglus C.Montgomery, Introduction to Statistical Quality Control, John Wiley & Sons, 2004.

REFERENCES:
1. Statistical Quality Control, Eugene L.Grant and Richard S.Leaven Worth, TMH, Seventh Edition, 2000.
2. Quality Control. Dale H.Besterfield, Pearson Education Asia, Seventh Edition,2004.

PTGE9021   PROFESSIONAL ETHICS IN ENGINEERING   L T P C
                                                              3 0 0 3

OBJECTIVE:
To sensitize the students on ethical values to be followed in engineering profession.

UNIT I   ENGINEERING ETHICS   9
Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Professions and Professionalism – Professional Ideals and Virtues – Uses of Ethical Theories

UNIT II   ENGINEERING AS SOCIAL EXPERIMENTATION   9
Engineering as Experimentation – Engineers as responsible Experimenters – Research Ethics - Codes of Ethics – Industrial Standards - A Balanced Outlook on Law – The Challenger Case Study

UNIT III ENGINEER'S RESPONSIBILITY FOR SAFETY 9
Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis – Reducing Risk – The Government Regulator's Approach to Risk - Chernobyl Case Studies and Bhopal

UNIT IV RESPONSIBILITIES AND RIGHTS 9
Collegiality and Loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) - Discrimination

UNIT V GLOBAL ISSUES 9
Multinational Corporations – Business Ethics - Environmental Ethics – Computer Ethics - Role in Technological Development – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Honesty – Moral Leadership – Sample Code of Conduct

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, New York (2005).
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering Ethics – Concepts and Cases", Thompson Learning, (2000).

REFERENCES:
1. Charles D Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, (1999).
2. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, (2003)
3. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, (2001)
4. Prof. (Col) P S Bajaj and Dr. Raj Agrawal, "Business Ethics – An Indian Perspective",Biztantra, New Delhi, (2004)
5. David Ermann and Michele S Shauf, "Computers, Ethics and Society", Oxford University Press, (2003)

PTIE9402 SIMULATION MODELING AND ANALYSIS L T P C
3 0 0 3

OBJECTIVE:
To cover various aspects of discrete dynamic, stochastic systems modeling and conducting experiments with those models on a computer.

UNIT I INTRODUCTION 3
Systems – Modelling – types – systems components – Simulation basics

UNIT II RANDOM NUMBERS/VARIATES 10
Random numbers – methods of generation – random variates for standard distributions like uniform, exponential, Poisson, binomial, normal etc – Testing of Random variates – Monte Carlo Simulation

UNIT III DESIGN OF SIMULATION EXPERIMENTS 12
Steps on Design of Simulation Experiments – Development of models using of High-level language for systems like Queuing, Inventory, Replacement, Production etc., – Model validation and verification, Output analysis.

UNIT IV   SIMULATION LANGUAGES   12

Need for simulation Languages – Comparisons & Selection of Languages – GPSS-ARENA- EXTEND – Study of any one of the languages

UNIT V   CASE STUDIES USING SIMULATION LANGUAGES   8

TOTAL: 45 PERIODS

REFERENCES:
1. Jerry Banks, John S Corson,Barry.L. Nelson,David M. Nicol and P.Shahabudeen, Discrete Event Systems Simulation, Pearson education, Fourth edition,2007.
2. Geoffrey Gordon, Systems Simulation, Prentice Hall, 2002
3. Law A M & Kelton W D, Simulation Modelling and analysis, Tata McGraw-Hill, 2003
4. David Kelton, Rondall P Sadowski, David T Sturrock, Simulation with Arena, Mc Graw Hill, 2004
5. Thomas J Schriber, Simulation Using GPSS, John Wiley, 2002.
6. http://www.bcnn.net

PTGE9022   TOTAL QUALITY MANAGEMENT   L T P C
3 0 0 3

OBJECTIVE:

To impart knowledge on Quality principles, practices and use of statistical tools to improve overall Quality Systems in an organization.

UNIT I   INTRODUCTION   9

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of manufacturing and service quality - Basic concepts of TQM - Definition of TQM – TQM Framework - Contributions of Deming, Juran and Crosby – Barriers to TQM.

UNIT II   TQM PRINCIPLES   9

Leadership – Strategic quality planning, Quality statements - Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement – PDSA cycle, 5s, Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating.

UNIT III   TQM TOOLS & TECHNIQUES I   9

The seven traditional tools of quality – New management tools – Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

UNIT IV   TQM TOOLS & TECHNIQUES II   9

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Cost of Quality – Performance measures.

UNIT V   QUALITY SYSTEMS   9

Need for ISO 9000- ISO 9000-2000 Quality System – Elements, Documentation, Quality auditing- QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – Case studies of TQM implementation in manufacturing and service sectors including IT.

TOTAL: 45 PERIODS

TEXT BOOK:
1. Dale H.Besterfiled, et at., "Total Quality Management", Pearson Education Asia, Third Edition, Indian Reprint (2006).

REFERENCES:
1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", (6th Edition), South-Western (Thomson Learning), 2005.
2. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, Third Edition (2003).
3. Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd. (2006)
4. Janakiraman,B and Gopal, R.K, "Total Quality Management – Text and Cases", Prentice Hall (India) Pvt. Ltd. (2006)

PTIE 9356   COMMUNICATION SKILLS AND PRODUCTION SYSTEM DESIGN
PROJECT   L T P C
0 0 3 2

OBJECTIVES:
To improve communication skills and to give an opportunity for the students to apply the concepts of various techniques covered in the areas of Industrial Engineering in a given practical situation.

Projects shall be assigned in the following areas:
- Forecasting and Aggregate Planning
- Materials Requirement Planning and Capacity Planning
- Transportation and Distribution of goods
- Group technology and Cellular manufacturing
- Production and Project Scheduling
- Quality Control
- Plant Layout Design
- Methods improvement in manufacturing and service organisation

TOTAL: 45 PERIODS

PTIE9401   DESIGN OF EXPERIMENTS   L T P C
3 0 0 3

OBJECTIVE:
To impart knowledge on statistical tools for industrial experimentation related to selection of product and process parameters in various environments.

UNIT I   CONCEPTS AND TERMINOLOGY   5
Review of hypothesis testing – P Value, "t" Vs paired "t" test, simple comparative experiment, planning of experiment – steps. Terminology - factors, levels, variables, Design principles – replication, randomization, blocking, confounding, Analysis of variance, sum of squares, degrees of freedom.

UNIT II   SINGLE FACTOR EXPERIMENTS   10
Completely randomized design, Randomized block design, effect of coding the observations, Latin Square design, orthogonal contrasts, comparison of treatment means – Duncan's multiple range test, Newman- Keuel's test, Fisher's LSD test, Tukey's test.

UNIT III FACTORIAL EXPERIMENTS 10
Main and interaction effects, Rules for sum of squares and expected mean square, two and three factor full factorial design, 2^k designs with two and three factors, Yate's algorithm, practical applications.

UNIT IV SPECIAL EXPERIMENTAL DESIGNS 10
Blocking and confounding in 2^k design, nested design, split – plot design, two level fractional factorial design, fitting regression models, introduction to response surface methods- Central composite design.

UNIT V TAGUCHI TECHNIQUES. 10
Introduction, Orthogonal designs, data analysis using ANOVA and response graph, parameter design – noise factors, objective functions (S/N ratios), multi-level factor OA designs, applications.

