BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ORISSA

Plastic Engineering

3rd Semester				4th Semester			
THEORY		*Contact Hours*		*THEORY*		*Contact Hours*	
Code	*Subject*	*L-T-P*	*Credits*	*Code*	*Subject*	*L-T-P*	*Credits*
BSCM1205	Mathematics – III	3-1-0	4	BSCM1210	Mathematics – IV	3-1-0	4
BEME2209	Fluid Mechanics & Machines	3-0-0	3	PCPE4202	Polymer Structure & Properties Relationship	3-0-0	3
BSMS1209	Material Sciences	3-0-0	3	PCPE4203	Plastic Materials & Application	3-1-0	4
PCPE4201	Fundamentals of Polymer Science	3-0-0	3	PCPE4204	Additives & Compounding	3-0-0	3
HSSM3204	Engineering Economics & Costing	3-0-0	3	HSSM3205	Organizational Behaviour	3-0-0	3
	OR				OR		
HSSM3205	Organisational Behaviour			HSSM3204	Engineering Economics & Costing		
BECS2212	C++ & Object Oriented Programming	3-0-0	3	BECS2208	Database Management Systems	3-0-0	3
	Credits (Theory)		19		Credits (Theory)		20
	PRACTICALS/SESSIONALS				*PRACTICALS/SESSIONALS*		
PCME7202	Mechanical Engineering Lab.	0-0-3	2	PCME7203	Machine Shop and Fabrication Practice	0-0-3	2
	OR				OR		
PCME7203	Machine Shop and Fabrication Practice			PCME7202	Mechanical Engineering Lab.		
BECS7212	C++ & Object Oriented Programming Lab	0-0-3	2	BECS7208	Database Management Systems Lab	0-0-3	2
HSSM7203	COMMUNICATION AND INTERPERSONAL SKILLS FOR CORPORATE READINESS	0-0-3	2	PCPE7202	Polymer Chemistry Lab.	0-0-3	2
	Credits (Practicals/ Sessionals)		6		Credits (Practicals/Sessionals)		6
	TOTAL SEMESTER CREDITS		25		TOTAL SEMESTER CREDITS		26

BSCM1205 **Mathematics - III**

Module-I **(18 hours)**

Partial differential equation of first order, Linear partial differential equation, Non-linear partial differential equation, Homogenous and non-homogeneous partial differential equation with constant co-efficient, Cauchy type, Monge's method, Second order partial differential equation
The vibrating string, the wave equation and its solution, the heat equation and its solution, Two dimensional wave equation and its solution, Laplace equation in polar, cylindrical and spherical coordinates, potential.

Module-II **(12 hours)**

Complex Analysis:
Analytic function, Cauchy-Riemann equations, Laplace equation, Conformal mapping,
Complex integration: Line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula, Derivatives of analytic functions

Module –III **(10 hours)**

Power Series, Taylor's series, Laurent's series, Singularities and zeros, Residue integration method, evaluation of real integrals.

Text books:

1. E. Kreyszig," Advanced Engineering Mathematics:, Eighth Edition, Wiley India
   Reading Chapters: 11,12(except 12.10),13,14,15
2. B.V. Ramana, " Higher Engineering Mathematics", McGraw Hill Education, 2008
   Reading chapter: 18

Reference books:

1. E.B. Saff, A.D.Snider, " Fundamental of Complex Analysis", Third Edition, Pearson Education, New Delhi
2. P. V. O'Neil, "Advanced Engineering Mathematics", CENGAGE Learning, New Delhi

BEME2209 Fluid Mechanics & Machines

Module I **(12 Lectures)**

Introduction : Scope of fluid mechanics and its development as a science

Physical property of Fluid: Density, specific gravity, specific weight, specific volume, surface tension and capillarity, viscosity, compressibility and bulk modulus, Fluid classification.

Fluid static Pressure, Pascal's Law, Pressure variation for incompressible fluid, atmospheric pressure, absolute pressure, gauge pressure and vacuum pressure, manometer.

Hydrostatic process on submerged surface, force on a horizontal submerged plane surface, force on a vertical submerged plane surface.

Buoyancy and flotation, Archimedes' principle, stability of immersed and floating bodies, determination of metacentric height.

Fluid kinematics : Introduction, description of fluid flow, classification of fluid flow. Acceleration of fluid particles, flow rate and continuity equation, differential equation of continuity,

Module II **(10 Lectures)**

Fluid dynamics : Introduction, Euler's equation along a streamline, energy equation, Bernoulli's equation,

Hydraulic Measurements: Water level measurements, velocity measurements, discharge measurements, venturimeter, orifice meter, current meter, pitot tube, orifice, notch and weir.

Module III **(14 Lectures)**

Hydraulic turbines and pumps: Impulse and reaction turbines, construction and working principle of tangential, radial and axial type turbines. Power of turbines, efficiency of turbines. Construction and working principles of centrifugal type pumps. Power and efficiency of the pump. Positive displacement pump.

Hydraulic systems: hydraulic accumulator, hydraulic intensifier, hydraulic ram, hydraulic lift, hydraulic crane, hydraulic press, hydraulic torque converter.

Text Books

1. Fluid Mechanics and hydraulic machines, Modi & Seth
2. Hydraulics fluid machines and fluid machines by S. Ramamrutham

Reference Books:

1. Fluid Mechanics by A.K. Mohanty, PHI
2. Introduction to Fluid Mechanics by Fox and McDonald, Willey Publications
3. Fluid Mechanics by Kundu, Elsevier
4. An Introduction to Fluid Dynamics by G.K.Batchelor, Cambridge University Press
5. Engineering Fluid Mechanics by Garde et. al., Scitech
6. Fluid Mechanics by J.F.Douglas, J.M.Gasiorek, J.A.Swaffield and L.B.Jack, Pearson Education.

BSMS 1209 **Material Science**

MODULE – I

1. Classification of Engineering Materials. Engineering properties of materials. Selection of Materials.
2. Electron theory of solids : Free electron theory of metals. Electrical conductivity; Thermal conductivity, Quantum theory of free electrons. Band theory of solids, Conductivity of metals
3. Conductors, Insulators, Semiconductors, Intrinsic and extrinsic semiconductors, Band theory of semi conductors Hall effect.
4. Super Conductors – Zero resistivity, Critical magnetic field and critical current density. Type I and II super conductors. Applications of Supercoductors.

MODULE – II

5. Dielectric Materials : Microscopic Displacement of atoms and molecules in an external dc electric field, Polarization and dielectric constant, Dielectric _nitially_lity. Temperature dependence, Dielectric Breakdown. Ferro electric material Piezoelectrics, Pyroelectrics, Dielectric Materials as electrical isulators.
6. Magentic Properties of Materials : Dia, Para and Ferro magenetic materials. Theory of magnetism, Ferro magnetic materials or Ferrites, Comparison of magnetic behaviour and magnetic parameters of Dia, Para and Ferro magnetic materials.
7. Optical Properties of Materials : Scattering, Refraction, Theory of Refraction and absorption, Atomic Theory of optical properties. Lasers, Optical fibres – Principle, structure, application of optical fibre.

MODULE – III

8. Plastics – Types : Thermosetting and thermoplastics. Transfer moulding, injection moulding, extension moulding, Blow moulding, Welding of plastics; Rubber types, application.
9. Ceramics : Types, Structure, Mechanical properties, applications
10. Composite Materials : Agglomerated Materials : Cermets, Reinforced Materials : Reinforced Concrete. Glass fibre reinforced plastics, Carbon fiber reinforced plastics. Whiskers, fiber reinforced plastics, Laminated plastic sheets. Tufnol, Properties of composites. Metal matrix composites, manufacturing procedure for fibre reinforced composites.
11. Environmental Degradation:Oxidation-Direct atmospheric attack,Aqueous corrosion-Electro chemical attack,Glavanic two –metal corrosion,corrosion by Gaseous reduction, Effect of mechanical stress on corrosion,method of corrosion prevention

Text book:

1. Vijaya M. S., Rangarajan G, Materials Science, TMH

2.Introduction to Materials science for engineers by James.F.shackelford,Madanapalli.k.Muralidhara ,Pearson(sixth edition)

Reference Book:

1. Rajendra V., Marikani A., Materials Science, TMH
2. Van Vlack L. H., Elements of Material Science and Engineering, Addison Wesley
3. Raghavan , Material Science
4. Callister W.D., Materials Science and Engineering, John Wiley & Sons.
5. Smith, Materials Science & Engineering.Mc. Graw Hill.
6. Processes and Material of manufacture : Lindberg, PHI.

PCPE4201 **Fundamentals of Polymer Science**

Module-I

Basics of fundamentals of chemistry related to polymers The Science of large molecules Basic concepts of polymer science-History of macromolecular Science-Nomenclature of polymers-Inter molecular forces and chemical bonding in polymers-Thermal transition.

Polymerization

Mechanism and kinetics-Molecular weight and molecular weight Distribution-and its measurements. Effect of Molecular weight on processing and properties.

Module-II

Polymer structure and morphology, Stereochemistry-Molecular interactions Crystalline structure and factors affecting crystallinity - Polymer-Structure property relationship. Physical and chemical methods of modifying polymer properties

Module-III

Reaction of polymers Reaction of polymer with other chemicals-Degradation and stabilisation of polymers.

Polymer characterisation techniques like UV, IR, NMR, DSC, TGA, TMA etc.

Text Books

1 Billmeyer Jr.; Fred W., Textbook of Polymer Science, Wiley- Interscience Publishers, New York (1962)

2.Fried; Joel R., Polymer Science and Technology, 2nd Edition, Prentice-Hall of India Pvt. Ltd., New Delhi (2003).

Reference Books

3. Ebewele, Robert O., Polymer Science and Technology, CRC Press, Boca Raton (2000).
4. Fried; Joel R., Polymer Science and Technology, Prentice-Hall of India Pvt. Ltd., New Delhi (2000).
5. Ghosh; Premamoy, Polymer Science and Technology of Plastics and Rubbers, Tata McGraw-Hill Publishing Co. Ltd., New Delhi (1990).
6. Ghosh; Premamoy, Polymer Science and Technology-Plastics, Rubbers, Blends and Composites, 2nd Edition, Tata McGraw-Hill Publishing Co. Ltd., New Delhi (2002).
7. Kaufmann; H. S. and Falcetta; J. J., Introduction to Polymer Science and Technology, John Wiley and Sons, New York (1977).
8. Kumar; Anil and Gupta; Rakesh K., Fundamentals of Polymers, McGraw-Hill Inc., (International Edition), New York (1998).
9. Kumar; Anil and Gupta; S. K., Fundamentals of Polymer Science and Engineering

HSSM3204 **Engineering Economics & Costing**

Module-I: **(12 hours)**

Engineering Economics – Nature and scope, General concepts on micro & macro economics. The Theory of demand, Demand function, Law of demand and its exceptions, Elasticity of demand, Law of supply and elasticity of supply. Determination of equilibrium price under perfect competition (Simple numerical problems to be solved). Theory of production, Law of variable proportion, Law of returns to scale.

Module-II: **(12 hours)**

Time value of money – Simple and compound interest, Cash flow diagram, Principle of economic equivalence. Evaluation of engineering projects – Present worth method, Future worth method, Annual worth method, internal rate of return method, Cost-benefit analysis in public projects. Depreciation policy, Depreciation of capital assets, Causes of depreciation, Straight line method and declining balance method.

Module-III: **(12 hours)**

Cost concepts, Elements of costs, Preparation of cost sheet, Segregation of costs into fixed and variable costs. Break-even analysis-Linear approach. (Simple numerical problems to be solved)
Banking: Meaning and functions of commercial banks; functions of Reserve Bank of India. Overview of Indian Financial system.

Text Books:

1. Riggs, Bedworth and Randhwa, "Engineering Economics", McGraw Hill Education India.
2. D.M. Mithani, Principles of Economics. Himalaya Publishing House

Reference Books :

1. Sasmita Mishra, "Engineering Economics & Costing ", PHI
2. Sullivan and Wicks, " Engineering Economy", Pearson
3. R.Paneer Seelvan, " Engineering Economics", PHI
4. Gupta, " Managerial Economics", TMH
5. Lal and Srivastav, " Cost Accounting", TMH

HSSM 3205 **Organizational Behaviour**

Module I :

The study of Organizational Behaviour : Definition and Meaning, Why Study OB
Learning – Nature of Learning, How Learning occurs, Learning and OB.
Foundations of Individual Behaviour : Personality – Meaning and Definition, Determinants of Personality, Personality Traits, Personality and OB.
Perception – Meaning and Definition, Perceptual Process, Importance of Perception in OB. Motivation – Nature and Importance, Herzberg's Two Factor Theory, Maslow's Need Hierarchy Theory, Alderfer's ERG Theory, Evaluations.

Module II :

Organizational Behaviour Process : Communication – Importance, Types, Gateways and Barriers to Communication, Communication as a tool for improving Interpersonal Effectiveness, Groups in Organizations – Nature, Types, Why do people join groups, Group Cohesiveness and Group Decision-making Managerial Implications, Effective Team Building. Leadership-Leadership & Management, Theories of Leadership-Trait theory, Leader Behaviour theory, Contingency Theory, Leadership and Follower ship, How to be an effective Leader, Conflict-Nature of Conflict and Conflict Resolution. An Introduction to Transactional Analysis (TA).

Module-III :

Organization : Organizational Culture – Meaning and Definition, Culture and Organizational Effectiveness. Introduction to Human Resource Management-Selection, Orientation, Training and Development, Performance Appraisal, Incentives Organizational Change – Importance of Change, Planned Change and OB techniques. International Organisational Behaviour – Trends in International Business, Cultural Differences and Similarities, Individual and Interpersonal Behaviour in Global Perspective.

Text Books :

1. Keith Davis, Organisational Behaviour, McGraw-Hill.
2. K.Aswathappa, Organisational Behaviour, Himalaya Publishing House.

Reference Books :

1. Stephen P. Robbins, Organisational Behaviour, Prentice Hall of India
2. Pradip N. Khandelwal, Organizational Behaviour, McGraw-Hill, New Delhi.
3. Uma Sekaran, "Organizational Behaviour", TATA McGraw-Hill, New Delhi.
4. Steven L McShane, Mary Ann Von Glinow, Radha R Sharma" Organizational Behaviour" , TATA McGraw- Hill.
5. D.K. Bhattachayya, "Organizational Behaviour", Oxford University Press
6. K.B.L.Srivastava & A.K.Samantaray, "Organizational Behaviour" India Tech
7. Kavita Singh, "Organizational Behaviour", Pearson

BECS2212 C++ & Object Oriented Programming

Module I **(08 hrs)**

Introduction to object oriented programming, user defined types, structures, unions, polymorphism, encapsulation. Getting started with C++ syntax, data-type, variables, strings, functions, default values in functions, recursion, namespaces, operators, flow control, arrays and pointers.

Module II **(16 hrs)**

Abstraction mechanism: Classes, private, public, constructors, destructors, member data, member functions, inline function, friend functions, static members, and references.
Inheritance: Class hierarchy, derived classes, single inheritance, multiple, multilevel, hybrid inheritance, role of virtual base class, constructor and destructor execution, base initialization using derived class constructors.
Polymorphism: Binding, Static binding, Dynamic binding, Static polymorphism: Function Overloading, Ambiguity in function overloading, Dynamic polymorphism: Base class pointer, object slicing, late binding, method overriding with virtual functions, pure virtual functions, abstract classes.
Operator Overloading: This pointer, applications of this pointer, Operator function, member and non member operator function, operator overloading, I/O operators.
Exception handling: Try, throw, and catch, exceptions and derived classes, function exception declaration.

Module III **(08 hrs)**

Dynamic memory management, new and delete operators, object copying, copy constructor, assignment operator, virtual destructor.
Template: template classes, template functions.
Namespaces: user defined namespaces, namespaces provided by library.

Text Books:

1. Object Oriented Programming with C++ - E. Balagurusamy, McGraw-Hill Education (India)
2. ANSI and Turbo C++ - Ashoke N. Kamthane, Pearson Education

Reference Books:

1. Big C++ - Wiley India
2. C++: The Complete Reference- Schildt, McGraw-Hill Education (India)
3. C++ and Object Oriented Programming – Jana, PHI Learning.
4. Object Oriented Programming with C++ - Rajiv Sahay, Oxford
5. Mastering C++ - Venugopal, McGraw-Hill Education (India)

PCME7202 **Mechanical Engineering Lab**

Group A

1. Determination of equilibrium of coplanar forces.
2. Determination of Moment of Inertia of Flywheel
3. Determination of tensile strength of materials by Universal Testing Machine.

Group B

4. Determination of Metacentric Height and application to stability of floating bodies.
5. Verification of Bernoulli's Theorem and its application to Venturimeter.
6. Determination of Cv and Cd of Orifices.

Group C

7. Calibration of Bourdon Tube Pressure gauge and measurement of pressure using manometers.
8. Study of Cut-Sections of 2 stroke and 4 stroke Diesel Engine.
9. Study of Cut-Sections of 2 stroke and 4 stroke Petrol Engine.

BECS7207 **C++ & Object Oriented Programming Lab**

1. Programs on concept of classes and objects.(1 class)
2. Programs using inheritance.(1 class)
3. Programs using static polymorphism.(1 class)
4. Programs on dynamic polymorphism.(1 class)
5. Programs on operator overloading.(1 class)
6. Programs on dynamic memory management using new, delete operators.(1 class)
7. Programs on copy constructor and usage of assignment operator.(1 class)
8. Programs on exception handling .(1 class)
9. Programs on generic programming using template function & template class.(1 class)
10. Programs on file handling.(1 class)

HSSM7203 Communication & Interpersonal skills for Corporate Readiness Lab.