TOTAL: 45 PERIODS

TEXT BOOK :
1. Douglus C.Montgomery, Design and Analysis of Experiments, John Wiley & Sons,2005

REFERENCES :
1. Angela M.Dean and Daniel Voss, Design and Analysis of Experiments, Springer texts in Statistics, 2000.
2. Philip J.Ross, Taguchi Techniques for Quality Engineering, Prentice Hall, 1989.

PTIE9301   PRINCIPLES OF MANAGEMENT   L T P C
3 0 0 3

OBJECTIVE:
To explain the basic principles of management, namely, Planning, Organizing ,Staffing, Leading and Controlling and application of these principles in any given organization.

UNIT I PLANNING 9
Nature and Purpose of Planning – Objectives –Strategies, Pricing & Planning Process and   Decision Making.

UNIT II ORGANIZING 9
Nature and Purpose of Organizing –Basic Departmentation – Line/Staff Authority and Decentralization –Effective Organization and Organizational Culture.

UNIT III STAFFING 9
HRM and Selection - Performance Appraisal & Wages Strategy –Manager and Organizationl Development..

UNIT IV LEADING 9
Managing and the human factor –Motivation –Leadership –Communication

UNIT V CONTROLLING AND INTERNATIONAL MANAGEMENT 9
The System & Process of Controlling –Controlling Techniques & IT Productivity and Operations Management– Overall Preventive Control –Towards a unified, Global Management Theory.

TOTAL: 45 PERIODS

TEXT BOOK:
1. Herold Koontz and Heinz Weibrich, "Essentials of Management", TMH, 2001.

REFERENCES:
1. James.A.F., Stones and R.Edward Freeman, "Management", PHI, 1992.
2. Josesph.L.Massic, "Essentials of Management", PHI, 1985.

PTIE9451   **PROJECT WORK**   L T P C
                                                                   0 0 12 6

The objective of project work is to enable the students, to work in convenient groups of not more than four members in a group, on a project involving some design and fabrication work or theoretical and experimental studies related to the respective engineering discipline.

Every project work shall have a guide who is a member of the faculty of the University. Twelve periods per week shall be allotted in the Time Table for this important activity and the students to receive directions from the guide, on library reading, laboratory work, and computer analysis, shall utilize this time. Or fieldwork as assigned by the guide and also to present in periodical seminars or viva to review the progress made in the project.

Each student shall finally produce a comprehensive report covering background information, literature-survey, problem statement, project work details, estimation of cost and conclusion. This final report shall be in typewritten form as specified in the guidelines.

The continuous assessment and semester evaluation may be carried out as specified in the guidelines to be issued from time to time.

PTIE9021   **PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING**   L T P C
                                                                      3 0 0 3

OBJECTIVE:
The purpose is to apprise the students on productivity improvement techniques for an organization and to create a system that response with flexibility of the changes through business process reengineering.

UNIT I   INTRODUCTION   3
Basic concept and meaning of Productivity – Significance of Productivity – Factors affecting Productivity – Productivity cycle, Scope of Productivity Engineering and Management.

UNIT II   PRODUCTIVITY MEASUREMENT AND EVALUATION   9
Productivity measurement in International, National and Industrial level – Total Productivity Model – Productivity measurement in Manufacturing and Service sectors – Performance Objective Productivity (PO) model – Need for Productivity Evaluation – Evaluation Methodology.

UNIT III   **PRODUCTIVITY PLANNING AND IMPLEMENTATION**   **9**

Need for Productivity Planning – Short term and long term productivity planning – Productivity improvement approaches, Principles - Productivity Improvement techniques – Technology based, Material based, Employee based, Product based techniques – Managerial aspects of Productivity Implementation schedule, Productivity audit and control.

UNIT IV   **REENGINEERING PROCESS**   **15**

Definition, Fundamentals of process reengineering – Principles, Methodology and guidelines for Organization Transformation, DSMCQ and PMP organization Transformation models – Process Improvement Models like PMI, Edosomwan, LMICIP and NPRDC Models.

UNIT V   **BPR TOOLS AND IMPLEMENTATION**   **9**

Analytical and Process Tools and Techniques - Role of Information and Communication Technology in BPR – Requirements and steps in BPR Implementation – Case studies.

TOTAL: 45 PERIODS

REFERENCES:

1. Sumanth, D.J.Productivity Engineering and Management, TMH, New Delhi, 1990.
2. Edosomwan, J.A. Organizational Transformation and Process re- Engineering, British Cataloging in publications, 1996.
3. Premvrat, Sardana, G.D. and Sahay, B.S. Productivity Management - A systems approach, Narosa Publications, New Delhi, 1998.

PTIE9022   **SAFETY ENGINEERING AND MANAGEMENT**   **L T P C**
                                                            3 0 0 3

OBJECTIVE:

To impart knowledge on safety engineering fundamentals and safety management practices.

UNIT I   **INTRODUCTION**   **9**

Evolution of modern safety concepts – Fire prevention – Mechanical hazards – Boilers, Pressure vessels, Electrical Exposure.

UNIT II   **CHEMICAL HAZARDS**   **9**

Chemical exposure – Toxic materials – Radiation Ionizing and Non-ionizing Radiation - Industrial Hygiene – Industrial Toxicology.

UNIT III   **ENVIRONMENTAL CONTROL**   **9**

Industrial Health Hazards – Environmental Control –Industrial Noise- Noise measuring instruments, Control of Noise, Vibration, - Personal Protection.

UNIT IV   **ENVIRONMENTAL CONTROL**   **9**

System Safety Analysis –Techniques – Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), HAZOP analysis and Risk Assessment.

UNIT V   **SAFETY REGULATIONS**   **9**

Explosions – Disaster management – catastrophe control, hazard control , Factories Act, Safety regulations Product safety – case studies.

TOTAL: 45 PERIODS

REFERENCES:
1. John V.Grimaldi, Safety Management, AITB S Publishers, 2003.
2. Safety Manual, EDEL Engineering Consultancy, 2000.
3. David L.Goetsch, Occupational Safety and Health for Technologists, Engineers and Managers, Pearson Education Ltd. 5th Edition 2005.

PTIE9023   **HUMAN RESOURCES MANAGEMENT**   **L T P C**
                                                            3 0 0 3

OBJECTIVE:
To introduce the basic principles of group dynamics and associated concepts required for Human resource management in organizations

UNIT I   INDIVIDUAL BEHAVIOR   9
Personality –Types –Influencing Personality – Learning Process, Attribute – Perception – Motivation Theories

UNIT II   GROUP BEHAVIOR   9
Group Organization, Group Dynamics, Emergence of Informal Leader, Leadership Styles-theories, Group decision making, Inter personal Relations, Communication - Team.

UNIT III   DYNAMICS OF ORGANIZATIONAL BEHAVIOR   9
 Organizational Climate, the Satisfactory –Organizational change – the Change Process & Change Management.

UNIT IV   HUMAN RESOURCES PLANNING   9
Requirements of Human Resources –HR audit, Recruitment-Selection-Interviews

UNIT V   HUMAN RESOURCES DEVELOPMENT   9
Employee Training-Career Development-Performance Appraisal-Compensation-safety and Health-Employee Relation-Management Development.

                                                TOTAL: 45 PERIODS

TEXT BOOK:
1. Stephen R. Robbins, "Organizational Behavior", PHI, 1998.

REFERENCES:
1. David A. Decenzo & Stephen R. Robbins, "Personnel/Human Resources Management", PHI, 1997.
2. Fred Lutherans, "Organizational Behavior", Oxford University Press, 2000.

PTIE9024   INFORMATION SYSTEMS ANALYSIS AND DESIGN   L T P C
                                                              3 0 0 3

OBJECTIVE:
To impart knowledge on the basics of systems analysis and design required for developing application software in a given environment.

UNIT I   OVERVIEW   6
Information and Management - types of information, Examples of Information systems, Information Systems analysis overview, Information gathering - sources

UNIT II   DATA FLOW DIAGRAMS   10
System Requirements specifications, Feasibility analysis, Data flow diagrams – logical and physical DFDs, Process specification methods, Decision tables

UNIT III   ER DIAGRAMS   12
Logical database design – ER model, Normalizing relations; Data input methods; Database Management Systems – database design, Object oriented systems modeling

UNIT IV   E-COMMERCE   8
Designing outputs, Security of Information systems, E-commerce

UNIT V   APPLICATIONS   9
System design example: Document and data flow diagrams, Feasibility of the system, System specifications, Database design, Control, audit and test plan

                                                    TOTAL: 45 PERIODS
REFERENCES:
1. V. Rajaraman, Analysis and Design of Information Systems, PHI, 2004
2. Jeffrey L Whitten et al, Systems Analysis and Design Methods, McGraHill,2003

PTIE9026   VALUE ENGINEERING AND PROJECT MANAGEMENT   L T P C
                                                              3 0 0 3
OBJECTIVE:
To give a brief account of the value analysis and engineering tool for productivity improvement through project management

UNIT I   VALUE ENGINEERING BASICS   9
Origin of Value Engineering, Meaning of value, Definition of Value Engineering and Value analysis, Difference between Value analysis and Value Engineering, Types of Value, function - Basic and Secondary functions, concept of cost and worth, creativity In Value Engineering.

UNIT II   VALUE ENGINEERING JOB PLAN AND PROCESS   9
Seven phases of job plan, FAST Diagram as Value Engineering Tool, Behavioural and organizational aspects of Value Engineering, Ten principles of Value analysis, Benefits of Value Engineering.

UNIT III   PROJECT FORMULATION AND APPRAISAL   9
Project Management – An overview, Feasibility and Technical analysis, Marketing feasibility, Financial and Economic feasibility, Formulation of Detailed Project Reports (DPR).

UNIT IV   PROJECT IMPLEMENTATION AND CONTROL   9
Project planning, Project organization, Tools and techniques of project management, Project management Information system, Human resources, Financial aspects.

UNIT V   PROJECT COMPLETION AND EVALUATION   9
Monitoring and Control of project, Integrated project management control system, Managing transition from project to operations, project review.

TOTAL: 45 PERIODS

REFERENCES:
1. Mudge, Arthur E. "Value Engineering"- A systematic approach, McGraw Hill, New York, 2000.
2. Martandtelsang, Industrial Engineering and Production Management" S.Chand and Company LTd., New Delhi, 2002.
3. Choudhury, S. "Project scheduling and monitoring in practice, South Asian Publishers, New Delhi, 2001.
4. Goodman, L.J. Project planning and Management – An integrated system for improving productivity, Van Norstand, New York, 2000.
5. Kerzner, H. "Project Management" A system for approach to planning, scheduling and controlling 2nd Rf/CBS publishers, Delhi, 2002.
6. P.Gopalakrishnan, Text book of Project Management, Macmillan, India, 2000.

PTIE9027   TECHNOLOGY MANAGEMENT   L T P C
                                                          3 0 0 3

UNIT I   INTRODUCTION   9
Technology management - Scope, components, and overview. Technology and environment, Technology and society, Technology Impact analysis, environmental, social, legal, political aspects, techniques for analysis - steps involved. Technology policy strategy: Science and technology Policy of India, implications to industry.

UNIT II   TECHNOLOGY FORECASTING MODELS   9
Technology forecasting - need, methodology and methods - trend Analysis, Analogy, Delphi, Soft System Methodology, Mathematical Models, Simulation, and System Dynamics.

UNIT III   EVALUATION METHODS   9
Technology Choice and Evaluation - Methods of analysing alternate technologies, Techno-economic feasibility studies, Need for multi-criteria considerations such as, social, environmental, and political, Analytic hierarchy method, Fuzzy multi-criteria decision making, and other methods.

UNIT IV　　　TECHNOLOGY TRANSFER　　　　　　　　　　　9

Technology Transfer and Acquisition - Import regulations, Implications of agreements like Uruguay Round and WTO, Bargaining process, Transfer option, MOU- Technology Adoption and Productivity - Adopting technology-human interactions, Organisational redesign and re-engineering, Technology productivity.

UNIT V　　　TECHNOLOGY INNOVATION　　　　　　　　　　9

Technology Absorption and Innovation - present status in India, Need for new outlook, Absorption strategies for acquired technology, creating new/improved technologies, Innovations. Technology Measurement- Technology Audit.

TOTAL: 45 PERIODS

TEXT BOOK:
1. Richard C. Dorf, Technology Management Handbook, CRC,1999

REFERENCES:
1. Joseph M. Putti, Management – A Functional Approach, McGraw Hill, 1997
2. Kenneth C. Lauden , MIS: Organisation and Technology, Prentice Hall, 1995
3. James A.Senn, Information technology in Business, Prentice Hall, 1995
4. Ronald J. Jordan, Security analysis and Portfolio Management, Prentice Hall, 1995
5 .Irvin M. Rubin, Organisational behavior an experimental approach, Prentice Hall, 1995
6. Gerard H. Gaynor, Handbook of Technology Management, McGraw-Hill Professional, 1996

PTIE9028　　　MODELING OF MANUFACTURING SYSTEMS　　　L T P C
**　　　　　　　　　　　　　　　　　　　　　　　　　　　　　3 0 0 3**

OBJECTIVE:
To cover some of the modeling paradigms applicable for discrete items manufacturing systems and evaluation of such systems performance.

UNIT I　　　FOCUSED FACTORIES　　　　　　　　　　　　9

Manufacturing Systems and Models, Focused factory types, Group Technology – assigning machines to groups, assigning parts to machines, Mathematical program for group formation

UNIT II　　　UNPACED PRODUCTION LINES　　　　　　　　9

Production lines – Paced with and without buffers – computing system effectiveness; unpaced lines – impact of random processing times and recovery of throughput through buffers

UNIT III　　　FMS PLANNING MODELS　　　　　　　　　　9

FMS planning and Control Hierarchy – part selection and loading problems – knapsack and loading heuristic

UNIT IV　　　MARKOV MODELS　　　　　　　　　　　　　9

Stochastic processes in manufacturing, Markov chain models – DTMC and CTMC, steady state analysis, Simulation models of manufacturing systems

UNIT V　　　QUEUING AND PETRINET MODELS　　　　　　9

Queuing networks in manufacturing – Jackson and Gordon Newell, product form solution, Petrinets in manufacturing – basic concepts, stochastic petrinets, system performance measure

TOTAL: 45 PERIODS

REFERENCES:
1. Ronald G Askin, "Modeling and Analysis of Manufacturing systems", Wiley sons, 2003.
2. Viswanadham and Narahari, "Performance modeling of automated manufacturing systems", PHI, 2003.
3. Nicholas J M, "Competitive Manufacturing Management", TMH, 2001.
4. Buzacot and Shantikumar, "Queueing networks in Manufacturing", Wiley Sons, 2000.
5. Reisig W, "System Design Using Petrinets", Springer, 2000.

PTIE9030   DECISION SUPPORT AND INTELLIGENT SYSTEMS   L T P C
3 0 0 3

OBJECTIVE:
To impart knowledge on basics of DSS and Knowledge based systems

UNIT I   INTRODUCTION   5
Managerial decision making, system modeling and support-preview of the modeling process-phases of decision making process.