Lab **30 hours**

This course will focus on communication in professional (work-related) situations of the kind that BPUT graduates may expect to encounter on entering the professional domain.

Some typical forms of work-related communication, oral or written, are listed below. Practice activities for all four skills can be designed around these or similar situations.

1. Gaining entry into an organization

   i. Preparing job-applications and CVs

   ii. Facing an interview

   iii. Participating in group discussion (as part of the recruitment process)

2 In-house communication

a. Superior/ Senior ➔ subordinate / junior (individual ➔ individual / group)
   i. Welcoming new entrants to the organization, introducing the workplace culture etc.
   ii. Briefing subordinates / juniors : explaining duties and responsibilities etc.
   ii. Motivating subordinates / juniors ('pep talk')
   iii. Instructing/ directing subordinates/ juniors
   iv. Expressing / recording appreciation, praising / rewarding a subordinate or junior
   v Reprimanding / correcting / disciplining a subordinate/junior (for a lapse) ; asking for an explanation etc.

b. Subordinate / Junior ➔ Superior / Senior
   i. Responding to the above
   ii. Reporting problems / difficulties / deficiencies
   iii. Offering suggestions

BSCM1210 Mathematics – IV

Module-I **(20 hours)**

Numerical methods:
Approximation and round of errors, Truncation error and Taylor's series
Roots of equation: The bisection method, the false-position method, fixed point iteration, the Newton-Raphson method, Muller's method
Linear algebraic equation: LU decomposition, the matrix inverse, Gauss-Seidel method
Interpolation: Newton divided difference interpolation, Lagrange Interpolation, Newton's forward and backward interpolation.
Numerical integration: The trapezoidal rule, The Simpson's rules, Gauss quadrature
Ordinary differential equation: Euler's method, Improvement of Euler's method, Runge-Kutta methods

Module-II **(10 Hours)**

Probability:
Probability, Random variables, Probability distributions, Mean and variance of distribution, Binomial, Poisson and Hypergeometric distributions, Normal distribution, Distribution of several random variables.

Module-III **(10 Hours)**

Mathematical Statistics:
Random sampling, Estimation of Parameters, Confidence Intervals, Testing of hypothesis, Acceptance sampling, Chi square test for goodness of fit , Regression Analysis, Fitting Straight Lines, Correlation analysis.

Text books:

1. S. C. Chapra and R. P. Canale, "*Numerical methods for Engineers*", Fifth Edition, McGraw Hill Education
   Reading Chapters : 2, 3(3.1, 3.2), 4(4.2, 4.3), 5(5.1, 5.2, 5.3), 6(6.4), 9(9.1, 9.2), 10(10.2), 13(13.1,13.2,13.5), 16(16.1, 16.2), 17(17.3), 20(20.1, 20.2, 20.3)

2. E. Kreyszig," Advanced Engineering Mathematics:, Eighth Edition, Wiley India
   Reading Chapters: 22, 23(except 23.5 and 23.8)

Reference books:

1. Jay L. Devore, "Probability and Statistics for Engineering and Sciences", Seventh Edition, Thomson/CENGAGE Learning India Pvt. Ltd
2. P. V.O'Neil, "Advanced Engineering Mathematics", CENGAGE Learning, New Delhi

PCPE4202 Polymer Structure and Property Relationship

Module-I

Structure of polymers - Linear, branched, cross linked, and network polymers - Homochain and hetero atomic chain polymers - Copolymers - Linear and cyclic arrangement - Prediction of polymer properties, group contribution techniques, topological techniques- Volumetric properties - molar volume, density, Van der Waals volume - Coefficient of linear thermal expansion and volumetric thermal expansion - Pressure volume temperature (PVT) relationship.

Mechanical properties - Stress-strain properties of polymers - Effect of polymer structure on modulus of elasticity, tensile strength, flexural strength, impact strength, yield strength, fracture toughness - Crazing in glassy polymers - Ductile brittle transition. Effect of additives on mechanical properties of polymers - Creep, stress relaxation, and fatigue.

Module-II

Thermodynamic and transition properties - Transition temperature in polymers, glass transition (Tg), melt transition (Tm), relationship between Tg and Tm - other transitions like ß-transitions, upper and lower glass transition temperatures - Prediction of Tg and Tm of polymers by group contributions. Calorimetric properties - Heat capacity, specific heat, latent heat of crystallization and fusion, enthalpy and entropy - Calculation of heat capacities of polymers.

Module-III

Electrical and optical properties - Effect of polymer structure on dielectric constant, power factor, dissipation factor, and loss factor - effect of frequency of voltage and temperature on dielectric properties - Prediction of molar polarization and effective dipole moment. Effect of additives on electrical properties of polymers. Optical properties - Effect of polymer structure on optical properties - clarity, transparency, haze, transmittance, reflectance, and gloss -Prediction of refractive indices of polymers by group contributions

Chemical Properties - Cohesive energy, cohesive energy density, solubility parameter, determination of solubility parameter of polymers - Prediction of solubility parameter -Effect of polymer structure on solubility in solvents and oils - Influence of structure in prediction of flame retardancy, water repellency - Chemical resistance of polymers - Polymer toxicity

Total Lectures = 45 Tutorials = 15

References Books

1. D.W. Van Krevelen And P.J. Hoftyzen, "Properties Of Polymer , 3rd Edition Elsevier Scientific, Publishing Company Amsterdam - Oxford - Newyork. 1990.
2. J.E. Mark Ed.AIP, Physical Properties Of Polymers Hand Book, Williston, Vt, 1996.

PCPE4203 Plastic Materials and Applications

Module-I

History-basic chemistry of polymers-nomenclature of polymers sources for raw materials- methods of manufacturing-general properties-processing behavior and applications - of the following:

Natural Polymers : Shellac resin and natural rubber.

Thermoplastics & its Applications

Commodity plastics & its applications

1. Polyolefin - Polyethylene, LDPE, HDPE, LLDPE, HMHDPE, Polypropylene Homo-polymers- Copolymers.
2. Polytyrene & Styrene copolymers - Polystyrene, HIPS, ABS, Styrene Acrylonitrile
3. Vinyl plastics - Polyvinyl chloride, Polyvinyl Acetate, Polyvinylidene chloride, Polyvinyl alcohol & others.
4. Cellulosics -Cellulose nitrate, cellulose acetate, cellulose acetate butyrate, Ethyl cellulose & others.

Module-II

Engineering Plastics & its Applications

UHMHDPE -EPDM - EVA
Polyamides - Nylons 6, 66, 6 10, 11, 12 etc.
Polyimides - Polyimidazoles.
Acrylic plastics - Polymethyl Methacrylate, Polyacrylonitrile.
Polyesters - Polyethylene terephthalate, polybutylene terephthalate.
Polycarbonate
Polyacetals - Polyoxymethylene
Aromatic ether - Polypheneylene oxide
Aromatic thioether - Polyphenylene sulphide
Polysulfone
Polyurethane
Fluoropolymers - Polyvinyl fluoride, Polyvinylidene fluoride, Polytetrafluoroethylene, Polychlorotrifluoroethylene.
Thermoplastic Elastomers
Speciality polymers viz.PEEK, polyimides, PAI & Ionomer

Liquid Crystalline Polymers

Metallocene Polymers

Thermoset materials & its Applications

Phenol formaldehyde - Urea formaldehyde - Melamine formaldehyde – Unsaturated polyesters, Alkyd resins - Epoxides - Polyurethane - Silicones
End use applications - case studies on applications (6 hours)

Module-III

Polymer blends and Alloys

Definition, advantages of polymers, blends and alloys, role of composition, properties and applications of parameters for compability, PVC – Nitrile rubber, ABS-PVC and PP-EPDM

Preleminary concepts of new materials such as electrically active polymers, Optoelectronic plastics, Bio-polymers, membrane plastics in bio medical applications. Polymer Concretes & Advanced ceramics. Reinforced Plastics – principles of composite reinforcement, effect of reinforcement on strength of plastics, Role and nature of binders and coupling agents, properties and applications of fibres in reinforcement (glass and carbon), Properties and applications of FRP's (Thermoset & Thermoplastics: un-saturated polyesters, epoxies, PU, nylon) .

Text Books

1. Plastic Materials Ed 7 - By Brydson, J.A
2. Hand Book of Plastics Materials & Technology - By Rubin, Irwin, J
3. Plastics Materials Hand Book - By Athalye, A.S

Reference Books

1. Plastics Engineering Hand Book Ed. 5 & Society of the Plastic Industry Inc - By SPI.
2. Plastics Materials and Processing - By Schwartz & Goodman
3. Plastics Materials (Properties & Application) - By Birley & Scott
4. Modern Plastics Hand Book - By Harper
5. Bikales; Norbert M. and Segal; Leon (Eds.), Cellulose and Cellulose Derivatives, Part IV (Volume V), Wiley- Interscience, New York (1971).
6. Birley; Arthur W. and Scott; Martyn J., Plastics Materials: Properties and Applications, Leonard Hill, Blackie and Sons Ltd., (1982)
7. Biron; Michel, Thermoplastics and Thermoplastic Composites: Technical Information for Plastics Users, Elsevier, Amsterdam (2007)
8. Davidson; Theodore, Polymers in Electronics, ACS Symposium Series 242, American Chemical Society, Washington D. C. (1984).
9. DuBois; P., Plastics in Agriculture, Applied Science Publishers Ltd., London (1978)

PCPE4204 **Additives and Compounding**

Module-I

Additives for plastics
Fillers-Antioxidants-Thermal Stabilizers, Lubricants-Plasticizers, Toughening-agents-Colourants-Fire retardants-Coupling agents-blowing-agents-Ultraviolet stabilizer-Antistatic agents-Anti blocking agents-Slip and antislip agents-processing aids-mould releasing agents.

Module-II

Compounding - Selection of polymers and compounding-ingredients-general objectives-possibilities and limitation of additives into polymer matrices.

Module-III

Mixing and mixing equipments.
Machine construction - specifications - temperature control system - operating characteristics - house keeping and maintenance of compounding machines.

Case studies on preference of one plastics to other and co-relation of properties of conventional materials and blends and alloys - case studies on application of blends and alloys.

Text Book

1.Polymer additives –by Muller

Reference Books

1. Al – Malaika; S. Golovoy; A and Wilkie (Eds), Chemistry and Technology of Polymer Additives, Black well Science Ltd, Oxford (1999)

2. Matthews; F.L. and Rawlings; R.D, Composite Materials, Engineering and Science Chairman and Hall, London (1994)

3. Plastics Testing Technology Hand Books by Vishu Shah

4. Hand Book of Plastics Test Methods by Brown R.P

5. Mascia; L.,The Role of Additives in Plastics, Edward Arnold Publishers Ltd., U. K. (1974).

6. Murphy; John, Additives for Plastics Handbook, 2nd Edition, Elsevier Advanced Technology, Oxford.

BECS2208 Database Management System

Module I : (10 hours)

Database System Architecture - Data Abstraction, Data Independence, Data Definitions and Data Manipulation Languages. Data models - Entity Relationship(ER), Mapping ER Model to Relational Model, Network .Relational and Object Oriented Data Models, Integrity Constraints and Data Manipulation Operations.

Module II : (12 hours)

Relation Query Languages, Relational Algebra and Relational Calculus, SQL.

Relational Database Design: Domain and Data dependency, Armstrong's Axioms, Normal Forms, Dependency Preservation, Lossless design.

Query Processing Strategy.

Module III: (10 hours)

Transaction processing: Recovery and Concurrency Control. Locking and Timestamp based Schedulers. Database Recovery System: Types of Data Base failure & Types of Database Recovery, Recovery techniques

Text Books:

1. Database System Concepts by Sudarshan, Korth (McGraw-Hill Education)
2. Fundamentals of Database System By Elmasari & Navathe- Pearson Education

References Books:

(1) An introduction to Database System – Bipin Desai, Galgotia Publications

(2) Database System: concept, Design & Application by S.K.Singh (Pearson Education)

(3) Database management system by leon &leon (Vikas publishing House).

(4) Fundamentals of Database Management System – Gillenson, Wiley India

(5) Database Modeling and Design: Logical Design by Toby J. Teorey, Sam S. Lightstone, and Tom Nadeau, "", 4th Edition, 2005, Elsevier India Publications, New Delhi

PCME7203 Machine Shop and Fabrication Practice

1. A job on lathe with taper turning, thread cutting, knurling and groove cutting
2. Gear cutting (with index head) on milling m/c
3. Working with shaper, planer and slotting m/c
4. Working with surface/ cylindrical grinding
5. TIG/ MIG welding, gas cutting

BECS7208 Database Managements System Lab

1. Use of SQL syntax: insertion, deletion, join, updation using SQL. (1 class)
2. Programs on join statements and SQL queries including where clause. (1 class)
3. Programs on procedures and functions. (1 class)
4. Programs on database triggers. (1 class)
5. Programs on packages. (1 class)
6. Programs on data recovery using check point technique. (1 class)
7. Concurrency control problem using lock operations. (1 class)
8. Programs on ODBC using either VB or VC++. (1 class)
9. Programs on JDBC. (1 class)
10. Programs on embedded SQL using C / C++ as host language. (1 class)

PCPE7202 Polymer Chemistry Lab.

Experiments:
Identification of polymers by simple methods like density, melting point, burning characteristics, solubility and confirmatory test by chemical analysis.

A.PLASTICS

Polyethylene
Polypropylene
Polystyrene
Polyvinyl Chloride
Polyamide
Polyethylene terephthalate
Polybutylene terephthalate
Polycarbonate
Polyacetal
Polyphenylene oxide
Polyphenylene sulphide
Phenol Formaldehyde
Urea formaldehyde
Melamine formaldehyde

B. Identification of Rubbers by Simple Methods

Natural Rubber (NR) Polybutylene Rubber (BR) Styrene Butadiene Rubber (SBR) Isoprene Rubber (IR) Isobutiene Isoprene Rubber (IIR) Chloroprene Rubber (CR) Acrylonitrile – Butadiene Rubber (NBR) Silicone Rubber Total: 90

Text Books

1.Plastics Testing Technology Hand Books by Vishu Shah
2.Hand Book of Plastics Test Methods by Brown R.P

Reference Books

1. Identification of plastics and rubbers by simple methods, CIPET publications 2002.

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BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ORISSA

PLASTIC ENGINEERING

5th SEMESTER				6th SEMESTER			
THEORY		*Contact Hours*		*THEORY*		*Contact Hours*	
Code	*Subject*	*L-T-P*	*Credits*	*Code*	*Subject*	*L-T-P*	*Credits*
HSSM3301	Principles of Management	3-0-0		HSSM3302	Optimization Engineering	3-0-0	
Or	or		3		or		3
HSSM3302	Optimization Engineering	3-0-0		HSSM3301	Principles of Management	3-0-0	
PCPL4301	Plastic Processing Technology	3-1-0	4	PCPL4304	Advanced Plastics Processing Techniques	3-1-0	4
PCPL4302	Plastics Testing Technique	3-1-0	4	PCPL4303	Mould Engineering	3-0-0	3
HSSM3303	Environmental Engineering and Safety	3-0-0	3		Professional Elective – II (Any One)	3-0-0	3
				PEPL5304	Material Engineering		
				PEPL5305	Polymerization Engineering		
				PEPL5306	Polymer Reaction Engineering		
	Professional Elective – I (Any One)	3-0-0	3		Professional Elective – III (Any One)	3-0-0	3
PEPL5301	CAD/CAM/CAE for Plastic Engineering						
PEPL5302	Fundamentals of Plastic Mould & Die Designing.			PEPL5307	Strength of Material		
				FEEE6301	Industrial Process Control & Dynamics		
PEPL5303	Plastic Product Design.			PEPL5309	Statistical Quality Control Technique		
	Free Elective – I (Any One)	3-0-0	3		Free Elective – II (Any One)	3-0-0	3
PCME4304	Machining Science & Technology			PEME5308	Non Conventional Energy Sources		
PECH5303	Fuel & Energy Technology			PCME4305	Heat Transfer		
PEEL5302	Renewable Energy System			PEME5306	Modern Manufacturing Process		
	Credits (Theory)		20		Credits (Theory)		19
	PRACTICALS/SESSIONALS				*PRACTICALS/SESSIONALS*		
PCPL7301	Plastics Processing Lab.-I	0-0-3	2	PCPL7303	Plastics Processing Lab.-II	0-0-3	2
PCPL7302	Plastics Testing Lab.-I	0-0-3	2	PCPL7304	Plastics Testing Lab.-II	0-0-3	2
PCPL7306	Mould Engineering Lab	0-0-3	2	PCPL7305	Design & Mold flow Analysis Practice Using CAD/CAM/ CAE	0-0-3	2
	Credits (Practicals / Sessionals)		6		Credits (Practicals/Sessionals)		6
	TOTAL SEMESTER CREDITS		26		TOTAL SEMESTER CREDITS		25
	TOTAL CUMULATIVE CREDITS				TOTAL CUMULATIVE CREDITS		

HSSM3301 **PRINCIPLES OF MANAGEMENT** (3-0-0)

Module I: Functions of Management

Concept of Management, Management as an Art or Science, The Process of Management, Managerial Skills, Good Managers are Born, not Made, Management is concerned with Ideas, Things and People, How a Manager Induces Workers to Put in Their Best, Levels and Types of Management, **Evolution of Management Thought**: Managerial Environment, The process of Management-Planning, Organizing, Directing, Staffing, Controlling.