UNIT II   ANALYSIS   10
DSS components- Data warehousing, access, analysis, mining and visualization-modeling and analysis-DSS development.

UNIT III   TECHNOLOGIES   10
Group support systems- enterprise DSS- supply chain and DSS-knowledge management methods, technologies and tools.

UNIT IV   EXPERT SYSTEMS   10
Artificial intelligence and expert systems-concepts, structure, types-knowledge acquisition and validation-difficulties, methods, selection.

UNIT V   SEMANTIC NETWORKS   10
Representation in logic and schemas, semantic networks, production rules and frames, inference techniques, intelligent system development, implementation and integration of management support systems.

TOTAL: 45 PERIODS

REFERENCES:
1. Efraim Turban and Jay E Aronson, Decision Support and Intelligent Systems, Pearson education Asia, Sixth edition, 2002.
2. S S Mitra, Decision support systems, tools and techniques, John Wiley, 1996.
3. Elain Rich and Kevin Knight, Artificial intelligence, TMH,1993.

PTIE9032   **SYSTEMS ENGINEERING**   **L T P C**
                                                                          3 0 0 3

OBJECTIVE:
To cover the basics of systems engineering study steps and associated techniques in the systems analysis.

UNIT I   INTRODUCTION   6
Definitions, Systems theory, Life-Cycle phases, Systems Engineering processes, Seven-phase and twenty-two phase life cycle for systems acquisition.

UNIT II   FORMULATION OF ISSUES   9
Problem or Issue identification, Formulation of issues with an example – Identification of needs, alterables, constraints, Value system design,   Requirements statement, Generation of Alternatives or System synthesis, Feasibility studies.

UNIT III   ANALYSIS OF ALTERNATIVES   12
Analysis of systems with uncertain and imperfect information, structural modeling – trees, causal loops, and influence diagrams, system dynamics models, Economic models, Reliability models, Discrete event models.

UNIT IV   DECISION ASSESSMENT   9
Interpretation of alternative courses of action, Formal Decisions – prescriptive and normative decision assessments, Descriptive decision models – Group decision making.

UNIT V   SYSTEMS ENGINEERING MANAGEMENT   9
Organizational structures, Methods for systems Engineering Management, Human and cognitive factors in Systems Engineering and Systems Management.

                                                          TOTAL: 45 PERIODS
TEXT BOOK:
1. Andrew P.Sage, James E.Armstrong Jr, "Introduction to Systems Engineering", John Wiley and Sons Inc. 2000.

REFERENCES:
1. Andrew P.Sage, "Systems Engineering", John Wiley & Sons, 1992.
2. Andrew P.Sage, William B.Rouse, "Hand book of Systems Engineering and Management", John Wiley & Sons, 1999.

PTIE9034   MAINTENANCE ENGINEERING AND MANAGEMENT   L T P C
                                                          3 0 0 3

OBJECTIVE:
To cover maintenance strategies, associated models for application and evaluation in different types of industries

UNIT I   MAINTENANCE CONCEPT   8
Need for Maintenance – Maintenance management – Tero technology – Challenges of physical asset management – Scope of Maintenance department – Maintenance organization – Maintenance costs – Imperfect maintenance – Toyota maintenance concept – Maintenance policies: PM, CM, DOM, OM – Condition monitoring.

UNIT II   MAINTENANCE MODELS   10
Probability models in maintenance – Choice between PM and b/d maintenance – Optimal PM schedule and quality loss – Inspection decisions: Maximization of profit – Minimization of downtime – Analysis of downtime – Repair time distribution: exponential, lognormal – System repair time – Maintainability prediction – Corrective maintenance downtime – Design for maintainability.

UNIT III   MAINTENANCE LOGISTICS   12
Maintenance planning – Maintenance scheduling – Priority systems – Proactive/reactive maintenance – Minimum/extensive maintenance – Work order form – Spare parts control: setting reorder point – Overall part availability – unique/interchangeable spares – Ebel graph – Capital spare – Maintenance resource requirements – Queuing theory applications: Optimal number of workshop machines – Optimal repair effort – Maintenance crew size – use of learning curves – simulation – Human factors in maintenance.

UNIT IV   REPLACEMENT MODELS   9
Component replacement decisions – Assumptions –Model for equipment whose operating cost increases with use – Preventive replacement age of item subject to breakdown – Preventive replacement interval/age: minimization of downtime, Capital equipment replacement decisions

UNIT V   ADVANCED MAINTENANCE   6
Total Productive Maintenance – Chronic and sporadic losses – Six big losses – Equipment effectiveness – Autonomous maintenance – Reliability Centered Maintenance – CMMS – Software maintenance.

TOTAL: 45 PERIODS

REFERENCES:
1. An introduction to Reliability and Maintainability Engineering –Charles E.Ebeling, Tata McGraw-Hill, New Delhi, 2003.
2. Maintenance, Replacement and Reliability –Andrew K.S.Jardine and Albert H.C.Tsang, Taylor & Francis, New York, 2006.
3. Autonomous maintenance in seven steps – Masaji Tajiri and Fumio Gotoh, Productivity Inc., Oregon, 1999.

PTIE9352   PRINCIPLES OFCOMPUTER INTEGRATED MANUFACTURING
SYSTEMS   L T P C
3 0 0 3

OBJECTIVE:
To provide some aspects of Fixed, Flexible and integrated automation along with their applications

UNIT I   GT AND FMS   9
Part families, production flow analysis, cellular manufacturing, ROC, Flexible manufacturing systems- components, FMS applications, FMS analysis – bottleneck model.

UNIT II   TRANSFER LINES   9
Automated production lines – applications, Analysis – with and without buffers, automated assembly systems, line unbalancing concept.

UNIT III   MANUFACTURING SUPPORT SYSTEMS   9

Product design and CAD, CAD/CAM and CIM, Computer aided process planning-variant and generative approaches, Concurrent engineering and design for manufacture, Lean production, Agile manufacturing.

UNIT IV   FUNDAMENTALS OF COMMUNICATIONS   9

Information, Communications matrix, Computer communications, Network architecture, Tools and techniques.

UNIT V   DATABASE   AND CIM MANAGEMENT   9

Manufacturing data, database technology, Database management, Management OF CIM – role, cost justification, expert systems

TOTAL: 45 PERIODS

REFERENCES:
1. Mickel P Groover, Automation production systems and computer integrated manufacturing, PHI, second edition, 2003.
2. S.Kant Vajpayee, Principles of Computer-Integrated Manufacturing, PHI, 2005

PTIE9353   RELIABILITY ENGINEERING   L T P C
3 0 0 3

OBJECTIVE:
To cover the basic concepts of reliability, reliability estimation, and reliability management

UNIT I   RELIABILITY CONCEPTS   6

Reliability definition – Reliability function – Graphical representation – a priori, a posteriori probabilities of survival. Component mortality – Mortality curve – Useful life – Reliability mathematics.

UNIT II   FAILURE DATA MODELING   13

Failure data requirements – Measures of reliability: Failure rate, MTBF, MTTF – Median time to failure – Comparison of measures of central tendency – Design life – Performance parameters using histogram – Survival curves – Failure time distributions Variable failure rates – Ranking of data – Probability plotting: Binomial, Exponential, Weibull hazard plotting – Goodness of fit: Chi square test – Kolmogorov Smirnov test – Confidence intervals.

UNIT III   RELIABILITY PREDICTION AND MODELING   13

Series – parallel configurations – Redundant systems – Standby systems – K out of n redundancy – Reliability of complex systems: RBD approach – Baye's decomposition method – Cut and tie sets – Fault tree analysis – Markov model – Software reliability prediction and measurement.

UNIT IV   RELIABILITY MANAGEMENT   8

Reliability in design – limitations – Reliability life testing – Reliability growth monitoring – Reliability allocation – Reliability Centered Maintenance (RCM) – Replacement models: Items that deteriorate with time – Items which fail completely –   Economic life of asset – Spares planning – System availability – Restorability demonstration.

UNIT V   RISK ASSESSMENT   5
Perception of risk and ALARP – Measurement of risk – Hazard identification: HAZOP, HAZID – FMEA – Probabilistic Risk Assessment. (PRA).

                                                              TOTAL: 45 PERIODS

REFERENCES:
1. An introduction to, "Reliability and Maintainability Engineering"- Charles E.Ebeling, TMH, 2000.
2. Practical Reliability Engineering – Patrick D.T.O'Corner John Wiley & Sons Ltd.,2003.
3. "Reliability for Technology, Engineering and Management", Paul Kales, Prentice Hall, New Jersey, 1998.

**PTIE9403   OPERATIONS SCHEDULING   L T P C
                                                              3 0 0 3**

OBJECTIVE:
To impart knowledge on various scheduling techniques applicable to Job shop, Flow shop configurations.

UNIT I   SCHEDULING AND SEQUENCING   6
Scheduling function – Scheduling theory – Sequencing and scheduling objectives – Constraints – Pure sequencing problem – Ready time – Flow time – Lateness – Tardiness- In process inventory – SPT, EDD, WSPT – Regular measure of performance-Sequencing theorems.

UNIT II   SINGLE MACHINE MODEL   10
Minimization of number of tardy jobs: Hodgson's algorithm – Minimizing mean flow time: Smith's rule – Minimizing mean tardiness: Wilkerson Irwin algorithm – Dynamic programming approach – Branch and Bound algorithm – Neighbourhood search technique – Non simultaneous arrivals – Minimizing mean tardiness for dependent jobs – Minimizing weighted mean flow time: Horn's method, Sidney's algorithm-Sequence dependent set up times.

UNIT III   PARALLEL MACHINE MODEL   8
Independent jobs: McNaughton's algorithm for makespan minimization– Heuristic procedures to minimize mean flow   time and makespan – Minimizing mean weighted flow time: H_1 heuristic and H_m heuristic– Dependent jobs: Hu's algorithm – Muntz Coffman algorithm.

UNIT IV   FLOW SHOP MODEL   10
Characteristics – Johnson's algorithm – Extension of Johnson's rule – Campbell Dudek Smith algorithm – Palmer's heuristic approach – Start lag, Stop lag – Mitten's algorithm – Ignall Schrage algorithm - Despatch index heuristic

UNIT V   JOB SHOP MODEL   11
Characteristics-Graphical description – Jackson's method – Feasible, Semi-active schedules – Active schedule generation – Non delay schedule generation – Heuristics schedule generation – Priority dispatching rules – simulation – Open shop scheduling

REFERENCES:
1.   Introduction to sequencing and scheduling – Kenneth R.Baker John Wiley & Sons, New York, 2000.
2.   Industrial scheduling – Dilip R.Sule, PWS Publishing company, Boston, 1997.

PTME9021   **ENERGY CONSERVATION AND MANAGEMENT**   **L T P C**
                                                                    3 0 0 3

AIM :
To instruct the importance of energy conservation in both thermal and electrical energy and its management for the better utilization of resources.

OBJECTIVES:
At the end of the course, the student is expected to
- Understand and analyse the plant energy data
- Carryout Energy audit and suggest methodologies for energy savings
- Energy accounting and balancing
- Able to utilise the available resources in optimal way

UNIT I   IMPORTANCE OF ENERGY CONSERVATION AND MANAGEMENT   8
World, National Energy consumption – environmental aspects – Energy prices, policies – Energy auditing : methodology, analysis, energy accounting – Measurements – Thermal and Electrical.

UNIT II   ELECTRICAL SYSTEMS   12
AC / DC current systems, Demand control, power factor correction, load management, Motor drives : motor efficiency testing, energy efficient motors, motor speed control – Lighting : lighting levels, efficient options, daylighting, timers – electrical distribution systems – Transformers – Power quality – harmonic distortion.

UNIT III   THERMAL SYSTEMS   10
Boiler – efficiency testing, excess air control, Steam distribution & use – steam traps, condensate recovery, flash steam utilization, Thermal Insulation. Heat exchanger networking – concept of pinch, target settling.

UNIT IV   ENERGY CONSERVATION   8
Energy conservation in Pumps, Fans (flow control) and blowers, Compressed Air Systems, Refrigeration and air conditioning systems – Waste heat recovery Recuperators, heat sheets, heat pipes, heat pumps.

UNIT V   ENERGY MANAGEMENT AND ECONOMICS   7
Energy resource management – Energy Management information systems – Computerized energy management – Energy economics – discount rate, payback period, internal rate of Return, life cycle costing – Financing energy conservation Projects.

TOTAL : 45 PERIODS

TEXT BOOKS:
1. L.C. Witte, P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.
2. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.

REFERENCES:
1. I.G.C. Dryden, "The Efficient Use of Energy" Butterworths, London, 1982
2. W.C. turner, "Energy Management Hand book" Wiley, New York, 1982.
3. W.R. Murphy and G. Mc KAY "Energy Management" Butterworths, London 1987.

PTME9029   **AUTOMOBILE ENGINEERING**   **L T P C**
                                                          3 0 0 3

AIM :
- Impartation of basic principles of Automotive Vehicular systems with suitable illustrations, numerical problems and enlightenment of development trends.

OBJECTIVES:
- To provide a comprehensive view of automobile engineering to the students.

PREREQUISITE :
Other branch students may be offered this course without any preconditions. However, a orientation programme lasting a duration of 10 hours may be offered on selected topics like thermodynamics and vehicle mechanics.

UNIT I   INTRODUCTION   5
Basic layouts of automotive vehicles including electric and hybrid electric systems, specifications and performance parameters of vehicles. Types of vehicle bodies & chasses.

UNIT II   ENGINE SYSTEMS   10
Reciprocating engine systems, Rotary engine systems, Electric motors, Hybrid systems, Gas turbine systems. Development trends like GDI and HCCI engine systems, complex hybrid electric systems, closed loop controls in piston engine systems, Alternate Fuel systems for propulsion engines. Vehicular pollutants emission and their controls. Three Way Catalytic converter features. Electronic Engine Management systems.

UNIT III   TRANSMISSION SYSTEM   10
Types of Clutch, gear box (manual and automatic), propeller shafting, differential and types of rear axle.

UNIT IV   AUTOMOTIVE SAFETY, HANDLING AND COMFORT SYSTEMS   10
Braking System, Steering System, Suspension system, Electrical system, Safety systems and HVAC system.

**UNIT V   TESTING AND SERVICING OF AUTOMOBILE ENGINES AND
                VEHICLES   10**
1. A brief discussion on the following :
2. Engine Tunning
3. Chassis Dynamometer
4. Tests for emissions of pollutants like HC, CO, CO2, NOx and particulates
5. Wind tunnel Testing of vehicles

                                                    TOTAL: 45 PERIODS

TEXT BOOKS:
1. Automotive Mechanics, William H Crouse and Donald L. Anglin, Tata McGraw-Hill Publishing Company Ltd., 2004, Tenth Edition.