Module II: Marketing Function of Management.

Modern Concept of Marketing, The Functional Classification of Marketing, Functions of a Marketing Management, Marketing Mix, Fundamental Needs of Customers, The Role of Distribution channels in Marketing, Advertising, Marketing, Consumerism and Environmentalism.

Module III: Financial Function & HRM Functions.

Financial Functions, Concept of Financial Management, Project Appraisal, Tools of Financial decisions making, Overview of Working Capital.

HRM Function of Management: Human Resource Management, Human Resource Development, Importance of HRM, Overview of Job Analysis, Job Description, Job Specification, Labour Turnover. Manpower Planning, Recruitment, Selection, Induction, Training and Development, Placement, Wage and Salary Administration, Performance Appraisal, Grievance Handling, Welfare Aspects.

Reference Books:

1. *Business Organization & Management, CR Basu, TMH*
2. *Business Organization & Management, Tulsia, Pandey, Pearson*
3. *Marketing Management, Kotler, Keller, Koshi, Jha, Pearson*
4. *Financial Management, I.M. Pandey, Vikas*
5. *Human Resource Management, Aswasthapa, TMH.*
1. *Modern Business Organisation & Management by Sherlekar, Himalaya Publishing House.*

HSSM3302 **OPTIMIZATION IN ENGINEERING** (3-0-0)

Module-I **(10 Hours)**

Idea of Engineering optimization problems, Classification of optimization algorithms, Modeling of problems and principle of modeling.

Linear programming: Formulation of LPP, Graphical solution, Simplex method, Big-M method, Revised simplex method, Duality theory and its application, Dual simplex method , Sensitivity analysis in linear programming

Module-II **(10 Hours)**

Transportation problems: Finding an initial basic feasible solution by Northwest Corner rule, Least Cost rule, Vogel's approximation method, Degeneracy, Optimality test, MODI method, Stepping stone method

Assignment problems: Hungarian method for solution of Assignment problems

Integer Programming: Branch and Bound algorithm for solution of integer Programming Problems

Queuing models: General characteristics, Markovian queuing model, M/M/1 model, Limited queue capacity, Multiple server, Finite sources, Queue discipline.

Module-III **(10 Hours)**

Non-linear programming: Introduction to non-linear programming.

Unconstraint optimization: Fibonacci and Golden Section Search method.

Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method

Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming

Introduction to Genetic Algorithm.

Recommended text books

1. A. Ravindran, D. T. Philips, J. Solberg, " *Operations Research- Principle and Practice*", Second edition, Wiley India Pvt Ltd
2. Kalyanmoy Deb, " *Optimization for Engineering Design*", PHI Learning Pvt Ltd

Recommended Reference books:

1. **S**tephen G. Nash, A. Sofer, " *Linear and Non-linear Programming*", McGraw Hill
2. A.Ravindran, K.M.Ragsdell, G.V.Reklaitis," *Engineering Optimization*", Second edition, Wiley India Pvt. Ltd
3. H.A.Taha,A.M.Natarajan, P.Balasubramanie, A.Tamilarasi, "*Operations Research*", Eighth Edition, Pearson Education
4. F.S.Hiller, G.J.Lieberman, " *Operations Research*", Eighth Edition, Tata McDraw Hill
5. P.K.Gupta, D.S.Hira, "*Operations Research*", S.Chand and Company Ltd.

PCPL4301 **PLASTICS PROCESSING TECHNOLOGY** (3-1-0)

Module –I Injection moulding,Compression moulding & Transfer moulding (18 hr)

Injection moulding -Principles processing- Process variables - Mould cycle – Moulding Machine–Specifications - Construction and maintenance –Mould setup- process trouble shooting.

Compression moulding- principles - Bulk factor and flow properties moulding materials-Process variables-Curing time- Mould temperature and Pressure requirements-preforms and preheating- common moulding faults and their correction-Finishing of moulded product.

Fundamental principles of transfer moulding-advantages over compression moulding-Equipment used- pressures requirements -Line pressures- Injection ram pressure-clamping-Heating requirements-Moulding faults - causes and remedies.

Module – II Extrusion, Blow moulding, Thermoforming (15 hr)

Basic principles of extrusion – Types of extruders, extruder parts- polymer flow mechanism, die entry effects and exit instabilities-melt fracture & Bambooing. Factors affecting the output of an extruder, process variables in extrusion- downstream equipments for the production of films, blown film, cast film/slot film, BO film, co extruded film. Tube/pipe-sizing take off equipment, extrusion coating, wire & cable covering

Injection and extrusion blow moulding processes, accumulation blow moulding-processing parameters- materials requirements -blow moulding machine features and operation -faults, causes and remedies-parison programming, blow moulding of difficult articles like fuel tanks, odd shaped containers with handles, limitation in blow moulding,

Basic principles and types of thermoforming processes, Thermoforming moulds-processing parameters—faults, causes and remedies.

Module – III Calendaring, Rotational molding and FRP & Laminates (12 hr)

Calendaring - principle and process description- types of calendar units -design of calendar roll, Heating and temp control, roll crown, roll crossing and roll bending - calendaring sheets and films, embossing, coating and lamination by calendar, comparison between calendaring and extrusion.

Introduction-principle-process-machinery used-materials-moulds process parameters-merits & demerits of rotomolding.

Introduction, FRP Processing methods- hand lay up-spray up -vacuum bag & pressure bag moulding, filament welding – pultrusion – pulforming- matched die moulding

Text Book

1. Injection Molding Theory & Practice , Irvin I. Rubin, Wiley-Interscience (1973)
2. Injection Molding Hand Book Third Ed., D.V Rosato, D.V. Rosato & M.G. Rosato, Kluwer academic publishers (2000)
3. Plastics: Material & Processing, A. Brent Strong, Third Ed., Prentice Hall (2005)

Reference Book:

1. A Guide to Injection Molding of Plastics, P.C. Bolur, allied Publishers (2000)
2. Development in Injection Molding, Ed. Whelan, Elsevier (1985)
3. Plastics Materials & Processing – S.S.Schwartz and S.H.Goodman, Nostrand Reinhold (1982)
4. Injection Molding, A.S. Athalye, second Ed. (1997).
5. INJECTION MOULDING OF PLASTICS:A USER GUIDE Klockner Winsor India Ltd (1994)
6. Innovation in Polymer Processing - By Stevenson
7. Extrusion The definitive Processing Guide and Hand Book - By Giles, H.H & Others
8. Compression Molding - By Iyesew, A.I
9. Polymer Extrusion - By Rauwedaal, Chris
10. Thermoforming - By James & Throne
11. Basic Principle of rotational molding - By Crawford, R.J & Throne, J.L

12. Basic Principle of Rotational Molding - By Bruins
13. Basic Principle of Thermoforming - By Brycle, D.M
14. Plastics Injection Molding - By Brycle, D.M
15. Injection molding of Plastics component - By Bown John
16. Plastics Mold Design Vol.1 Compression & Transfer Moulds - By Bebb
17. Plastics forming - By Beadle
18. Calendering of Plastics - By Elden & Swan

PCPL4302 **PLASTICS TESTING TECHNIQUES** (3-1-0)

Module – I Standards, specifications and testing (18 hr)

Standard and specification-National and International standards-Test specimen preparation-preconditioning and test atmosphere.

Mechanical Properties: Hardness-tensile strength-compressive strength-shear strength-flexural strength-heat strength-impact strength-dynamic stress-strain properties-creep-relaxation and set tests-friction and wear-abrasion test-fatigue-burst strength-and folding endurance.

Thermal Properties: Specific heat and thermal conductivity thermal dependant properties-thermal endurance-glass transition temperature-thermal yield tests-Heat deflection temperature- Vicat softening temperature- Marten's heat resistance test-low temperature brittle point and flexibility test-coefficient of thermal expansion-shrinkage-Thermal stability-Thermal ageing and flammability.

Module – II Optical and electrical properties (15 hr)

Optical Properties -Refractive index-light transmission-haze-clarity-gloss-colour guard and microscope. Electrical Properties-Insulation resistance-power factor-permittivity – dielectric strength-tracking resistance-arc resistance and antistatic test.

Permeation properties: Water absorption-soluble and insoluble matter-chemical resistance environmental stress cracking resistance-ageing-gas permeability-water vapour permeability and weathering

Knowledge and exposure on Sectorial Testing Standards

Preconditioning and test atmosphere - Testing of Mechanical, Thermal, Optical, Electrical properties, Permeability Properties and Rheological properties.

Module – III Product testing (12 hr)

Pipe and fittings-film and sheets-container testing and FRP based products.

Factors for designing tests for newer products- Factors affecting the quality of materials and products- analysis of failure and its measurements

Techniques of characterization-Principles and application of DSC- TGA AND FTIR, Concepts of non-destructive testing

Text Books

1. Hand Book of Plastics Testing Technology, Shah, Vishnu, John Wiley and Sons, SPE Monograph (1984)
2. Hand Book of Polymer Testing, Brown; Roger P (Ed.), Marcel Dekker, Inc, New York (1999)
3. Hand Book of Plastics Technology 2 vol. By Allen, W.S & Baker P.N

Reference Books

1. Plastic Engineering Hand Book & D-5 By Society of Plastics Industry Inc
2. Brown; Paul F (Ed), Hand Book of Plastics Test Methods, Longman Scientific and Technical, Harlow88
3. Blythe;A. R, Electrical Properties of Polymers, Cambridge University Press, Cambridge (1979).
4. Electrical Properties of Polymers, Blythe;Tony and Bloor; David, 2nd Ed, Cambridge Press
5. Plastic Engineering Hand Book & D-5 By Society of Plastics Industry Inc
6. Mitcheli Jr.; John, Applied Polymer Analysis and Characterization-Recent Development in Techniques, Instrumentation, Problem Solving, Hanser Publishers

HSSM3303 **ENVIRONMENTAL ENGINEERING & SAFETY**

(3-0-0)

Module – I

Ecological Concepts: Biotic components, Ecosystem Process: Energy, Food Chain, Water cycle, Oxygen cycle, Nitrogen cycle etc., Environmental gradients, Tolerance levels of environment factor, EU, US and Indian Environmental Law. Chemistry in Environmental Engineering: Atmospheric chemistry, Soil chemistry. Noise pollution-Noise standards, measurement and control. Water Treatment: water quality standards and parameters, Ground water. Water treatment processes, Pre-treatment of water, Conventional process, Advanced water treatment process.

Module – II

(a)Waste Water Treatment: DO and BOD of Waste water treatment process, pretreatment, primary and secondary treatment of waste water, Activated sludge treatment: Anaerobic digestion, Reactor configurations and methane production.

(b)Air Pollution : Air pollution and pollutants, criteria pollutants, Acid deposition, Global climate change –greenhouse gases, non-criteria pollutants, air pollution meteorology, Atmospheric dispersion. Industrial Air Emission Control. Flue gas desulphurization, NOx removal, Fugitive emissions.

(c) Solid waste, Hazardous waste management, Solid Waste Management, Source classification and composition of MSW: Separation, storage and transportation, Reuse and recycling, Waste Minimization Techniques. Hazardous Waste Management, Hazardous waste and their generation, Transportation and treatment: Incinerators, Inorganic waste treatment. E.I.A., Environmental auditing,

Module – III

Occupational Safety and Health Acts, Safety procedures, Type of Accidents, Chemical and Heat Burns, Prevention of Accidents involving Hazardous substances, Human error and Hazard Analysis. Hazard Control Measures in integratednsteel industry, Petroleum Refinery, L.P.G. Bottling, Pharmaceutical industry. Fire Prevention – Detection, Extinguishing Fire, Electrical Safety, Product Safety. Safety Management- Safety Handling and Storage of Hazardous Materials, Corrosive Substances, Gas Cylinders, Hydro Carbons and Wastes. Personal Protective Equipments.

Text Book :

1. Environmental Engineering Irwin/ McGraw Hill International Edition, 1997, G. Kiely,
2. Environmental Engineering by Prof B.K. Mohapatra, Dhanpat Rai & Co Publication
3. Industrial Safety Management, L. M. Deshmukh, Tata McGraw Hill Publication.

Reference Books

1. Environmental Engineering by Arcadio P. Sincero & Gergoria A. Sincero PHI Publication
2. Principles of Environmental Engineering and Science, M. L. Davis and S. J. Masen, McGraw Hill International Edition, 2004
3. Environmental Science, Curringham & Saigo, TMH,
4. Man and Environment by Dash & Mishra
5. An Introduction to Environmental Engineering and Science by Gilbert M. Masters & Wendell P. Ela - PHI Publication.
6. Industrial Safety Management and Technology, Colling. D A – Prentice Hall, New Delhi.

PEPL5301 **CAD/CAM/CAE FOR PLASTICS ENGINEERING**

Module I Computer Aided Designing Fundamentals (12 hours)

Output primitives (pints, lines, curves, etc.,) 2-D Transformation, Translation, Scaling, Rotation, windowing, View ports clipping transformation.

Interactive CAD programs AutoCAD, Auto LISP/C/C++., creation of surface, solids etc., using solid modeling package (prismatic and revolved parts), Data exchange, customizing- Representation of curves –surface modeling technique – surface patch – Bezier and B-spline surfaces – Volume modeling – Boundary models – CSG other modeling techniques- surface editing- Data Exchange and communication standards- 2D Representation –Integration of design analysis and CAD- mesh generation techniques – post processing – 3D Model generation.

Module II Computer Aided Manufacturing (12 hour)

Introduction to CAM software packages, Automation strategies in production process – G - Codes & M – Codes - NC system –part programming – APT language – DNC-CNC and Adaptive Control- Accuracy, repeatability, End efficacy, sensors, control systems & type of programming, post processing.

control systems – Linear Feed back Steady state optimal control, Adaptive Control,

Manufacturing methods for fabrication of moulds & dies- Design FMS workstations – analysis methods – automated Materials Handling – Types –Computer Integrated Production Planning System – Computer Processes interface – Process Monitoring – Supervisory Computer Control – Computer Monitoring – Types & Strategies.

Module III Computer Aided Engineering (11 hour)

Computer modeling for polymer processing: Models of Material Behavior, Model simplifications, Finite difference, Finite element techniques for field problems, Simulation of viscoelastic fluid flow, computer implementation of Process models. Advanced computational techniques, Supercomputing and Visualization of Results.

Concept of A.I. and knowledge based systems in selection and processing of polymers.

CAE in Mould Manufacture: Computerized numerical control. Flexible manufacturing.

Total Lectures = 35

Reference Books

1. Computer Integrated Manufacturing Paul G. Ranky (Prentice Hall, 1990.)
2. CAD/CAM/CIM Radhakrishnan, P. & Subramanyan. S. (Wiley Eastern Ltd., 1994.)
3. An Introduction to Automated Process Planning Chang. T.C. & Wysk (Prentice Hall Inc., Englewood Cliffs - New Jersey.)
4. Computer Integrated Manufacturing Systems Yoram Koren (McGraw Hill, 1983.)
5. Automation, Production and Systems and Computer - Integrated Manufacturing Mikell P. Groover,(Prentice Hall of India Pvt. Ltd., 1998.)

6. Computer Graphics- Donald Hearn and M.Pauline Baker (*Prentice Hall, Inc., 1992)*

7. CAD/CAM principles, practice and manufacturing management - By Chris McMohan and Jimmi (Browne Pearson Education Asia,Ltd.,2000)
8. Braun; Dietrich, Cherdron; Harald and Ritter; Helmut, Polymer Synthesis: Theory and Practice-Fundamentals, Methods, Experiments, 3rd Edition, Springer Verlag, Berlin (2001).

PEPL5302 **FUNDAMENTALS OF PLASTICS MOULD / DIE DESIGN** (3-0-0)

Module I Product Design **(12 hour)**

Orthographic projection-Projection of solids—vertical and horizontal surfaces-Inclined Surfaces-Curved Surfaces-Sectional views and assembly drawing.

Basic Principles-Shrinkage-Flash lines-Undercuts-suggested Wall thickness-Draft-Tolerance-Moulded holes-threads-radius- moulded hinges-integral hinge-snap fits - product design thumb rules - case studies and product design.

Module II Mould Design **(12 hour)**

Parting line-Construction of core and cavity-types of gate-types of ejection-Mould temperature control - cooling - Mould alignment Mould anciliary parts.

Types of moulds-two plate - three plate - split moulds - Machine selection-Principles of shrinkage allowances-materials for mould parts-life of mould-mould maintenance-case studies on mould design. Injection Moulds for threaded components – automatic unscrewing – various unscrewing methods

Module III Screw Design **(11 hour)**

Extrusion die design–Construction features of an extruder, Process, Characteristics of Polymer melt, Die geometry, Die head Pressure, characteristics of land length to Profile thickness, Extrudate die swell, Die materials, Classification of dies-Dies for Solid Section, Dies for Hollow Profiles, Blown film dies, Flat film dies, Parison dies, Wire and cable Coating dies, Spiral mandrel die, Fish tail die, Adjustable Core die

Total Lectures = 35

Text Books

1. Injection Mould Design for Thermoplastic - By Pye, R.G.W
2. Injection Mould & Molding - By Dym
3. Injection Moulds – 130 Proven Design - By Gastrow, H
4. Plastics Product Design Engineering Hand Book - By Dubois, H
5. Plastics Product Design & Process Engineering - By Belofsky, Harold
6. Laszlo Sors and Imre Balazs, “Design of Plastics Moulds and Dies”, Elsevier, Amsterdam - Oxford – Tokyo - NY, 1989.