REFERENCES:
1. Automotive Handbook, Bosch, Robert Bosch GmbH, Germany, 2004, Sixth Edition.
2. Automotive Technology – A Systems Approach, Jack Erjavek, Thomson Learning, 3rd Edition, 1999.

PTME9301   **DESIGN OF JIGS, FIXTURES AND PRESS TOOLS**   **L T P C**
                                                                   3 0 0 3

AIM:
- To appreciate and understand the importance of tool design in the overall product cycle.

OBJECTIVES:
- To understand the functions and design principles of Jigs, fixtures and press tools
- To gain proficiency in the development of required views of the final design.

UNIT I   LOCATING AND CLAMPING PRINCIPLES: **8**
Objectives of tool design- Function and advantages of Jigs and fixtures – Basic elements – principles of location – Locating methods and devices – Redundant Location – Principles of clamping – Mechanical actuation – pneumatic and hydraulic actuation Standard parts – Drill bushes and Jig buttons – Tolerances and materials used.

UNIT II   JIGS AND FIXTURES   10
Design and development of jigs and fixtures for given component- Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems- Quick change fixtures.

UNIT III   PRESS WORKING TERMINOLOGIES & ELEMENTS OF CUTTING DIES
                                                                          10
Press Working Terminologies - operations – Types of presses – press accessories – Computation of press capacity – Strip layout – Material Utilization – Shearing action – Clearances – Press Work Materials – Center of pressure- Design of various elements of dies – Die Block – Punch holder, Die set, guide plates – Stops – Strippers – Pilots – Selection of Standard parts – Design and preparation of four standard views of simple blanking, piercing, compound and progressive dies.

UNIT IV   BENDING, FORMING AND DRAWING DIES   10
Difference between bending, forming and drawing – Blank development for above operations– Types of Bending dies – Press capacity – Spring back – knockouts – direct and indirect– pressure pads – Ejectors – Variables affecting Metal flow in drawing operations– draw die inserts – draw beads- ironing–Design and development of bending, forming, drawing reverse re-drawing and combination dies – Blank development for axi-symmetric, rectangular and elliptic parts – Single and double action dies.

UNIT V   MISCELLANEOUS TOPICS   7
Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine Blanking dies – recent trends in tool design- computer Aids for sheet metal forming Analysis – basic introduction - tooling for numerically controlled machines- setup reduction for work holding – Single minute exchange of dies – Poka Yoke - Course should be supplemented with visits to industries.
(Use of Approved design Data Book permitted).
                                                        TOTAL: 45 PERIODS

TEXT BOOKS:
1. Joshi, P.H. "Jigs and Fixtures", Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2004.
2. Donaldson, Lecain and Goold "Tool Design", III rd Edition Tata McGraw Hill, 2000.

REFERENCES:
1. K. Venkataraman, "Design of Jigs Fixtures & Press Tools", Tata McGraw Hill, New Delhi, 2005.Kempster, "Jigs and Fixture Design", Hoddes and Stoughton – Third Edition 1974.
2. Joshi, P.H. "Press Tools" – Design and Construction", Wheels publishing, 1996.
3. Hoffman "Jigs and Fixture Design" – Thomson Delmar Learning, Singapore, 2004.
4. ASTME Fundamentals of Tool Design Prentice Hall of India. Design Data Hand Book, PSG College of Technology, Coimbatore.

PTME9351   **FINITE ELEMENT ANALYSIS**   **L T P C**
                                                                3 0 0 3

AIM:
• To appreciate the need for and applications of numerical techniques for solving problems in mechanical Engineering**.**

OBJECTIVES:
• To introduce the concepts of Mathematical Modeling of Engineering Problems.
• To appreciate the use of FEM to a range of Engineering Problems.

UNIT I   INTRODUCTION   9
Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems – Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT II   ONE-DIMENSIONAL PROBLEMS   9
One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors. Assembly of Matrices - solution of problems from solid mechanics and heat transfer- Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation – Transverse deflections and Natural frequencies of beams.

UNIT III   TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS   9
Second Order 2D Equations involving Scalar Variable Functions – Variational formulation – Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts – Quadrilateral elements – Higher Order Elements.

UNIT IV   TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS   9
Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements.

UNIT V   ISOPARAMETRIC FORMULATION AND MISCELLANEOUS TOPICS   9
Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems –

                                                         TOTAL : 45 PERIODS
TEXT BOOKS:
1. Seshu. P. "Textbook of Finite Element Analysis" Prentice Hall of India, 2003.
2. J.N. Reddy, " Finite Element Method" Tata McGraw Hill, 2003.

REFERENCES:
1. Chandrupatla and Belegundu, "Introduction to Finite Elements in Engineering" PHI / Pearson Education, 2003.
2. Logan. D.L. "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2002.
3. Cook R.D., Malkus. D.S. Plesha, ME., "Concepts and Applications of Finite Element Analysis", John – Wiley Sons 2003.
4. S.S. Rao, "The Finite Element Method in Engineering "Butter worth Heinemann, 2001.

PTMF9021	PRODUCT DESIGN AND DEVELOPMENT	L T P C
		3 0 0 3

AIM:
The course aims at providing the basic concepts of product design, product features and its architecture so that student can have a basic knowledge in the common features a product has and how to incorporate them suitably in product.

OBJECTIVE:
The student will be able to design some products for the given set of applications; also the knowledge gained through prototyping technology will help the student to make a prototype of a problem and hence product design and development can be achieved.

UNIT I   INTRODUCTION   5
Need for IPPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – Behaviour analysis. Understanding customer – prompting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specifications.

UNIT II   CONCEPT GNERATION AND SELECTION   5
Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits.

UNIT III   PRODUCT ARCHITECTURE   10
Implications – Product change – variety – component standardization – product performance – manufacturability – product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications.

UNIT IV   INDUSTRIAL DESIGN   10
Integrate process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically – Need for industrial design – impact – design process – investigation of for industrial design – impact – design process – investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.

UNIT V   DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT 15

Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity – Prototype basics – principles of prototyping – planning for prototypes – Economic Analysis – Understanding and representing tasks – baseline project planning – accelerating the project – project execution.

TOTAL: 45 PERIODS

TEXT BOOK:

1. Kari T.Ulrich and Steven D.Eppinger,"Product Design and Development", McGrtaw-Hill International Edns. 1999.

REFERENCES:

1. Kemnneth Crow,"Concurrent Engg./Integrated Product Development",DRM Associates,26/3, Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.
2. Stephen Rosenthal,"Effective Product Design and Development", Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.
3. Staurt Pugh,"Tool Design –Integrated Methods for Successful Product Engineering", Addison Wesley Publishing, New york, NY.

WEB REFERENCE BOOK:

http://www.me.mit/.2.7444.

PTMF9031   ROBOTICS   L T P C
3 0 0 3

AIM:

To provide in-depth knowledge in various elements of Industrial Robotics

OBJECTIVE:

The objective of this course in to impart knowledge in the fundamentals of Industrial Robotics, viz. Robot Anatomy, Drives, Sensors, end effectors, Robot kinematics and programming

UNIT I   FUNDAMENTALS OF ROBOT   8

Robot – Definition – Robot Anatomy – Co ordinate Systems, Work Envelope Types and classification – Specifications – pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and their Functions – Need for Robots – Different Applications.

UNIT II   ROBOT DRIVE SYSTEMS AND END EFFECTORS   9

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of all these Drives. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

UNIT III   SENSORS AND MACHINE VISION   10

Requirements of a sensor, Principles and Applications of the following types of Sensors – Types of sensors – contact and non contact sensors.

UNIT IV   ROBOT KINEMATICS AND ROBOT PROGRAMMING   9

Homogeneous Transformation equation – DH representation - Forward kinematics, Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of manipulators with Three Degrees of Freedom, Six Degrees of freedom – Deviations and problems.

Lead Through Programming, Robot Programming Languages – VAL programming – Motion Commands, Sensor Commands, End Effecter commands and simple programs.

UNIT V   IMPLEMENTATION AND ROBOT ECONOMICS   9

Advanced Robotics – Micro and Bio robotics - Implementation of Robots in Industries – Various Steps; Safety considerations for Robot Operations; Economic Analysis of Robots – Pay back method, Euac Method, Rate of Return Method.

TOTAL: 45 PERIODS

TEXT BOOK:
1. M.P.Groover, "Industrial Robotics – Technology, Programming and Applications", McGraw Hill, 2001.

REFERENCES:
1. Fu, K.S.Gonzaiz R.C., and Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill Book Co., 1987.
2. Yoram Koren, "Robotics for Engineers", McGraw Hill Book Co., 1992.
3. Janakiraman, P.A., "Robotics and Image Processing", Tata McGraw Hill, 1995.
4. Surendar Kumar, "Industrial Robots and Computer Integrated Manufacturing", Oxford and IBH Publishing Co. Pvt. Ltd., 1991.
5. S.R.Deb"Robotics Technology oand Flexible Automation" Tata McGraw Hill Book Co., 1994.

PTMF9035   ELECTRONICS MANUFACTURING TECHNOLOGY   L T P C
3 0 0 3

AIM:
To import knowledge on electronics manufacturing and packaging technology.

OBJECTIVES:
Upon the completion of the subject, student will be able to:
- Understand wafer preparation and PCB fabrication
- Know the types of Mounting Technologies and components for electronics assembly
- Appreciate SMT process in detail.
- Know various Defects, Inspection Equipments SMT assembly process.
- Learn repair, rework and quality aspects of Electronics assemblies.

UNIT I   INTRODUCTION TO ELECTRONICS MANUFACTURING   8

History, definition, wafer preparation by growing, machining, and polishing, diffusion, microlithography, etching and cleaning, Printed circuit boards, types- single sided, double sided, multi layer and flexible printed circuit board, design, materials, manufacturing, inspection.

UNIT II   COMPONENTS AND PACKAGING   9

Introduction to packaging, types-Through hole technology(THT) and Surface mount technology(SMT), Through hole components – axial, radial, multi leaded, odd form.

Surface-mount components- active, passive. Interconnections - chip to lead interconnection, die bonding, wire bonding, TAB, flip chip, chip on board, multi chip module, direct chip array module, leaded, leadless, area array and embedded packaging, miniaturization and trends.

UNIT III   SURFACE MOUNT TECHNOLOGY PROCESS   12
Introduction to the SMT Process, SMT equipment and material handling systems, handling of components and assemblies - moisture sensitivity and ESD, safety and precautions needed, IPC and other standards, stencil printing process - solder paste material, storage and handling, stencils and squeegees, process parameters, quality control. Component placement- equipment type, flexibility, accuracy of placement, throughput, packaging of components for automated assembly, Cp and Cpk and process control. soldering- reflow process, process parameters, profile generation and control, solder joint metallurgy, adhesive, underfill and encapsulation process - applications, materials, storage and handling, process and parameters.

UNIT IV   INSPECTION AND TESTING   9
Inspection techniques, equipment and principle - AOI, X-ray. Defects and Corrective action - stencil printing process, component placement process, reflow soldering process, underfill and encapsulation process, electrical testing of PCB assemblies- In circuit test, functional testing, fixtures and jigs.

UNIT V   REPAIR, REWORK, QUALITY AND RELIABILITY OF ELECTRONICS   ASSEMBLIES   7
Repair tools, methods, rework criteria and process, thermo-mechanical effects and thermal management, Reliability fundamentals, reliability testing, failure analysis, design for manufacturability, assembly, reworkability, testing, reliability, and environment.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Surface Mount Technology –Principles and practice by Ray Prasad – second edition , Chapman and Hall ,1997 ,New York , ISBN 0-41-12921-3
2. Fundamentals of microsystem packaging by Rao.R .Tummala, Mc -Graw Hill 2001 , ISBN 00-71-37169-9

REFERENCES:
1. Failure Modes and Mechanisms in Electronic Packages, Puligandla Viswanadham and Pratap Singh, Chapman and Hall, New York , N.Y. ISBN 0-412-105591-8
2. Area Array Interconnection Handbook, Paul Totta and Karl Puttlitz, and Kathleen Stalter , Kluwer Academic Publishers, Norwell, MA, USA, 2001.
   ISBN 0-7923-7919-5.
3. Reflow Soldering Process and Trouble Shooting SMT,BGA,CSP and Flip Chip Technologies by Ning-Cheng Lee,Elsevier Science, ISBN 0-7506-7218-8.
4. Surface Mount Technology Terms and Concepts by Zarrow , Phil, Elsevier Science and Technology,1997.ISBN 0750698756
5. Electronic Packaging and Interconnection Handbook, by C.A.Harper, Second Edition, McGraw Hill Inc., New York, N.Y.,1997,ISBN 0-07-026694-8
6. www.ipc.org
7. www.smta.org

PTMF9402   **FLEXIBLE MANUFACTURING SYSTEMS**   **L T P C**
                                                                   3 0 0 3

AIM:
To impart knowledge on group technology, simulation, computer control, automatic manufacturing systems and factory of the future.

OBJECTIVES:
At the end of this course the student should be able to understand
- Modern manufacturing systems
- To understand the concepts and applications of flexible manufacturing systems

UNIT I   PLANNING, SCHEDULING AND CONTROL OF FLEXIBLE
**   MANUFACTURING SYSTEMS   9**
Introduction to FMS– development of manufacturing systems – benefits – major elements – types of flexibility – FMS application and flexibility –single product, single batch, n – batch scheduling problem – knowledge based scheduling system.

UNIT II   COMPUTER CONTROL AND SOFTWARE FOR FLEXIBLE
**   MANUFACTURING SYSTEMS   9**
Introduction – composition of FMS– hierarchy of computer control –computer control of work center and assembly lines – FMS supervisory computer control – types of software specification and selection – trends.

UNIT III   FMS SIMULATION AND DATA BASE   9
Application of simulation–model of FMS–simulation software – limitation – manufacturing data systems–data flow–FMS database systems–planning for FMS database.

UNIT IV   GROUP TECHNOLOGY AND JUSTIFICATION OF FMS   9
Introduction – matrix formulation – mathematical programming formulation –graph formulation – knowledge based system for group technology – economic justification of FMS- application of possibility distributions in FMS systems justification.

UNIT V   APPLICATIONS OF FMS AND FACTORY OF THE FUTURE   9
FMS application in machining, sheet metal fabrication, prismatic component production – aerospace application – FMS development towards factories of the future – artificial intelligence and expert systems in FMS – design philosophy and characteristics for future.

                                                        TOTAL: 45 PERIODS

TEXT BOOK:
1. Jha, N.K. "Handbook of flexible manufacturing systems", Academic Press Inc., 1991.

REFERENCES:
1. Radhakrishnan P. and Subramanyan S., "CAD/CAM/CIM", Wiley Eastern Ltd., New Age International Ltd., 1994.
2. Raouf, A. and Ben-Daya, M., Editors, "Flexible manufacturing systems: recent development", Elsevier Science, 1995.
3. Groover M.P., "Automation, production systems and computer integrated manufacturing", Prentice Hall of India Pvt., New Delhi, 1996.
4. Kalpakjian, "Manufacturing engineering and technology", Addison-Wesley Publishsing Co., 1995.
5. Taiichi Ohno, "Toyota production system: beyond large-scale production", Productivity Press (India) Pvt. Ltd. 1992.