Reference Books

1. Plastic Design & Processing - By Sharma, S.C
2. Plastics Moulds & Dies - By Sors, & Others
3. Injection Mould Design Fundamentals (Vol. I& II) - By Glanvill & Denton

PEPL5303 **PLASTICS PRODUCT DESIGN** (3-0-0)

Module I Product Design (12 hour)

Concepts - size, shape and function - form and function - Aesthetics, Ergonomics - shrinkage, Flash lines. Undercuts - External & Internal - Wall thickness - variances in wall thickness - emphasize on designing with engineering plastics. Taper or draft. Fits & Tolerances. Designing with plastics for load bearing applications like gears, bearing, sandwich laminates. Design of radii, fillets, ribs and bosses

Module II Moulded threads—thread pieces—threaded holes (12 hour)

Moulded Holes - through holes - blind holes - threaded holes - side holes - holes parallel to draw - nearness of holes to each other and side wall - moulding holes not parallel to draw - drilled and tapped holes. Design of integral hinges, snap fits- Inserts-Materials-Selection of metal for inserts-minimum wall thickness of material around inserts-anchorage-relieving moulding stresses around inserts-location of inserts in the part-moulded in inserts-pressed in inserts

Quality and economy-tooling aspects on product design-process variables vs product design-product design appraisal..Prototype development – rapid prototyping techniques – stereo lithography.

Module III Composite product design (11 hour)

Concepts of composite product design-Design requirements-functional-safety-reliability –cost ffectiveness

Design constraints- factor of safety -design failure criteria- design optimization.

Design date-physical, mechanical and functional properties of composites-code of practice of loading on structures-structure properties relation of composites-failure criteria and design.

Design of simple structural elements-tension bars-columns-beams-pipes-plates and shells.

Design of joints-bolted joints and bonded joints

Total Lectures = 35

Text Books

1. Plastics Product Design Engineering Hand Book- By Dubois, H
2. Belofsky, H., “Plastics Product Design and Processing Engineering, Hanser Publishers, Munich Vienna New York, 1994.

Reference Books

1. Robert A. Malloy, “Plastic Part Design for Injection Moulding”, Hanser Publishers, Munich Vienna, New York, 1994.
2. Paul A. Tres, “Designing Plastic Parts for Assembly”, 2nd Revised Edition, Hanser Publishers, Munich Vienna New York, 1994.
3. N G Mc Crum, Principles of Polymer Engineering, Oxford Science Publications, New York, 1997

PCME4304 **MACHINING SCIENCE & TECHNOLOGY** (3-0-0)

Module – I **(13 hours)**

Geometry of cutting tools in ASA and ORS, Effect of Geometrical parameters on cutting force and surface finish, Mechanics of chip formation, Merchant's theory, Force relationship and velocity relationship, Cutting tool materials, Types of Tool Wear: Flank wear, Crater wear, Wear measurement, Cutting fluid and its effect; Machinability Criteria, Tool life and Taylor's equation, Effect of variables on tool life and surface finish, Measurement of cutting force, Lathe tool dynamometer, Drill tool dynamometer. Economics of machining.

Module – II **(13 hours)**

Conventional machining process and machine tools – Turning, Drilling, Shaping, Planning, Milling, Grinding. Machine tools used for these processes, their specifications and various techniques used.

Principles of machine tools : Kinematics of machine tools, speed transmission from motor to spindle , speed reversal mechanism, mechanism for feed motion, Tool holding and job holding methods in different Machine tools, Types of surface generated, Indexing mechanism and thread cutting mechanism, Quick return mechanism,.

Production Machine tools – Capstan and turret lathes, single spindle and multi spindle semiautomatics, Gear shaper and Gear hobbing machines, Copying lathe and transfer machine

Module – III **(10 hours)**

Non-traditional Machining processes :

Ultrasonic Machining, Laser Beam Machining, Plasma Arc Machining, Electro Chemical Machining, Electro Discharge Machining, Wire EDM , Abrasive Jet Machining

Text Books :

1. Fundamentals of Machining and Machine Tools, G.Boothroyd and W.A.Knight, CRC Press
2. Metal Cutting Principles, M.C.Shaw, Oxford University Press
3. Metal Cutting Theory and Practice, A.Bhattacharya, Central Book Publishers

Reference Books :

1. Manufacturing Technology – by P.N.Rao, Tata McGraw Hill publication.
2. Modern Manufacturing Processes, P.C.Pandey, H.S.Shan, Tata McGraw Hill
3. Manufacturing Science, Ghosh and Mallik, East West Press.
4. Metal Cutting Theory and Practice, D.A.Stephenson and J.S.Agapiou, CRC Press
5. Machining Technology; Machine Tools and Operation, H.A.Youssef and H. El-Hofy, CRC Press
6. Machine Tools and Manufacturing Technology, Krar, Rapisarda and Check, Cengage Learning
7. Technology of Machine Tools, Krar, Gill and Smidt, Tata McGraw Hill
8. Principles of Metal Cutting, G.Kuppuswamy, Universities Press
9. Metal Cutting and Machne Tools, G.T.Reddy, Scitech
10. Fundamentals of tool Engineering Design, S.K.Basu, S.K.Mukherjee, R. Mishra , Oxford & IBH Pub Co.
11. Machine Tools, R.N.Datta, New Central Book Agency

PECH5303 **FUEL AND ENERGY TECHNOLOGY** (3-0-0)

Module - I

Fuels : Solid Fuels : Coal - Origin, Chemical composition, calorific value, Classifications, Characteristics & distribution of Indian coals, Storage and spontaneous combustion of coal, Coal washing and blending, Pertrographic constituents of coal, Carbonization of coal, manufacture and properties of metallurgical coke, recovery of by-products.

Module - II

Liquid Fuels : Origin and composition of crude oil, crude oil distillation and its products with special reference to gasoline, Kerosene and diesel oil, cracking and reforming, Coaltar distillation Products,Shale oil. Gaseous Fuels : Natural gas, coal gas. Coke oven and blast furnace gas, Manufacture of Water gas and producer gas, Carburetted water gas.

Module - III

Synthetic Fuels : Hydrogenation of coal, fischer – Tropsch synthesis, Introduction.
Nuclear fuels and nuclear reactors, moderators and structural materials.
Combustion : Combustion of solids fuels, Pulverized coal. Calculation of volumes and weights of air necessary for combustion of fuels, gas analysis.

Books :

1. Fuels and Combustion - S. Sarkar
2. Elements of Fuel Technology - Himus
3. Solid, Liquid and gaseous fuel - Brame and King.
4. Elements of Fuels, Furnaces and Refractories, O. P. Gupta.

PEEL5302 **RENEWABLE ENERGY SYSTEMS**

Module I **(5 Hours)**

Introduction

Fossil fuel based systems Impact of fossil fuel based systems, Non conventional energy – seasonal variations and availability, Renewable energy – sources and features, Hybrid energy systems, Distributed energy systems and dispersed generation (DG)

Module II: **(20 Hours)**

Solar Photovoltaic systems:

Operating principle, Photovoltaic cell concepts, Cell, module, array, Series and parallel connections, Maximum power point tracking, Applications, Battery charging, Pumping, Lighting, Peltier cooling

Solar processes and spectral composition of solar radiation; Radiation flux at the Earth's surface. Solar collectors. Types and performance characteristics. Applications

Wind Energy:

Wind energy conversion; efficiency limit for wind energy conversion, types of converters, aerodynamics of wind rotors, power ~ speed and torque ~ speed characteristics of wind turbines, wind turbine control systems; conversion to electrical power: induction and synchronous generators, grid connected and self excited induction generator operation, constant voltage and constant frequency generation with power electronic control, single and double output systems, reactive power compensation; Characteristics of wind power plant. Applications:

Module III **(15 hours)**

Biomass Power:
Operating principle, Combustion and fermentation, Anaerobic digester. Wood gassifier, Pyrolysis, Applications, Bio gas, Wood stoves, Bio diesel, Combustion engine. Application,

Hybrid Systems
Need for Hybrid Systems, Range and type of Hybrid systems, Case studies of Diesel-PV, Wind-PV, Microhydel-PV, Biomass-Diesel systems, electric and hybrid electric vehicles

Text Books:

1. D. P. Kothari, K. C. Singal, R. Ranjan, *Renewable Energy Sources and Emerging Technologies*, Prentice Hall of India, New Delhi, 2008.
2. B.H.Khan, Non-Conventional Energy Resources, Tata McGrawHill, 2009
3. S. N. Bhadra, D. Kastha, S. Banerjee, *Wind Electrical Systems*, Oxford Univ. Press, New Delhi, 2005.

Reference Books:

1. S. A. Abbasi, N. Abbasi, *Renewable Energy Sources and Their Environmental Impact*, Prentice Hall of India, New Delhi, 2006.

PCPL7301 **PLASTICS PROCESSING LAB – I** (0-0-3)

Sl. No.	Name of M/c/ Equipment/Mould	Description of Practical Exercise to be done
1.	Hand operated Injection Moulding Machine	(i) Study of Machine in Idle-Run Observation (IRO), Parts & functions, operating principle, Free sketch of Machine-parts (ii) Operation practice to produce moulding on different hand injection moulds.
2.	Injection Moulding Semi Automatic	(i) Study of Machine of all types in IRO. Comparative study of Pneumatic type & Hydraulic type of Machine, Operating Principle - Line-diagrams and specifications. (ii) Operation practice of Pneumatic & Hydraulic types- Cycle-time analysis, observations of Process-Parameters
3.	Extrusion Processes on Extruders	(i) Study of Extruders in IRO, Free sketch of machines, their parts and parts-function, List of products manufactured by Extrusion-Process. Study of different types of extrusion process. (ii) Operation-Practice by Trainee on setting up of Process-parameter to produce Blown-Film on Film-plant, observations on extruder output, size of film produced and technical specifications of machines to be recorded.
4.	Compression moulding - Hand Operated	(i) Study of machine IRO Free sketch of parts & study of part-function, comparison of Compression and injection moulding processes. (ii) Operating Principle of Hand Compression Press, mould setting-procedure & parameter setting, operation practice on different compression moulds, machine specification
5.	Blow Moulding Hand Operated	(i) Study of Hand Blow Moulding machine, Free-sketch of machine parts & study of part-function, machine specification (ii) Die-centering practice by Trainees, operation of Hand Blow Machines, to produce components observations, cycle-time analysis Procedure of operation and observations.
6.	Scrap Grinding	(i) Machine Study in IRO, specification, study of parts & function, Line Diagram (ii) Operation-practice with different materials and output study in Kg/hour for different materials.
7.	Injection Moulding machine Automatic	Study of machine Parts & function- clamping systems- Technical specification of Machine, study of process sequence in Machine, Study & definitions- Definitions of all Processing Parameters & controls.
9.	Blow-Moulding Semi Automatic	Technical specification - Mould clamping -, operation practice with different moulds, Familiarization with control-switches/ valves cycle-time analysis & procedure of

		operation.
10	Introduction to maintenance	Basic knowledge of Hydraulic & Pneumatic systems, Electrical system, Definition of terms- Hydraulic fluid, viscosity Directional Valves, Resistance, Current, Voltage, Power, Hydraulic Pumps - Types & function, electrical heaters, thermocouples and temperature control parameters and timers, electrical Motors -Types & function.

PCPL7302 **PLASTICS TESTING LAB -I** (0-0-3)

Sl. No.	Experiment/Exercise
1	Determination of Melt flow index of plastics materials
2	Study of Mechanical properties of plastics & test methods
3	Study of Weathering properties.
4	Determination of Burst strength & tear strength of films
5	Determination of Hardness (Rockwell, shore A & shore D, Barcol
6	Specimen preparation by Injection moulding, contour cutting, compression moulding, contour punching, etc.
7	Testing of Electrical and Optical properties of Plastics materials
8	Introduction to product testing

PCPL7306 **MOULD ENGINEERING LAB** (0-0-3)

Experiments

1. Study of different types of Cutting tools.
2. Measurements using Micrometer, vernier, Height gauge and Slip gauge.
3. Measurement of angles and tapers.
4. Checking of straightness using auto collimeter.
5. Application of Dial gauge.
6. Pantograph milling and Drilling M/c, EDM, Wire cut
7. Study and Detailing of mould assembly
8. Gas assisted and Water assisted Injection mould and Hot runner mould
9. Hand compression mould design – positive, semi positive, displacement type mould, and design with split cavities
10. Transfer mould design (pot type & top plunger type)
11. Automatic unscrewing mould
12. Design of Rotational & Thermoforming Mould
13. Mould design for industrial component

(Any 8 experiments from the above)

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6th Semester

PCPL4304 ADVANCED PLASTIC PROCESSING TECHNIQUES (3-1-0)

Module I Specialized Injection Moulding Processes (15 hours)

Thin wall product moulding-multi material and multi colour moulding-sandwich moulding-thermoset injection moulding. Micro Processor Controlled Injection moulding operation. Statistical quality control and process control. All electric injection moulding - Merits & Demerits

Gas Assist Moulding, Water Assist molding, Reaction Injection molding, Liquid Injection Molding, Lost Core molding, Thermoset Injection molding, Structural foam molding: a) Low pressure Foam b) High pressure Foam, In-mold Decoration/ Reaction Transfer Molding, Filament Winding, Metal/Ceramic Powder Molding,

Module II Advanced Blow Moulding and Extrusion (15 hours)

Classification of Advanced Blow Moulding Process, Deep draw Double Wall Blow Moulding, Press Blow Moulding, Stretch Blow Moulding – Injection Stretch Blow Moulding, Extrusion Stretch Blow Molding Merits & Demerits- Profile Extrusion Process, Multi layer film, Co- extruder Sheets & Pipes, – Process, Process Control, Process Optimization, Application, Merits & Demerits

Machining & Joining of Plastics - Importance of machining –machining methods-joining-welding of plastics- Adhesive Bonding- Mechanical fasteners.

Other Secondary Processes-printing, painting, Hot stamping, In mould decoration, Electro-plating and vacuum metalizing.

Module III Casting and coating (20 hours)

Introduction – casting processes-operation and control of casting processes- plastisol processing.

Coating Process - Introduction-coating methods- process and applications

Cellular plastics - Introduction- foaming processes -foam moulding- RIM Casting foams, steam chest moulding structural foam moulding–applications-foamed extrusion.

Total Lectures = 35 Tutorials= 10

Text Books

1. Plastic Engineering Hand Book & D – 5 - By Society of Plastic Industry Inc.
2. Plastics Material & Processing- By Strong, A, Brent

Reference

1. Cheremisinoff; Nicholas P. and Cheremisinoff; Paul N. (Eds.), Handbook of Applied Polymer Processing Technology, Marcel Dekker Inc., New York (1996)
2. Plastics Materials & Processing - By Schwartz & Goodman Thermoforming - By James & Throne
3. Basic Principle of rotational molding - By Crawford, R.J & Throne, J.L Plastics Technology Mchraw -By Milby
4. Welding of Plastics - By New Man
5. Calendering of Plastics - By Elden & Swan

PCPL4303 **MOULD ENGINEERING** (3-0-0)

Module I Mould Making (12 hours)

Mold Making: Introduction of mold parts, Mechanism of metal cutting, types of tools, influence of tool angles, Cutting fluids, Tool materials used including coated tools. Studies of various machining operations: Turning, Shaping, Planning, Drilling, Grinding (Surface, Cylindrical, Tool & Cutter, Rotary Grinding), Milling (Horizontal / Copy Milling / Vertical / Ram / Tool Milling).

Die sinking (copy milling), Pentograph, Profile grinding, Electrical discharge machining - Characteristics, physical processes, special technological features, types of EDM, design consideration & functions and technological planning. Applications of wire cut EDM in mold making.

Module II Electroforming for mold manufacturing (12 hours)

materials for electroforming, design & materials for models, machining for electroformed blanks, mold cavities, economy & service life. Hobbing process for mold making – advantages- elements of hobbing - materials used for cavity, lubrication, depth of hobbing-hobbing presses- operations

Polishing technology in mold making: Definition of surface roughness, basis of polishing technology- Types of polishing tools, methods of polishing -surface texturing - Process description-patterns and mold shapes, - mold preparation- limitations of chemical texturing.

Module III (11 hours)

Metrology and inspection: Scope of inspection, Procedures, Choices of basic measuring instruments, Vernier, Micrometer, Surface Plates, Angle plates, Squares, Vernier height gauges, Depth gauges, Slip gauges, Dial gauges, Surface roughness measurement, Hardness testing, Comparators, Optical profiles projectors, Tool makers microscope, Optical flats - types and uses.

Total Lectures = 35

Text Books

1. . R.G.W.Pye, Injection Mold Design, East West Press Pvt. Ltd., New Delhi.
2. Klus Stokhert (Edt.),Mold making handbook for Plastic Engineers, Hanser Publication NY,1983

References Books

HMT Production Technology, TMH (India), 1992
Bhattacharya, A New Technology, IB Publishers, 1984
Stoeckhert & Menning, Mold making handbook, 2nd edition, Hanser Publishers, Munich.
W.A.J Chapman, Workshop Technology, Vol I & II, ELBS.
Herbert Rees, Mold Engineering, Hanser Publishers, NY. George Menges & Paul Mohren
How To Make Injection Molds, Hanser Publishers.
7.DuBois; J. Harry and Pribble; W. I. (Eds.), Plastics Mold Engineering, SPE Polymer Technology Series, Revised Edition, Van Nostrand Reinhold Co., New York (1965)

Professional Elective – II (3-0-0)

PEPL5304 MATERIALS ENGINEERING

Module I (12 hours)

Classes of materials, Selection of materials and processes in engineering design, environmental impact of materials, microstructure-property relations and mechanisms of failure Solidification, crystalline structure, deformation imperfections, Alloys types and phases, equilibrium diagram, critical points, Iron carbon equilibrium diagram, constitute of Metals, Steel & Polymers

Module II (12 hours)

Heat treatment processes and constituents T-T diagram. Introduction to heat treatment furnaces. Effect of alloying element on the properties of carbon steels, SAE/AISI and other classifications, general properties, compositions and uses of structural, corrosion resisting and heat resisting steels.