PTMG9071   **MARKETING MANAGEMENT**   **L T P C**
                                                              3 0 0 3

OBJECTIVE:
To introduce the basic concepts of marketing, product pricing, marketing planning and sales promotion.

UNIT I   CONCEPTS IN MARKETING   9
Definition, Marketing Process, Dynamics, Needs, Wants and Demands, Marketing concepts, Environment, Mix, types, Philosophies, Selling Vs Marketing, Consumer Goods, Industrial Goods, Product, Hierarchy.

UNIT II   BUYING BEHAVIOUR AND MARKET SEGMENTATION   9
Cultural, Demographic factors, Motives, Types, Buying Decision, Segmentation factors, Demographic, Psychographic and Geographic Segmentation, Process, Patterns.

UNIT III   PRODUCT PRICING AND MARKETING RESEARCH   9
Objectives, Pricing, Decisions and Pricing Methods, Pricing Management, Introduction, Uses, Process of Marketing Research.

UNIT IV   MARKETING PLANNING AND STRATEGY FORMULATION   9
Components of a Marketing Plan, Strategy Formulation and the Marketing Process. Implementation, Portfolio Analysis, BCG, GEC Grids.

UNIT V   ADVERTISING, SALES PROMOTION AND DISTRIBUTION   9
Characteristics, Impact, Goals, Types, Sales Promotion – Point of purchase, Unique Selling propositions, Characteristics, Wholesaling, Retailing, Channel Design, Logistics Modern Trends in Retailing.

                                                      TOTAL: 45 PERIODS

TEXT BOOKS:
1. Govindarajan, M., "Modern Marketing Management", Narosa Publishing House, New Delhi 1999.
2. Green Paul, E. and Donald Tull, "Research for Marketing Decisions", 1975.
3. Ramaswamy, V.S. and S.Namakumari, "Marketing Environment Planning, Implementation and control the Indian Context", 1990.

REFERENCE:
1. Philip Kotler, "Marketing Management – Analysis Planning Implementation and Control".

PTMG 9072   **ENTREPRENEURSHIP DEVELOPMENT**   **L T P C**
                                                    3 0 0 3

OBJECTIVE:
Study of this subject provides an understanding of the scope of an entrepreneur, key areas of development, financial assistance by the institutions, methods of taxation and tax benefits, etc**.**

UNIT I   ENTREPRENEURSHIP   9
 Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur - Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

UNIT II   MOTIVATION   9
Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Entrepreneurial Skills - Self Rating, Business Game, Thematic Appreciation Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

UNIT III   BUSINESS   9
Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

UNIT IV   FINANCING AND ACCOUNTING   9
Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management of working Capital, Costing, Break Even Analysis, Network Analysis Techniques of PERT / CPM – Taxation – Income Tax, Excise Duty – Sales Tax.

UNITV   SUPPORT TO ENTREPRENEURS   9
Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.

                                                     TOTAL: 45 PERIODS

TEXT BOOKS:
1. S.S.Khanka "Entrepreneurial Development" S.Chand & Co. Ltd. Ram Nagar New Delhi, 1999.
2. Kurahko & Hodgetts, " Enterprenuership – Theory, process and practices", Thomson learning 6th   edition.

REFERENCES:
1. Hisrich R D and Peters M P, "Entrepreneurship" 5th Edition Tata McGraw-Hill, 2002.
2. Mathew J Manimala," Enterprenuership theory at cross roads: paradigms and praxis" Dream tech 2nd edition 2006.
3. Rabindra N. Kanungo "Entrepreneurship and innovation", Sage Publications, New Delhi, 1998.
4. EDII " Faulty and External Experts – A Hand Book for New Entrepreneurs", Entrepreneurship Development Institute of India, Ahmedabad, 1986.

PTPT9071   PACKAGING MATERIALS & TECHNOLOGY   LT P C
                                                                3 0 0 3

OBJECTIVE:
To study the fundamentals of packaging, manufacturing process, packaging materials and package testing.

UNIT I   FUNDAMENTALS OF PACKAGING   6
Definition, functions of packaging, types and selection of package, Packaging hazards, interaction of package and contents, materials and machine interface, Environmental and recycling considerations - life cycle assessment

Package Design - Fundamentals, factors influencing design, stages in package development,graphic design, Structural design – simulation softwares

UNIT II   PACKAGING MATERIALS   11
Major Plastic packaging materials viz. Polyolefins, Polystyrene, Polyvinylchloride, Polyesters, Polyamides (Nylons), Polycarbonate and newer materials such as High Nitrile Polymers, Polyethylene Napthalate (PEN), Nanomaterials, biodegradable materials – properties and applications, recycling; Wood, Paper, Textile, Glass, Metals - Tin, Steel, aluminum, Labelling materials, Cushioning Materials – properties and areas of application.

UNIT III   CONVERSION TECHNOLOGY   12
Extrusion – Blown film, cast film, sheet, multilayer film & sheet, Lamination, Injection moulding, Blow moulding, Thermoforming; Cartoning Machinery, Bottling, Can former, Form Fill and Seal machines, Corrugated box manufacturing machineries, Drums – types of drums, moulded pulp containers, Closures, Application of Robotics in packaging.
Surface treatment for printing, Printing processes – offset, flexo, gravure and pad printing

UNIT IV   SPECIALITY PACKAGING   9
Aerosol packaging, Shrink and Stretch wrapping, Blister packaging, Anti-static packaging,   Aseptic packaging, Active packaging, Modified Atmospheric Packaging, Ovenable package; Cosmetic packaging, Hardware packaging, Textile packaging, Food packaging; Child resistant and Health care packaging, Export packaging, Lidding, RFID in packaging.

UNIT V   TESTING   7
Package Testing – Drop test, Impact test, Vibration Test, Stacking and Compression test, Packaging Materials Testing: Mechanical – Tensile, tear burst, impact, compression test, Elongation, barrier properties - WVTR test, Adhesion test, Optical – Gloss, haze and clarity; Chemical Resistance test – solvents and chemicals, solubility test, burning test, solvent retention; Hardness and corrosion test for metals; Clarity and brittleness test for glass.

                                                    TOTAL: 45 PERIODS
TEXT BOOKS:
1. Aaron L.Brody & Kenneth S.Marsh, "Encyclopedia of Packaging Technology",John Wiley Interscience Publication, II Edition, 1997.
2. F.A. Paine, "Fundamentals of Packaging", Brookside Press Ltd., London, 1990.
3. A.S.Athayle, "Plastics in Flexible Packaging", Multi-tech Publishing Co., First Edition, 1992.

REFERENCES:

1. Mark J.Kirwar, "Paper and Paperboard Packaging Technology", Blackwell Publishing, 2005
2. "Handbook of Package Design Research", Water stem Wiley Intrascience, 1981.
3. Paine, "Packaging Development", PIRA International, 1990.
4. Arthur Hirsch, "Flexible Food Packaging", Van Nostor and Reinhold, New York, 1991.
5. E.P.Danger, "Selecting Colour for Packaging", Grover Technical Press, 1987.
6. Susan E.M.Salke & et al, Plastics Packaging, Hansar, 2nd edition 2004.
7. Bill Stewart, "Packaging Design Strategies", Pira International Ltd, 2nd Edition 2004.
8. Gunilla Johnson, "Corrugated Board Packaging", PIRA International, 1993.