General properties, composition and uses of alloys of aluminum, copper, nickel and bearing materials, corrosion and its prevention.

Module III (11 hours)

Elementary idea of rubber plastic, ceramics, Cutting tools and the materials spring alloy, electric, magnetic and non-magnetic alloys. Introduction to the mechanical behavior of the materials such as tension, compression, fracture, fatigue and creep. Introduction to refractory materials.

Total Lectures = 35

References Books:

1. M. Arumugham, Material Science, Anuradha Agencies, 1st Ed., 1987. G. E. Dieter, Mechanical metallurgy, McGraw Hill, 2000.
2. Klaus Stoeckhert, Mold making handbook for the Plastic engineers, Hanser Pub. Data book on Plastics; CIPET, Chennai
3. J. C. Anderson, K. D. Leaver, R. D.Rawlings , J. M. Alexander, Material Science, Donald S. Clark and Wilbur R Warney, Physical metallurgy, Affltd. East west press. C. W. Richards, Engineering material Science, Prentice Hall of India.

PEPL5305 **POLYMERIZATION ENGINEERING**

Module I (12 hours)

Industrial methods of polymerization such as a bulk, solution, emulsion, suspension. Layout and arrangement of polymer plant. Stereochemistry of polymers and stereo-specific polymerization. Catalysts-their utility in polymers and stereo-specific polymerizations.

Catalysts-their utility in polymer manufacture, Zieglar-Natta, Metallocene and others.

Module II (12 hours)

Manufacturing processes of basic raw materials and intermediates of synthetic polymers. Production technology, properties and application of important plastics such as polyethylene, polypropylene, polystyrene and polyvinyl chloride.

Brief introduction of copolymers based on the common monomers such as ethylene, vinyl chloride, styrene, acrylates and methacrylates etc.

Module III (11 hours)

Formaldehyde and its reaction products with phenol, urea and melamine. Preparation of moulding powders.

Total Lectures: 35

Reference Books :

1. Principles of Polymerization by George Odian
2. Kuran; Witold, Principles of Cordination Polymerization, John Wiley & Sons Ltd., Chishester (2001).
3. Polymer Science & Technology of Plastics & Rubbers by P Ghosh
4. Polymer Science by Gowriker-Viswanathan-Sreedhar
5. Odian; George, Principles of Polymerization, McGraw-Hill Book Co., New York (1970).
6. Polymerization Process Modeling, N A Dotson, R Galvan, R L Laurence and M Tirrell, VCH Pub., Ind., 1996
7. Reaction Engineering of Step Growth Polymerization, S K Gupta and Anil Kumar, Plenum Press, 1987

PEPL5306 **POLYMER REACTION ENGINEERING**

Module III (10 hours)

Elements of Chemical Reaction Engineering: Introduction to chemical kinetics. Representation of expression for reaction rate, Temperature dependent and concentration dependent. Interpretation of Batch Reactor data for various types of reactions taking place in constant volume and variable volume batch reactors.

Module II (12 hours)

Reactor design – performance equations for batch and flow reactors – design for single reactions – multiple reactions. Heat effects in reactors – conversions – equilibrium – non-ideal flow in reactors.

Single Ideal Reactors: Batch, CSTR and Plug Flow Reactors. Reactor choices for single and multiple reactions Viz. Series and parallel reactions. Residence time distribution in non-ideal flow reactors.

Module III (13 hours)

Heterogeneous reacting systems – models for reaction controlled – diffusion controlled mechanisms – application to design – solid catalyzed reactions – experimental methods for rates – application to design.

Polymerization reactors – by free radical mechanism – characterization of mixtures of polymers – mechanism – rate equations – design of reactors for free radical polymerization – stepwise addition and condensation polymerization and copolymerization – analysis of rate equation – polymerization in batch reactors – flow reactors.

Total Lectures = 35

Reference Books

1. J .M. Smith, Chemical Engineering Kinetics, McGraw-Hill, 1975.
2. H. Scott Fogler, Elements of chemical reaction engineering, PHI, 1992.
3. M.Kh. Karapetyants, Chemical Thermodynamics, Mir Publications, USSR, 1978.
4. G.N.Pandy, J.C.Chaudari, Chemical Engg. Thermodynamics –Khanna Publishers.
5. L.H.Sperling, Introduction to Physical polymer science, John Wiley & Sons. London.
6. Octave Levenspiel, Chemical Reaction Engineering, Wiley Eastern Ltd.
7. C.D. Holland & G. Rayboard Anthony, Fundamentals of chemical reaction Engineering.
8. Asua; Jose M, (Ed), Polymer Reaction Engineering, Blackwell Publishing, Ltd, Oxford
9. Gupta; Santosh Kumar and Kumar; Anil, Reaction Engineering of Step Growth Polymerization, Plenum Press, New York (1987).
10. McCrum; N. G., Buckley; C. P. and Bucknall; C. B., Principles of Polymer Engineering, Oxford University Press, Oxford (1988).[CN171]
11. McCrum; N. G., Buckley; C. P. and Bucknall; C. B., Principles of Polymer Engineering, Oxford Science Publications, Oxford University Press, Oxford (1995).
12. McCrum; N. G., Buckley; C.P. and Bucknall; C. B., Solutions Manual- Principles of Polymer Engineering, Oxford Science Publications, Oxford University Press, Oxford (89)
13. Meyer; Thierry and Keurentjes; Jos (Eds.), Handbook of Polymer Reaction Engineering, Volume1, Wiley-VCH, Weinheim (2005).
14. Meyer; Thierry and Keurentjes; Jos (Eds.), Handbook of Polymer Reaction Engineering, Volume2, Wiley-VCH, Weinheim (2005)

PEPL5308 **STRENGTH OF MATERIALS**

Module I (12 hours)

Elasticity: Stress and strain, compressive, tensile, shear and bearing stress - Stress - strain diagram, Hooks law, modulus of elasticity, modulus of rigidity, bulk modulus of rigidity, bulk modulus, Poisson's ration. Relationship between elastic constraints and temperature stresses, composite bars, dead, live and shock loads.

Properties of section, calculation of areas, centroid, neutral axis, moment of inertia, modulus of section, radius of gyration with reference to structural shapes.

Module II (12 hours)

Theory of simple bends - relationship between load shearing force and bending moment. Bending moment and shear force diagram for cantilever, simple supported and over hanging beams - bending stresses.

Deflection - deflection of beams in simple cases. Principal stresses and stains.

Torsion in solid and hollow shafts - combined bending and torsion.

Module III (11 hours)

Thin and thick cylinders and shells subjected to internal and external pressures.

Column and struts - long and short columns - axial and eccentric loading - effect of end conditions – equivalent length and slenderness ratio - Euler and Rankine formulae.

Total Lectures = 35

References Books:

1. R.S. Khurmi, Applied Mechanics and Strength of Materials S.Chand & Co., (6th ed), New Delhi, 1987.
2. P.N. Singh and I.K.Jha, Elementary Mechanics and Solids, Wiley Eastern, New Delhi.
3. Timoshenko, Strength of Materials
4. Singer, Strength of Materials

FEEE6301 **INDUSTRIAL PROCESS CONTROL & DYNAMICS** (3-0-0)

Module-I (10 Hrs))

Analog Signal Conditioning

Introduction, Principles of Analog Signal Conditioning, Signal-Level Changes, Linearization, Conversions, Zero adjustment, Span adjustment, Level changing, AC/DC Power supply, Filtering and Impedance Matching, Passive Circuits, Divider Circuit, Bridge Circuits, RC Filters, Operational Amplifiers, Op Amp Characteristics, Op Amp Specifications, Op Amp Circuits in Instrumentation, Voltage Follower, inverting Amplifier, Non- inverting Amplifier, Differential Amplifier, Active Filters, Protection Voltage-to –Current Converter, Current-to-Voltage Converter, Integrator, Linearization. Book-1-Ch-2.2,2.3,2.4,2.5,2.6.

Digital Signal Conditioning

Introduction, Review of Digital Fundamentals, Digital Information, Fractional Binary Numbers, Boolean Algebra, Digital Electronics, Programmable Logic Controllers, Busses and Tri-State Buffers, Converters, Comparators, Digital-to-Analog Converters (DCA), Analog-to-Digital Converters (ADCs), Sample and Hold, Multiplexer and De-multiplexer, decoder and encoder, Pulse modulations, Digital recorder. Book-1-Ch-3.1,3.2,3.3,3.4,3.5.

Module-2 (20 Hrs)

Thermal Sensors

Definition of Temperature, Metal Resistance versus Temperature Device, Thermistors, Thermocouples, Other Thermal Sensors, Design Consideration.
Book-1-Ch-4.1,4.2,4.3,4.4,4.5,4.6,4.7.

Mechanical Sensors: Displacement, Position Sensors, Strain Sensors, Motion Sensors, Pressure Sensors, Flow Sensors. Book-1-Ch-5.2,5.3,5.4,5.5,5.6

Optical Sensors: Photodetectors, Pyrometry, Leser Principles,Applications.
Book-1-6.2,6.3,6.4,6.5,6.6.

Final Control: Final Control Operation, Signal Conversions, Switching and Control Devices, Actuators, control Elements. Book-1-Ch-7.2,7.3,7.4,7.5,7.6.

Discrete-State Process Control: Characteristics of the System, Relay Controllers and Ladder diagrams, PLCs. Book-1-Ch-8.2,8.3,8.4,8.4,8.5.

Module-3 (10 Hrs)

Controller Principles: Process Characteristics, Control System Parameters, Discontinuous and Continuous Controller Modes, Composite Control Modes. Book-1-Ch-9.2,9.3,9.4,9.5,9.6.

Analog Controllers: Electronic controllers, pneumatic controllers, design consideration.
Book-1-10.2,10.3,10.4,10.5.

Casecade,Feedforward, and Ratio Control: Casecade Control,Feedfrrward Control,Feedforward-feedback cControl Configuration,Ratio Control. Book-2, Ch-!0.1,!0.2,!0.3,!0.4,!0.5.

Selective and Adaptive Control Systems: Selective Control, Adaptive Control,Adaptive Control Configuration. Book-2. Ch-11.1,11.2,11.3,11.4.

TEXT BOOK

1.-PROCESS CONTROL INSTRUMENTATION TECHNOLOGY BY-Curtis D.Johnson.PHI Pub.
2-PROCESS CONTROL PRINCIPLES AND APPLICATIONS BY-Surekha Bhanot. Oxford Pub.

Reference:-

Process control Systems and Instrumentation By-Terry Bartelt , Cengage Learning Publication

PEPL5309 STATISTICAL QUALITY CONTROL TECHNIQUES

Module I (11 hours)

Introduction to quality – Basic concepts – definitions – quality of design vs conformance costs of quality; variation concepts; Investigational methods; quality assurance functions and their evaluations.

SQC Techniques and their applications – Organizing data collection; summarization of data, presentation if data in the form of pie diagrams; Histograms and frequency distributions,- Measures of central tendency and dispersion; their calculation and interpretation-

Module II (12 hours)

Concept of distributions; Normal, Binomial and Poisson Mean and Variance of distributions – Concept of Sampling distribution; 't', 'F', and 'x' distributions. Introduction to tests of simple hypothesis; Single Mean, Standard Deviation; Two sample tests for means and variable and attribute type of data- Their interpretation; Special purpose charts;

Dominant systems, Process and Product check – Inspection, quality control & testing schemes: Concepts of Acceptance Sampling – Attribute characteristics, Single, Double Sampling Plans – OC curves,

Module III (12 hours)

Explanation of IS2500 Standard tables – Correlation and regression analysis- Introduction of Statistical design of experiments for product quality improvement.

Organization for quality control- quality audit- concept of quality circles- ISO 9000- concepts, procedures and documentations. Total Lectures = 35

Reference Book

1. Banks, Jerry : Principles of Quality Control, John Wiley & Sons.
2. Agarwal B.L. : Basic Statistics, New Age International (P) Ltd., New Delhi.
3. Grant E.L. & Leavenworth R.S. : Statistical Quality Control : McGraw Hill Book Company, New Delhi.

PEME5308 NON-CONVENTIONAL ENERGY SOURCES(3-0-0)

Module I **(10 Classes)**

Energy, Ecology and environment: Introduction, Classification of Energy Resources, Common Forms of Energy, Energy Chain, Advantages and Disadvantages of Conventional Energy Sources, Importance and Salient Features of Non-Conventional Energy Sources, Environmental and ecological Aspects of Energy use, Environment-Economy-Energy and Sustainable Development, World Energy Status, Energy Scenario in India.

Energy Conservation and Energy Storage: Salient Features of "Energy Conservation Act, 2001", Various Aspects of Energy Conservation, Principles of Energy Conservation, General Electrical ECO's (Energy Conservation Opportunities),

Solar Energy: Basics, The Sun as a Source of Energy, Sun, Earth Radiation Spectrums, Extraterrestrial and Terrestrial Radiations, Spectral Energy Distribution of Solar Radiation, Depletion of Solar Radiation, Measurements of Solar Radiation, Solar Time (Local Apparent Time), Solar Radiation Geometry, Solar Day Length, Empirical Equations for Estimating Solar Radiation(Hourly Global, Diffuse and Beam Radiations) on Horizontal Surface Under Cloudless and Cloudy Skies, Solar Radiation on Inclined Plane Surface only (empirical relations for numerical)

Module II **(15 Classes)**

Solar Thermal Systems: Solar Collectors: Flat plate and concentric collectors, Solar Water Heater, Solar Passive Space - Heating and Cooling Systems, Solar Refrigeration and Air-Conditioning Systems, Solar Cookers, Solar Furnaces, Solar Green House, Solar Dryer, Solar Distillation (or Desalination of Water),

Solar Photovoltaic Systems: Solar Cell Fundamentals, Solar Cell Characteristics, Solar Cell Classification, Solar Cell, Module, Panel and Array Construction, Solar PV Systems, Solar PV Applications.

Wind Energy: Origin of Winds, Nature of Winds, Wind Turbine Siting, Major Applications of Wind Power, Wind Turbine Types and Their Construction, Wind Energy Conversion Systems (WECS), Effects of Wind Speed and Grid Condition (System Integration),

Module III **(15 Classes)**

Biomass Energy: Photosynthesis Process, Usable Forms of Biomass, their Composition and Fuel Properties, Biomass Resources , Biomass Conversion Technologies, Urban Waste to Energy Conversion, Biomass Gasification ,Biomass Liquefaction, Biomass to Ethanol Production, Biogas Production from Waste Biomass, Energy Farming.

Miscellaneous Non-conventional Technologies

Geothermal Energy: Applications, Origin and Distribution of Geothermal Energy, Types of Geothermal Resource.

Ocean Energy: Tidal Energy, Wave Energy, Ocean Thermal Energy

Fuel Cell Technology: Types, Principle of operation, Advantages and disadvantages.

Text Book:

1. Non Conventional Energy Sources: B.M Khan, TMH Publications
2. Renewable Energy Sources and Emerging Technology: D.P.Kothari and etal., PHI
3. Renewable Energy Sources & Conversion Technology: N.K.Bansal, Manfred Kleenman & Michael Meliss, TMH Publication.

Reference:

1. Renewable Energy Sources:Fundamentals & Applications:G.N.Tiwari & M.K.Ghosal, Narosa Pub
2. Non Conventional Energy Resources: D.S. Chauhan and S.K.Srivastava, New Age International
3. Non Conventional Energy Sources: H.P.Garg
4. Non-Conventional Energy Systems: G.D.Rai, Khanna publications
5. Solar Energy Technology: Sukhatme and Nayak, TMH
6. Renewable Energy, Godfrey Boyle, Oxford University Press

PCME4305 **HEAT TRANSFER (3-0-0)**

Module-I (15 hours)

1. **Introduction:**
   Modes of heat transfer: conduction, convection, and radiation ,Mechanism & basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity, Thermal conductance &Thermal resistance, Contact resistance, convective heat transfer coefficient, radiation heat transfer coefficient , Electrical analogy, combined modes of heat transfer.initial conditions *and* Boundary conditions of 1st, 2nd and 3rd Kind.
2. **Heat Conduction:**
   The General heat conduction in Cartesian, polar-cylindrical and polar-spherical co-ordinates, Simplification of the general equation for one and two dimensional steady/ transient conduction with constant/ variable thermal conductivity with / without heat generation.
   Solution of the one dimensional steady state heat conduction problem in case of plane walls, cylinders and spheres for simple and composite cases. Critical insulation thickness, Heat transfer in extended surfaces (pin fins) without heat generation, Long fin, short fin with insulated tip and without insulated tip and fin connected between two heat sources. Fin efficiency and fin effectiveness.
   Conduction in solids with negligible internal temperature gradient (Lumped heat analysis).
   Solution of Cartesian problems in two dimensions (steady state conduction with constant thermal conductivity and no heat generation) by variable separation method. Numerical methods for heat conduction analysis.

Module-II (15 hours)

3. **Convective Heat Transfer:**
   (a) Introduction to convective flow - forced and free. Dimensional analysis of forced and free connective heat transfer. Application of dimensional analysis, physical significance of Grashoff , Reynolds, Prandtl, Nusselt and Stanton numbers.
   (b) Conservation equations for mass, momentum and energy for 2-dimensional convective heat transfer in case of incompressible flow, Hydrodynamic and thermal boundary layers for flow over a flat plate. Critical Reynolds number; general expressions for drag coefficient and drag force Reynolds-Colbourn analogy. Thermal boundary layer; general expression for local heat transfer coefficient; Average heat transfer Coefficient; Nusselt number. Flow inside a duct- velocity boundary layer, hydrodynamic entrance length and hydro dynamically developed flow; flow through tubes (internal flow). Use of empirical relations for solving turbulent conditions for external and internal flow.

4. Mechanism of heat transfer during natural convection, Experimental heat transfer correlations for natural convection in the following cases
   (a) Vertical and horizontal plates

(b) Inside and outside flows in case of tubes

5. Heat transfer for boiling liquids and condensing vapours :

Types of condensation, use of correlations for condensation on vertical flat surfaces, horizontal tube and; regimes of pool boiling, pool boiling correlations. Critical heat flux, concept of forced boiling. Numerical problems.

Module-III (10 hours)

6. Radiative heat exchange :

Introduction, Radiation properties, definitions of various terms used in radiation heat transfer; Absorptivity,reflectivity & transmissivity.Emissive power & emissivity, Kirchoff's identity, Planck's relation for monochromatic emissive power of a black body, Derivation of Stefan-Boltzmann law and Wien's displacement law from Planck's relation, Radiation shape factor, Relation for shape factor and shape factor algebra. Heat exchange between black bodies through non-absorbing medium. Gray bodies and real bodies, Heat exchange between gray bodies. Radiosity and Irradiation, Electrical analogy and radiation network for 2-body and 3-body radiations exchange in non-absorbing medium, Radiation shields.

7. Heat Exchangers :

Introduction, Types of heat exchanger, The overall heat transfer coefficient and fouling factors, LMTD and - NTU analysis of heat exchangers.

Text Books :

1. Fundamentals of Engineering Heat and Mass Transfer: R.C.Sachdeva, New Age International Publishers, 4th Edition

2. Heat Transfer : J.P.Holman, TMH Publications

3. Basic Heat Transfer by Necati Ozisik, Mcgrawhills Publications

References :

1 Heat Transfer: P.S.Ghosdastidar, Oxford University Press

2. Heat Transfer by P.K. Nag, TMH

3. Heat Transfer by S.P. Sukhatme, TMH

4. Heat Transfer: A.F.Mills and V.Ganesan, Pearson Education, 2nd Edition

5. Heat and Mass Transfer: Domkundwar and Arora, Danpatrai and sons

6. Heat Transfer : R.K.Rajput, Laxmi Publications

7. Heat and Mass Transfer: A Practical Approach, Y.A.Cengel, Tata Macgraw Hills Education Private Limited

PEME5306 **MODERN MANUFACTURING PROCESSES** (3-0-0)

Module I **(12 hours)**

ULTRASONIC MACHINING (USM): Introduction, equipment, tool materials & tool size, abrasive slurry, cutting tool system design:- Effect of parameters on Material removal rate, tool wear, Accuracy, surface finish, applications, advantages & Disadvantages of USM.

ABRASIVE JET MACHINING (AJM): Introduction, Equipment, Variables in AJM: Carrier Gas, Type of abrasive work material, stand off distance (SOD), nozzle design, shape of cut. Process characteristics-Material removal rate, Nozzle wear, Accuracy & surface finish. Applications, advantages & Disadvantages of AJM.

Water Jet Machining: Principle, Equipment, Operation, Application, Advantages and limitations of Water Jet machining.

ELECTROCHEMICAL MACHINING (ECM): Introduction, study of ECM machine, elements of ECM process: ECM Process characteristics – Material removal rate, Accuracy, surface finish, Applications, Electrochemical turning, Grinding, Honing, deburring, Advantages, Limitations.

CHEMICAL MACHINING (CHM): Introduction, elements of process, chemical blanking process, process characteristics of CHM: material removal rate, accuracy, surface finish, Hydrogen embrittlement, advantages & application of CHM.

Module II **(13Lectures)**

ELECTRICAL DISCHARGE MACHINING (EDM): Introduction, mechanism of metal removal, dielectric fluid, spark generator, EDM tools (electrodes) Electrode feed control, EDM process characteristics: metal removal rate, accuracy, surface finish, Heat Affected Zone. Machine tool selection, Application, electrical discharge grinding, wire EDM.

PLASMA ARC MACHINING (PAM): Introduction, equipment, non-thermal generation of plasma, selection of gas, Mechanism of metal removal, PAM parameters, process characteristics. Applications, Advantages and limitations.

LASER BEAM MACHINING (LBM): Introduction, equipment of LBM mechanism of metal removal, LBM parameters, Process characteristics, Applications, Advantages & limitations.

ELECTRON BEAM MACHINING (EBM): Principles, equipment, operations, applications, advantages and limitation of EBM.

Module III **(11 Lectures)**

Introduction to Surface engineering, High speed machining and grinding: Application of advanced coatings in high performance modern cutting tools and high performance super-abrasive grinding wheels, Micro and nano machining of glasses and ceramics. Theory and application of chemical processing: Chemical Machining, Aching of semi conductors, Coating and Electroless forming, PVD and CVD; Introduction to Reverse Engineering, Concurrent Engineering and Rapid prototyping:

Text Books:

1. Modern machining process, Pandey and Shan, Tata McGraw Hill 2000
2. Manufacturing Engg. & Technology, Kalpakjian , Pearson Education
3. Manufacturing Science, A.Ghosh & A.K. Mallik, EWP

Reference Books

1. Metals Handbook: Machining Volume 16, Joseph R. Davis (Editor), American Society of Metals.
2. Surface Wear Analysis, Treatment & Prevention-ASM International,Materials Park,OH, U.S.A.,1st Ed.95
3. Production Technology, HMT, Tata McGraw Hill. 2001
4. Modern Machining Process, Aditya. 2002
5. Non-Conventional Machining, P.K.Mishra,The Institution of Engineers (India) Test book series, Narosa Publishing House – 2005.
6. Introduction to Rapid Prototyping, A Ghosh, North West Publication

PCPL7303 **PLASTICS PROCESSING LAB – II** (0-0-3)

Sl. No.	Name of M/c/ Equipment/Mould	Description of Practical Exercise to be done*
1.	Automatic Injection Moulding M/C	Idle-run observation (IRO) & study of Injection Unit, Clamping Unit, Process-Control knobs, safety precautions, start-up Procedure, Shut-down Procedure, Sketch of Machine Platens, Clamping system, type of nozzle used in M/c etc., study of Hydraulic System used in the M/c. M/c Operation-Practice, Process parameter setting for a particular mould on the Machine, Operation of Machine in Hand, Semi Automatic & Automatic-mode to produce components, observations of all parameters, cycle-time analysis, use of different plastics material for moulding & comparison, Moulding faults analysis for causes and remedies.
2.	MICRO-PROCESSOR Controlled Injection Moulding M/C	Study of Basic concepts of Micro processor control, Comparison of Micro Processor- Controlled M/cs with Conventional M/Cs, Machine Setting Procedure, Procedure for Process-Parameter-setting on monitor or control Panel. Operation of M/c with Mould fixing & setting on the M/c with different plastics materials, cycle-time analysis, Analysis of Product defects, causes & remedies during M/c operation, listing of important operating procedure points, safety precautions through M/C Instruction/Manual operating.
3.	Blown Film Extruder Pipe/Tube Extruder	Procedure for setting up of Process-parameters e.g. Temperature on different zones, Screw-Speed, Nip-roller speed, Winder Speed, Blow-ratio, control of cooling-Air on bubble, Methodology & practice by trainees to fix the Blown Film die on M/C familiarization of Die-parts & their function, Technical specification of M/cs, defects, causes & remedies, Practice of operating M/c to produce different sizes of Blown Film. Study of the Machine-parts & function from Screw drive to the Cater pillar. Practice of Die setting on the machine, SIZING TECHNIQUES, Procedure for setting up of parameters & operation practice in running the Machine to produce pipe/ Tube/ film.
4.	Compression & Transfer Moulding (Semi-Automatic)	Setting up procedure for operation of M/c, safety precautions, Type of Mould Clamping arrangement available on M/c-Platen, Mould Clamping procedure on M/c, Operation of M/c by setting the optimum Temperature, curing time, clamping force, ejector-stroke etc. on continuous basis, Analysis of Product defects & remedies, Analysis of Cycle-time, Practice on operation of compression & Transfer moulds with thermoset materials.
5.	Automatic Blow Moulding Machine	Machine-setting Procedure, Parameter-setting Procedure, Method of Mould fixing & parison-die setting on the M/c, Practice by trainees to remove& fix the parison die to produce on appropriate Parison for blowing, type of blowing systems, operation-practice on different moulds, cycle-time analysis, process-faults & remedies.
6.	Thermoforming (Vacuum forming)	Study of Process Principle, type of moulds & material used, Familiarisation with the M/c controls for operation, Operation Practice by trainee, observation on Cycle-time, processing-defects & remedies.
7.	Rotational Moulding	Machine-study in IRO, Process Principle & sequence of operation, Raw materials used, Mould-clamping practice on the M/c, operation practice to produce Roto moulded components, Cycle-time analysis, Comparison of process with other processing processes.

8.	Plastics-coating. Sealing, Welding & Screen-Printing	Principle of coating equipments, Process-method, type of material used, sequence of Operation in Coating. Principle of Operation of Heat-Sealing equipments, High frequency Welding & Hot stamping operation. Familiarisation of screen printing process, methodology for screen preparation, type of inks used.
10.	FRP Demonstration Facility	Study of types of Resin, fibres used in the process, sequence of Process operation in Hand-lay up process, operation Practice for Hand-lay up Process for producing FRP-products, Precautions during the process, Process-defects & analysis for the remedies.
11.	Maintenance Work on Processing M/cs.\	Practical exposure to the preventive maintenance checkpoints for all processing machine. Daily startup and shut down maintenance checks, housekeeping checking hydraulics and electrical circuit for safety, routine flaut and remedies.

PCPL7304 **PLASTICS TESTING LAB – II** (0-0-3)

Sl . No.	**Experiment/Exercise**
1)	Compounding, Blending using Two Roll Mill and Specimen preparation
2)	Determinations of Carbon Black Content and Dispersion of Olefinic Plastics
3)	Determination of environmental stress cracking resistance for Polyethylene
4)	Testing of HDPE/RPVC Pipes
5)	Testing of Water Storage Tanks/Containers
6)	Testing of Films/Sheets
7)	Testing of HDPE/PP Woven Sacks/Tapes
8)	Testing of Bottles for Vanaspati, Ghee, Milk Packing
9)	Testing of Plastics Products for Determination of Mechanical properties

PCPL7305 DESIGN & MOLDFLOW ANALYSIS PRACTICE USING CAD/CAE LAB (0-0-3)

I. Injection mould design using CAD

Design calculations: No. of cavities, Selection of injection moulding machine, shot capacity, plasticizing rate, Clamping force, Injection pressure &Tool strength calculations related to -

Two plate, three plate, split and hot runner moulds.

II. Semi - Automatic Compression Mould using CAD.

Design calculations: Economic determination of no. of cavities, flash thickness allowances, design of mould cavity, design of loading chamber, bulk factor, loading chamber depth & heat requirement for heating the mould related to

Open-flash type, Semi-positive and fully positive type moulds.

III. Transfer mould design using CAD.

Design calculations: Pot calculation, runner & gate dimensions, bulk factor & shrinkage allowances for thermo set plastics & Minimum moulding pressure related to -

Pot and Plunger transfer moulds.

IV. Part design for an Injection Moulded Component using MOLDFLOW CAE.

1. 3D Modeling using MOLDFLOW & Flow and Cooling analysis.

Reference Books

1. R.G.W.Pye, Injection Mould Design, SPE Publication.
2. P.S.Cracknell and R.W.Dyson, Hand Book of thermoplastics injection mould design, Chapman & Hall, 1993.
3. Herbert Rees, Mould Engineering, Hanser publishers, Munich, Vienna N.Y. 1994.
4. Technical Directory on Design and Tooling for plastics, CIPET, Guindy, Chennai.
5. Design calculations for Compression moulds, Machinery publications, Yellow series, U.K.
6. Mould Flow Manual & Part - Adviser Manual - MOULD FLOW
7. Laszco Sors and Imre Blazs, Design of Plastic Moulds and Dies, Elsevier, Amsterdam -Oxford - Tokyo NY, 1989.

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BIJU PATNAIK UNIVERSITY OF TECHNOLOGY , ORISSA

Plastic Engineering

7th Semester				8th Semester			
Code	**Subject**	**Credit Hrs**	**Credit**	**Code**	**Subject**	**Credit Hrs**	**Credit**
PCPL4401	Polymer Composite Technology	3-0-0	3	HSSM3403	Marketing Management	3-0-0	3
PCPL4402	Polymer Physics	3-0-0	3		Professional Elective – VI	3-0-0	3
	Professional Elective – IV	3-0-0	3	PEPL5407	Specialty Elastomers		
PEPL5401	Polymer Rheology			PEPL5408	Polyurethane Technology		
PEPL5402	Characterization of Polymers			PEPL5409	Adhesive and Surface Coatings		
PEPL5403	Specialty polymer				Professional Elective – VII	3-0-0	3
	Professional Elective – V	3-0-0	3	PEPL5410	Plastics Product Design Using CAD/CAM/CAE		
PEPL5404	Plastic Waste Management & Recycling Technology			PEPL5411	Nylon Technology		
PEPL5405	Plastics Packaging Technology			PEPL5412	Biomedical plastics		
PEPL5406	Fiber Technology				Free Elective – V	3-0-0	3
	Free Elective – III	3-0-0	3	FEMT6401	Total Quality Management		
PCMT4403	Corrosion & degradation of Materials			FEPL6404	Internet & Web Technology		
PEBM5401	Transducers & Instrumentation			PCME4404	Production Operation Management		
FEPL6401	Industrial Safety & Hazard Management						
	Free Elective – IV	3-0-0	3				
HSSM3401	Entrepreneurship Development						
FEPL6402	Biodegradable Polymers						
FEPL6403	Polymer Nanocomposites						
Practicals / Sessionals					***Practicals/Sessionals***		
PCPL7401	Project	0-0-6	4	PCPL7403	Project	0-0-6	4
PCPL7402	Seminar	0-0-4	2	PCPL7404	Seminar	0-0-4	2
				PCPL7405	Entrepreneurship Project	0-0-3	2
				PCPL7406	Comprehensive Viva-Voce	0-0-3	2
	Total Credit		24		Total Credit		22

7th Semester

POLYMER COMPOSITE TECHNOLOGY

Module -I

Introduction of composite material- comparison between composites and other materials-advantages and disadvantages. Principles of composite reinforcement- Effect of fibrous reinforcement on composite strength-Types of reinforcements- natural fibre, glass, carbon/graphite, aramid fibres, high strength and high modulus fibers.

Module -II

Thermosetting and thermoplastic materials for the composites and their selection for particular application-

Processing and production techniques-Hand-lay-up, Spray-up, Bag moldings, Filament winding and Pultrusion.

Module -III

Prepreg- manufacture and characterization. Sheet moulding and dough moulding compounds and their processing, Preform and resin transfer moldings. Hybrid and sand witch type composites.

Total Lectures = 35

Reference Books

1. Astrom; B.T, Manufacture of Polymer Composites, Chapman and Hall, London (1997)
2. Bunsell; A. R. and J. Renard, Fundamentals of Fibre Reinforced Composite Materials, Institute of Physics Publishing Ltd., Bristol (2005).
3. Hollaway; Leonard (Ed.), Handbook of Polymer Composites for Engineers, Woodhead Publishing Ltd., Cambridge (1994), Reprint (2007).
4. Miller; Edward, Introduction to Plastics and Composites, Marcel Dekker, Inc., New York (1996)

POLYMER PHYSICS

Module I

Conformations and configurations - isomerism in polymers - Tacticity, stereoisomerism, geometric isomerism - Unperturbed and Gaussian chains - Random coils and average end to end distance - Random flight analysis.

Thermodynamics of polymers- Entropy and enthalpy – Energy driven and entropy driven elasticity - Entropic and energetic contributions to the elastic force in rubbers

Module II

Amorphous State - Transition temperatures - Glass transition temperature - Free volume, kinetic and thermodynamic views of glass transition - Crystalline State - polymorphism - Polymer single crystals, lamellae, spherulites, fringed micelle model - Degree of crystallinity, factors affecting crystallinity - X-ray diffraction.

Module III

Chain orientation - Concept of chain orientation - orientation in amorphous and crystalline polymers – Uniaxial and biaxial orientation

Polymer solutions - Terms and definitions, types of solutions - Hildebrand approach, Flory Huggins theory - Thermodynamic view of miscibility, Critical solution temperatures (

Total Lectures = 35

References Books

1. Paul C. Painter and Michael M. Coleman, Fundamentals of Polymer Science, Technomic Publishing Co. Inc., Lancaster, USA ,1994.
2. Ulf W. Gedde, Polymer Physics, Chapman & Hall, 1995.
3. Cowie; J. M. G., Polymers: Chemistry and Physics of Modern Materials, 2nd Edition, Blackie and Sons Ltd., Glasgow (1991).

Mark; J. E., Eisenberg; A., Graessley; W. E., Mandlekern; L. and Koenig; J. L., Physical Properties of Polymers, American Chemical Society, Washington D. C. (1984).

PROFESSIONAL ELECTIVE – IV

POLYMER RHEOLOGY

Module I

Viscoelastic behavior of Polymer solution and melts stress-strain curves for Polymers, creep of Polymeric material, elastic deformation, irrecoverable follow deformation. Rubber like deformation, Time-temp superposition (WLF Equation) Models of viscollastity such as Maxwell and kelvin model. Types of viscosity, stress relaxation.

Module II

Introduction and Basic concept of Rheology, classification of fluids, Newtonian and non Newtonian fluids, shear stress, shear strain and shear rate, shear modulus, bulk modulus, Zero shear viscosity,

Methods to determine shear viscosity by capillary viscometer, cone and plate viscometer, Cup and bob viscometer, Measurement of normal stresses. Theories of viscocities of dilute (De-bye Bueche theory) and conc. Solutions (Grasselley's entanglement theory)

Module III

Rheology of dilute and concentrated suspensions, effect of Rheology during Injection moulding and extrusion and blow moulding of polymers. Rheometers- Bubble inflation rheometers, compressional rheometer, stress relaxation instruments. Torque rheometer, rotational & sliding surface rheometer

Total Lectures: 35

1. Ferry JD Viscoelastic Properties of Polymers, 3rd ed, John Wiley & Sons, New York(1980).
2. Han CD. Rheology in Polymer Processing, Academic Press, New York (1976)
3. Chang Dae Han, Rheology and Processing of Polymeric Materials Volume I &II, Oxford University Press, New York (2007)
4. Yamakawa H. *Modern Theory of Polymer Solutions*, Harper Row, New York (1971)

CHARACTERISATION OF POLYMERS

Module I

Determination of molecular weight, viscometry, end group analysis, colligative property, osmometry, light scattering technique, determination of molecular weight and molecular weight determination, gel permeation chromatography.

Module II

Differential thermal analysis (DTA), Differential scanning Calorimetry (DSC), Thermogavimetric analysis (TGA), Thermo mechanical analysis (TMA), Dynamic mechanical thermal analysis (DMTA).

Module III

Spectroscopic methods- Infrared spectroscopy (IR), Nuclear magnetic resonance spectroscopy (NMR), Gas chromatography(GC), Mass spectrometer(MS) and GC –MS

X –ray diffraction, Optical microscopy, Electron microscopy (TEM)

Total Lecture: 35 Hours

TEXT BOOKS

1. Hunt & James, Polymer characterization – Chapman & Hall, London, 1993

REFERENCES

1. ASTM – Volume: 8.01, 8.02 & 8.03, 2000
2. Kampff, Characterization of plastics using physical methods, Experimental techniques and practical applications
3. D. Campbell & J.R. White, Polymer Characterization, Chapman & Hall, 1989.

SPECIALITY POLYMERS

Module I

High temperature and fire resistant polymers improving low performance polymers for high temperature use – polymers, for low fire hazards – polymers for high temperature resistance – Fluoropolymers. polyphenylene sulphide, polysulphones, polyketones, Heterocyclic polymers. Biological and inorganic ionic polymers- Polymer concrete- polymers for biomedical applications, polymeric binders for rocket propellants

Module II

Polymers with electrical and electronic properties- Polymers in telecommunications and power transmission, polymers as insulators- polymers in power transmission Conducting polymers, conducting mechanisms, polyacetylene, polyparaphenylene polypyrrole, organometallic polymers, photo conducting polymers, polymers in non-linear optics, polymers with piezoelectric and pyro-electric properties, liquid crystalline polymers.

Module III

Ionic Polymers, synthesis, physical properties and applications, Ion-exchange, Hydrophilicity, Ionomers based on polyethylene, elastomeric ionomers. Ionomers based on polystyrene, ionomers based on PTFE, ionomers with polyaromatic backbones, polyelectrolytes for ion exchange, polyelectrolytes based on carboxylates, polymers with integral ions, polyelectrolyte complexes.

Total Lecture: 35 Hours

Reference Books:

1. H.F.Mark, (Ed), Encyclopedia of polymer Science & Engineering, John Wiley & Sons, New York, 1989.
2. Matrin.T.Goosey, Plastics for Electronics, Elsevier, Applied Science, 1985.
3. R.W. Dyson, Specialty Polymers, Chapman & Hall, 2nd edition, 1998.
4. Manas Chanda, Salil.K.Roy, Plastics Technology Hand book, 2nd edition, Marcel Dekker, New York, 1993

PROFESSIONAL ELECTIVE – V

PLASTIC WASTE MANAGEMENT & RECYCLING TECHNIQUES

Module I

Plastic & environment value additions, global policy, regulations, waste energy management.

Waste treatment of various plastic plants, estimations of power requirement & efficiency of size reduction operation of plastics, environment pollution.

Need for recycling – Sorting and segregation of waste – Plastics identification- Plastics production and composition – Plastics waste – Composition, quantities and disposal alternatives.

Module II

Primary recycling – Equipments for primary recycling. Specific recycling techniques – PE films, PP battery case – Crushing and separation – PET films.

Recycling of plastics from urban waste – rheology, density, mechanical behavior. Secondary recycling Plastics wastes containing paper – hydrolytic treatment – processing methods – processing of mixed plastics waste – household waste – industrial sector.

Module III

Use of recyclable plastics in motor vehicles – recoverable materials – disposal of residuals – recyclable plastic components – virgin and recycled HDPE – Fluorinated and unfluorinated HDPE – fuel tanks. Tertiary recycling – Reactors used – Advantages – Dry method wet method - use of recyclable plastics in automobiles.

Total Lecture: 35 Hours

Reference Books

1. Plastic Waste Management" Marcel Dekker, New York, 1995.
2. Edited by Nabil Mustafa, Plastic waste management, 1st edition, Marcel Decker, New York,1993
3. John Schiles, Polymer Recycling.
   Edited by Dr.J.S.Anand, Recyclic & Plastics Waste Management, CIPET, Journal of India, 1997.

PLASTICS PACKAGING TECHNOLOGY

Module I

Functions of packaging, advantages of plastic packaging, distribution hazards, special requirements of food and medical packaging, packaging legislation and regulation.

Packaging as a system: Elements, approach, package, design, relation criteria for packaging materials, packaging equipment checklist, case histories

Major packaging plastics PE, PP, PS, PVC, polyesters, PVDE, vinyl acetate, PVA, EVA , PV Alcohol, PA,PC ionomers & fluro polymers.

Module II

Conversion process – Moulding, Extrusion, Rotary thermoforming, Lamination, metalizing, decoration process, Shrink wrapping, Pallet & stretch wrapping, sealing methods, Plasma barrier coatings

Extrusion, film and flexible packaging – extrusion, cast film & sheet, Blow film, Multi layer film & sheet coatings, laminations & co-extrusions , stretch and shrink wrap , pouching , sealing , evaluation of seals in flexible packages , advantages of flexible packaging – flexible packaging products.

Module III

Thermoformed packages: Position & thermoforming & wrap forming, variations in thermoforming and solid phase pressure forming, scrabbles, twin sheet & melt – to-mold thermoforming, skin packaging, thermoforming moulds, thermoforming fill- real, Polystyrene & other foams systems cushioning

Testing plastic packages- Barrier, Migration & compatibility, printing, labeling & pigmenting, Sterilization for health care products. Packaging hazards and their controls- Environmental considerations.

Total Lecture: 35 Hours

Reference Books

1. Susan E.M. Seleke, Understanding plastic packaging Technology, Hanser publications – Munich
2. A.S. Altalye, Plastics in packaging, Tata McGraw – Hill publishing Co. Ltd., New Delhi.
3. Briston; John H. and Katan; Leonard L., Plastics in Contact with Food, Food Trade Press Ltd., London (1974).
4. Briston; John, Advances in Plastics Packaging, Pira International, Leatherhead (1992).

FIBER TECHNOLOGY

Module I

Introduction to natural and synthetic polymers. Essential characteristics and molecular architecture of fibre forming polymers.

Concept of order in polymers, crystallinity, orientation, physical structure of natural and man-made fibers.

Module II

Physical methods for investigating fiber structure. Optical properties of oriented polymers and fibres, refractive index and birefringence.

Melt spinning, dry and wet spinning of fibers. Fiber drawing, heat setting, texturing and mechanical properties of fibers based on viscose, cellulose acetate, polyamides.

Module III

Fiber drawing, heat setting, texturing and mechanical properties of fibers based on polyesters, acrylics, polypropylene, glass and carbon-fibres. General principles of finishing and dying of fibers. Common types of finishes applied to textile fibers.

Total Lecture: 35 Hours

Reference Books

1. Billmeyer Jr.; Fred W., Synthetic Polymers, Doubleday and Co. Inc., New York (1972).
2. Gupta, V.B., and Kothari, V.K., Manufactured Fibre Technology, Chapman & Hall, 1997.
3. Fourne, Franz, “Synthetic Fibres, Machines and Equipment, Manufacture, Properties”, Hanser Publishes, 1999.
4. Corbman, Bernard P, “Textiles fibre to fabric”, Sixth Edition, McGraw Hill, 1983

FREE ELECTIVE III

CORROSION & DEGRADATION OF MATERIALS (3-0-0)

Module I (12 Hours)

Technological importance of corrosion study, corrosion as non equilibrium process, corrosion rate expressions, electrochemical principles of corrosion-cell analogy, concept of single electrode potential, reference electrodes, e.m.f. and galvanic series-their uses in corrosion studies, polarization, passivity.

Module II (12 Hours)

Different forms of corrosion-uniform attack, galvanic, crevice, pitting, intergranular, selective leaching, erosion, stress corrosion cracking-their characteristic features, causes and remedial measures.

Principles of corrosion prevention-material selection, control of environment including inhibitors, cathodic and anodic protection, coatings and design considerations. Corrosion testing methods.

Module III (14 Hours)

Introduction to high temperature corrosion, Pilling-Bedworth ratio, oxidation kinetics, oxide defect structures, Wagner-Hauffe valence approach in alloy oxidation, catastrophic oxidation, internal oxidation.

Considerations in high temperature alloy design, prevention of high temperature corrosion -use of coatings.

Liquid metal attack - liquid metal embrittlement, preventive measures.

Chemical degradation of non-metallic materials like rubbers, plastics, ceramics etc.

Hydrogen damage - types, characteristics, mechanism and preventive measures.

Books for reference:

1. Corrosion Engineering by Fontana, M.G., McGraw-Hill.
2. Corrosion & Corrosion Control by H.H. Uhlig, John Wiley & Sons.
3. Introduction to Metallic Corrosion by Evans.
4. Introduction to Electrochemistry by S.Glasstone.
5. An Introduction to Science of Corrosion & its Inhibition by S.N. Banerjee, Oxonian Press Pvt. Ltd.

TRANSDUCERS & INSTRUMENTATION (3-0-0)

Module –1 10 lectures
Elements of a general measurement system;
Static Characteristics: systematic characteristics, statistical characteristics, calibration;
Dynamic characteristics of measurement systems: transfer functions of typical sensing elements, step and frequency response of first and second order elements, dynamic error in measurement systems. (Bentley: Chapters 1-4)

Module-2 14 lectures
Sensing elements: Resistive sensing elements: potentiometers, Resistance Temperature Detector (RTD), thermistors, strain gages.
Capacitive sensing elements: variable separation, area and dielectric;
Inductive sensing elements: variable reluctance and LVDT displacement sensors;
Electromagnetic sensing elements: velocity sensors,
Thermoelctric sensing elements: laws, thermocouple characteristics, installation problems, cold junction compensation.
IC temperature sensor
Elastic sensing elements: Bourdon tube, bellows, and diaphragms for pressure sensing, force and torque measurement.
(Bentley: Sections 8.1 to 8.6; Ghosh: Section 10.3 to 10.4).

Module-3 10 lectures
Signal Conditioning Elements:
Deflection bridges: design of resistive and reactive bridges, push-pull configuration for improvement of linearity and sensitivity
Amplifiers: Operational amplifiers-ideal and non-ideal performances, inverting, non-inverting and differential amplifiers, instrumentation amplifier, filters. A.C. carrier systems, phase sensitive demodulators and its applications in instrumentation.
(Bentley: Sections 9.1 to 9.3; Ghosh: Sections 15.1 and 15.2) .

Text Books:
1. Principles of Measurement Systems- J.P. Bentley (3/e), Pearson Education, New Delhi, 2007.
2. Introduction to Measurement and Instrumentation- A.K. Ghosh(3/e), PHI Learning, 2009.
3. Transducers and Instrumentation- D.V.S. Murthy (2/e), PHI Learning, New Delhi, 2009.

Reference Books:
1. Measurement Systems Application & Design- E.O.Doeblin (4/e),McGrawHill,International,NY.
2. Instrumentation for Engineering Measurements- J.W. Dally, W.F. Riley and K.G. McConnel (2/e), John Wiley, NY, 2003.
3. Industrial Instrumentation- T.R. Padmanabhan, Springer, London, 2000.

INDUSTRIAL SAFETY & HAZARD MANAGEMENT

Module I

Industrial safety, industrial hygiene and safety aspects related to toxicity, noise, pressure, temperature, vibrations, radiation etc. explosions including dust, vapor, cloud and mist explosion.

Elements of safety, safety aspects related to site, plant layout, process development and design stages, identification of hazards and its estimation, risk, risk analysis and assessment methods, fault free method, event free method, scope of risk assessment, controlling toxic chemicals and flammable materials.

Module II

Toxic substances and degree of toxicity, its estimation, their entry routes into human system, their doses and responses, control techniques for toxic substances exposure, use of respirators, ventilation systems.

Prevention of losses, pressure relief, provision for firefighting, release of hazardous materials from tanks, pipes through holes and cracks, relief system: types and location of relief's.

Module III

Handling, transportation and storage of flammable liquids, gases, and toxic materials and wastes, regulation and legislation, government role, risk management routines, emergency preparedness, disaster planning and management.

Training practices on Basic First Aids

Total Lecture: 35 Hours

Text Book

1. Management Information Systems by A.K. Gupta, Second Edition – 2003, S. Chand & Co. Ltd., Ram Nagar, New Delhi – 110055, Chapters - 1,2,3,4,8,9,13,14

REFERENCE BOOK :

1. Fluid Power Control by J.F. Blackburn, G. Reethof & J.L. Shearer, John Wiley & Son Inc. & The Technology Press of M.I.T.

FREE ELECTIVES IV

ENTREPRENEURSHIP DEVELOPMENT

Module I: Understanding Entrepreneurship 10Hrs

Concept of Entrepreneurship, Motivation for Economic Development and Entrepreneurial Achievement, Enterprise and Society

Why and how to start Business – Entrepreneurial traits and skills, Mind Vrs Money in Commencing New Ventures, Entrepreneurial success and failures, Environmental dynamics and change.

Entrepreneurial Process

Step by step approach to entrepreneurial start up

Decision for Entrepreneurial start up.

Module II: Setting up of a small Business Enterprise. 10Hrs

Identifying the Business opportunity - Business opportunities in various sectors, formalities for setting up small enterprises in manufacturing and services, Environmental pollution and allied regulatory and non-regulatory clearances for new venture promotion in SME sector.

Writing a Business plan, components of a B-Plan, determining Bankability of the project.

Module III: Institutional Support for SME. 10Hrs

Central / State level Institution promoting SME.

Financial Management in small business.

Marketing Management, problems & strategies

Problems of HRM – Relevant Labour – laws.

Sickness in Small Enterprises.

Causes and symptoms of sickness – cures of sickness.

Govt. policies on revival of sickness and remedial measures.

Reference Books:

1. Entrepreneurship Development, Small Business Enterprises, Chavantimath, Pearson.
2. Entrepreneurial Development, S.S. Khanka, S Chand
3. Entrepreneurship, Barringer BR, Ireland R.D., Pearson
4. Entrepreneurship, David H Holt, PHI
5. Entrepreneurship, Kurilko, D.F. and Attodgets RM, Cengage
6. The Dynamics of Entrepreneurial Development & Management, Vasant Desai, HPH.
7. Entrepreneurship, Roy, Oxford
8. Entrepreneurship, Hisrich, Peters, Shepherd, TMH

BIO- DEGRADABLE POLYMERS

Module I

Introduction, enzymes – enzyme nomenclature – enzyme specificity – physical factors affecting the activity of enzymes – enzyme mechanism, Chemical degradation initiates biodegradation, Hydrolysis of synthetic biodegradable polymers.

Starch technology, Manufacture of master batch, Conversion technology – processing precautions – cyclic conversion process, physical properties of products –Quality control testing of degradation – auto oxidation measurement – biodegradation assessment – soil burial test.

Module II

Introduction, History, biosynthesis, Isolation – solvent extraction - sodium hypo chloride digestion, enzymatic digestion, Properties – crystal structure – nascent morphology, degradation - Intracellular biodegradation - extra cellular biodegradation – thermal degradation – hydrolytic degradation – environmental degradation – effects of recycling, applications, economics, future prospects.

Polyethylene/starch film, reprocessing polyethylene/corn starch film scrap – learning to reprocess PE/S - Calcium oxide moisture scavenger – temperature control – accounting for pro-oxidant – handling PE/S

Module III

Introduction, defining biodegradability, criteria used in the evaluation of biodegradable polymers, tiered systems for evaluating biodegradability, choice of environment, choosing the most appropriate methodology, description of current test methods – screening test for ready biodegradability, tests for inherent biodegradability, tests for simulation studies, other methods for assessing biodegradability – petri dish screen – environmental chamber method – soil burial tests, Test method developments for the future.

Total Lecture: 35 Hours

Reference Books:

1. G.J.L Griffin Blackie (ed.), Chemistry & Technology of biodegradable polymers Academic & Professional London 1994.
2. Yoshiharu Doi , Kazuhiko Fukuda(ed.) Biodegradable plastics & Polymers Elsevier 1994
3. Abraham J.Donb & others(ed.) Handbook of Biodegradable polymers

POLYMER NANOCOMPOSITES

Module I

General introduction to nanocomposites; Basics of Inorganic Materials Chemistry and Nano chemistry

Inorganic-Organic and Inorganic-Polymer Nanocomposite Materials

Module II

Nanocomposites: particulate, clay, and carbon nanotube nanocomposites- synthesis, Structure, properties characterization and applications.

Clay/Polymer Nanocomposites: Physical and chemical properties of clay nanoparticles; Synthesis; Potential Applications

Module III

Metal/Polymer Nanocomposites: Physical and chemical properties of metal nanoparticles; Synthesis; Potential Applications

Rheology and processing; Applications and economics

Total Lecture: 35 Hours

References

1. Polymer nanocomposites: synthesis, characterization, and modeling / Ramanan Krishnamoorti, editor; Richard A. Vaia, editor. Washington, D.C.: American Chemical Society: Distributed by Oxford University Press (2002)
2. Polymer-clay nanocomposites / edited by T.J. Pinnavaia & G.W. Beall, Chichester; New York: John Wiley (2000).3. Polymer-layered silicate nanocomposites: preparation, properties, and uses of a new class of Materials, M. Alexandre, P. Dubois,Mater.Sci. Eng., 28, 1-63 (2000).
3. Polymer matrix nanocomposites, processing, manufacturing, and application: An overview, F. Hussain, M.Hojjati, M. Okamoto, R.E. Gorga, J. Comp. Mater., 40, 1511- 1575 (2006)
4. Vikas Mittal, Polymer Nanotube Nanocomposites John Wiley & Sons, New Jersey (2010)

8th Semester

MARKETING MANAGEMENT (3-0-0)

Objective of the Course: The course aims at introducing the basic concepts of marketing to the undergraduate students in engineering. The learning shall help the students in better designing, manufacturing and selling product/ service packages keeping competitive market, customers and cost in view.

Module -I (10 hours)

Marketing Management: Concept, Process, Functions and relevance in the current context.
Marketing Environment: Elements of micro and macro environment
Competition Analysis: Factors contributing to competition, porter's five forces model, Identifying and analyzing competitors.
Marketing Planning : Exploring Opportunity, Product –market selection, Marketing Planning Process.
Market Research and Information Systems: Research Process, The Internet and World Wide Web based Information collection and processing, Database, Data Warehouses and Data Mining, Global Market Research.
Consumer Behavior: Factors influencing consumer behavior, consumer decision process. Organizational buying behavior.

Module- II (10 hours)

Market Segmentation, Targeting and Positioning: Definition, Bases of segmenting consumer and Industrial markets. Target Market strategies: Market Positioning.
Market Demand Forecasting: Key Terms, Forecasting Tools: Short term tools: Moving average and Exponential smoothing methods, Long-term forecasting Tools: Time series analysis, Econometrics methods, Qualitative tools : Buying Intention Survey, Sales Force Opinion and Delphi Techniques.
Product Planning : Product Life Cycle, New Product Development Process, Branding Strategy, Positioning a Brand, Brand Equity, Packaging and Labeling, Product-mix and Product Line, Planned Obsolescence.

Module - III (10 hours)

Pricing Decision: Objectives and Factors influencing pricing, Pricing method and strategies.
Integrated Marketing Communication(IMC)- Concept of IMC, the marketing communication process, Promotion Mix, elements of promotion mix, Direct marketing.
Channels of Distributions: Types of intermediaries, functions of distribution channels, channel levels, Designing Distribution Channels, Physical Distribution, Supply Chain Management (Basic only).
Trends in Marketing: Green Marketing, Customer Relationship Management, E-marketing, Rural Marketing and Service Marketing (concepts only)
Books:

Text Book:

1. Etzel , Walker ,Stanton and Pandit, Marketing, 14/e, Tata McGraw Hill.
2. Saxena, "Marketing Management" Tata McGraw Hill, 4/e.

Reference

1. Grewal, Levy, 'Marketing' Tata McGraw Hill, special Indian edition.
2. Karunakaran "Marketing Management", Himalaya Publishing House, 2010/e.
3. Kotler, Keller,Koshy and Jha, "Marketing Management", 13/e, Pearson Education.

PROFESSIONAL ELECTIVE – VI

SPECIALITY ELASTOMERS

Module I

Introduction of specialty rubbers – Silicones (Q) – Introduction, Manufacture – Structure and its influence on properties – Compounding – Fabrication – Curing – General properties – Applications – Copolymers – PMQ, PVLQ, FMQ, FVMQ – Silicones Rubber for medical use.

Epichlorohydrin – (CO, ECO, ETIR) – Introduction – Manufacture – Structure and its influence on properties – Compounding and Curing Properties and application. Fluoro Elastomers (FKM) – Introduction – Manufacture – Structure and its influence on properties – Compounding – Curing – Properties and applications.

Module II

Polyurethane Rubbers – Introduction Manufacture – Structure and its influence on properties – Compounding – Curing – Properties and applications. Thermoplastic Polyurethanes – Introduction – Manufacture – Structure and its influence on Properties – Compounding – Curing – Properties and applications.

Acrylic Rubber (ACM), Ethylene acrylic copolymers, Introduction, Manufacture – Structure and its influence on Properties – Compounding – Curing – Properties and applications. Ethylene Vinyl Acetate – Copolymer – Introduction, Manufacture – Structure and its influence on Properties – Compounding – Curing – Properties and applications

Module III

Chlorinated Polyethylene – Introduction – Manufacture – Structure and its influence on Properties – Compounding – Curing – Properties and applications. Chlorosulphonated polyethylene – Introduction – Manufacture – Structure and its influence on properties – Compounding – Curing – Properties – Applications. EPM, EDPM – Introduction, Manufacture – Structure and its influence on Properties – Compounding – Curing - Properties and applications.

Total Lecture: 35 Hours

Reference Books:

1. Hoffmann, Rubber Technology Hand Book, Hanser Publishers Munich– 1989.
2. Anil. K., Bhowmick, Howard L. Stephens (ed.) Hand Book of Elastomers, New
3. Development & Technology, Marcel Decker Inc. New York, 1988
4. Penn; W. S. (Ed.), Injection Moulding of Elastomers, MacLaren and Sons Ltd., London (1969).
5. Houwink; R. (Ed.), Elastomers and Plastomers: Their Chemistry, Physics and Technology, Volume-1 General Theory, Elsevier Publishing Co., Inc., New York (1950).

POLYURETHANE TECHNOLOGY

Module I

Introduction to polyurethane- chemistry and materials of polyurethane manufacture: basic reaction, cross linking in polyurethane, important building blocks for polyurethane- Polyurethane processing-basic design principles of polyurethane- steps in the polyurethane processing. Processing equipment- foam, carpet backing, Flexible foams-flexible molded foams & semi-rigid molded foams. Reinforced RIM – trends in the use of RIM and RRIM.

Module II

Rigid polyurethane foams-chemistry of raw materials, manufacturing of rigid polyurethane, properties, relationship between production methods and properties-application of rigid polyurethane. Polyurethane skin integral foam- production, properties and applications.

Solid polyurethane materials- polyurethane casting systems- thermoplastic polyurethane elastomers: processing- properties and applications, polyurethane paints, technique and coatings, adhesives builders, processing and applications.

Module III

Determination of composition and testing of polyurethane-chemical compositions, detection methods, identification of functional groups, determinations of properties materials and products (Characterisation, physics/mechanical, temp dependence, chemical performance, combustibility) polyurethane and environment health and safety: making and using polyurethane safety.

Total Lecture: 35 Hours

Reference Books:

1. Dr. Gumter Oertal (ed.), Polyurethane Hand Book, Hanser Publication Munich.
2. George woods,The ICI Polyurethane book -published journls by ICI, John Wiley and sons NY
3. Bruins; Paul F. (Ed.), Polyurethane Technology, Interscience Publishers, New York (1969)

ADHESIVES AND SURFACE COATINGS

Module I

Adhesives – concepts and terminology, functions of adhesives, advantages and disadvantages of adhesive bonding, criteria for selection of adhesives.

Types of adhesives, structural adhesives, Urethane structured adhesives, Modified acrylic structural adhesives, phenolic adhesives and modifiers, anaerobic adhesives, cyanoacrylate adhesives, Hot melt adhesives, pressure sensitive adhesives, RTV Silicone adhesives, sealants, water based adhesives. Specialty adhesives, adhesives in aerospace, adhesive in automobile industry, conductive adhesives, adhesives in building construction, adhesive in electrical industry.

Module II

Joint design, stress, types of joints, selection of joint detail, joint criteria, surface preparation of adherend -metals, plastics and rubbers. Adhesive bonding process-methods for adhesives application and bonding equipment-, testing and quality control.

Introduction to surface coatings –Components of paints. Pigments, pigment properties, different types, extenders, solvents, oils, driers, diluents, lacquers, varnishes, paint preparation, formulation, factors affecting pigment dispersion, preparation of pigment dispersion.

Module III

Different types of paints- classification based on polymeric resin, emulsion, oil and alkyd paints, acrylic paints, epoxy coatings, polyurethane, silicones, chlorinated rubbers. Classification based on application, fluropolymers, vinyl resins, appliance furnishes, automotive finishes, coil coatings, can coatings, marine coatings, aircraft coatings.

Surface preparation and paint application. Paint properties and their evaluation – mechanism of film formation, factors affecting coating properties, methods used for film preparation – barrier properties, optical properties, ageing properties, rheological properties and adhesion properties of coatings.

Total Lecture: 35 Hours

Reference Books:

1. Handbook of Adhesives – Skeist, Irvind, Van Nistrand, New York, 1990, 3rd Edition
Gerald L. Schreberger, Adhesive in manufacturing, Marcel Dekker Inc., New York, 1983
2. W.C. Wake, Adhesion and the formulation of adhesives. Applied Science Publishers, London, 1976
3. Swaraj Paul, Surface Coatings, John Wiley & Sons, NY, 1985.
4. George Mathews, Polymer Mixing Technology, Applied Science Publishers. Sheilds, Hand book of adhesives, Butterworths, 1984.

PLASTICS PRODUCT DESIGN USING CAD/CAM/CAE

UNIT I

Plastics Product Design : Material Selection - Properties – Mouldability - Fits and Tolerance – Shrinkage – Warpage - Wall Thickness – Fillets - Sharp Corners - Ribs and Bosses - Holes-Moulded Threads - Inserts and Fasteners – Integral hinge – Lettering on Moulded Products. Surface finish – Functional / Aesthetic aspects of part shape-Safety aspects of part shape -Safety aspects if the part should burn - Safety aspects if the part should fail - Use of color and design to promote safety.

UNIT II

Introduction to CAD/CAM –Wire frame model, Surface and Solid Modeling –NC Machines – NC Part Programming – Manual part programming – Computer assisted part programming – APT Language – Manual data input – NC Programming using CAD/CAM – Computer automated part programming.

Finite element analysis - introduction, types of analysis - need for approximation - Weight residual, Ritz and Galerkin method - Variational. Procedure for finite element analysis - stiffness matrix, solution procedure, details of finite element analysis package, model building, post processing

UNIT IV

Introduction to CAE for plastics– Design principles for part design, Analysis using CAE software. Case studies – Interpretation of results. Identification of Uneconomical design-redesign for manufacture.

Rapid Prototyping – Streolithography – Laminated Object Manufacturing, Selective Laser Sintering – Solider – Vacuum Casting – Resin injection – Application of rapid prototyping. Rapid Tooling – Cast – IT Epoxy Tooling System, Parts in Minutes – Vacuum grade Polyurethanes, Composite tooling board.

Total Lecture: 35 Hours

Reference Books

1. Technology of Computer Aided Design and Manufacturing, S Kumar & A K Jha, Danpatrai & Co, 1998
2. Tucker III, C L, Fundamentals of Computer Modeling for Polymer Processing, Hanser, 1989
3. R.D.Beck Plastics Product Design,
4. C-B & Liv C.N.K. Computer aided design & manufacture, East West Press.
4. Durvent W.R. The Lithographic Hand book, Narosa Pub., 1995. Paul F. Jacob. Rapid Prototyping and manufacture Fundamentals of Stereolithography, 1985

NYLON TECHNOLOGY

Module I

Introduction- nylon synthesis - principle of polyamidation- polymerization techniques- polymerization equilibria. Kinetic molecular mass, deformation of chemical attack.

Physical structure: Structure properties relationship-crystallizing, melting temperature, to solubility, molecular weight, melt viscosity, degradation and stabilization, Identification and characterization of nylon. Properties (tribological, durability, water absorption dimension stability (immersion resistance, thermal/ electrical/optical properties, flammability resistance to permeation

Applications)

Module II

Fundamentals of Melt Processing: Measurements of viscosity, PVT relationships, importance of moisture, effect of molecular mass, shear, temperature, additives and channel shape.

Processing techniques of melt processing: Processing reagents, material handling and drying, injection moulding, extrusion, blow moulding and monomer processing.

Other processing Techniques: Powder coating, blending and solution coatings. Secondary Treatments: Assembly, Moisture conditioning, mechanical surface clearing, and decorating.

Module III

Modification: Physical change- co-polymerization-transparent nylons, filled and reinforced nylons, toughened nylons, fire retardant nylons, plasticized and lubricated nylons, additives for heat stabilization, processing and color and other modifications.

Commercial Nylon Blends And Their Applications: PA6, PA66, PA46, PA6/2,PA11 &PA12

Raw materials- preparation –polymerization- Methods of manufacturing, modifications, processing (methods, procedure processing parameters etc.,)

Total Lecture: 35 Hours

Reference Books:

1. Malvin I. Kohan (ed.) Nylon plastics hand book, Hanser publisher, 1995.
2. Nicholar P. Chermisinof (ed.) Hand book of engineering Polymeric materials Marcel Dekker inc.N.Y. 19

BIO MEDICALS PLASTICS

Module I

BIOMATERIALS: Biocompatibility, Stabilization, Inflammation And Wound Healing, Blood Clotting System, Biological response to Implants, Implant Design And Applications.

BIOMEDICL POLYMERS: Criteria for the selection of biomedical polymers, physico-chemical aspects of the blood compatibility of polymeric surface. Biomedical polymers from biological source, poly hydroxy alkanoic acids, microbial polysaccharides, silk, collagen. microbial cellulose, hyaluronic acid, synthetic polymers such as PMMA, silicon rubber, polyethylene, natural rubber, hydrogels.

Module II

BIOMEDICAL APPLICATIONS OF POLYMERS: Permanent Implants For Function-Orthopedics, Cardio Vascular, Respiratory Patches And Tubes, Digestive System, Genitourinary System, Nervous System, Orbital (Corneal And Lens Prosthesis) – Permanent Implant For Cosmoses, Other Applications Of Engineered Material In Clinical Practices, Silicone Implants. Polymer Membranes, Polymer Skin, Polymeric Blood.

Module III

POLYMERIC LENSES: Contact Lenses, Hard Lenses, Gas Permeable Lenses, Flexible Lenses, Soft Lenses, Hydrogels, Equilibrium Swelling, Absorption And Desorption, Oxygen Permeability, Types of Soft

DENTAL POLYMERS: Dental applications, denture bases, dentate reliners, crown and bridge resins, plastic teeth, mouth protectors, maxillofacial prosthetic materials, restorative material, polyelectrolyte based restoratives, sealants, adhesives, dental impression and duplicating materials, agar, algmater elastomers.

Total Lecture: 35 Hours

Reference Books:

1. Bio-materials, An Introduction – J B Park, Pleneum Press
2. Plastics Materials – J S Brydson
3. H.F. Mark (Ed), Encyclopedia of polymer science and engineering, John Wiley and Sons New York, 1989.
4. Comprehensive Polymer Science Vol.7 Alcock., Contemporary Polymer Chemistry
5. Second Ed. Manas Chanda, Salil K. Roy (Ed) Plastic Technology Hand Book Marcel Dekker, Inc. New York, 1993.
6. B.Sedlacek, C.G.Overberger, J.F.Mark, (ed.) Medical polymers: Chemical problems.

Free Elective- V

TOTAL QUALITY MANAGEMENT

Module – I (12 hours)
An Overview: Quality Definition, Quality, Price, Value Relationship, Evolution in Quality Management – Inspection, Quality Control, Statistical Quality Control, Quality Assurance, Total Quality Management
Thoughts/ Contribution of Quality Gurus: Deming's 14 Points, Deming PDCA Cycle, Juran's Trilogy, and Crosby's Zero Defect.
Core Concepts of TQM: Top Management Leadership, Customer Orientation, Total Employee Involvement, Continuous Process Improvement
Supplier Partnership: Partnering, Sourcing, Selection, Certification, Relation development

Module – II (12 hours)
Concept of Quality Control and Quality Improvement: Costs of Quality - Prevention, Appraisal, Internal Failure, External Failure.
Failure: Random and Assignable causes; Statistical Process Control Charts – X & R chart, p-chart, c-chart, Concept of process capability
Acceptance Sampling and OC curve, Buyer risk and Supplier risk, Average Outgoing Quality
Emphasis on small improvements – Kaizen, People participation Quality Circle, QC Tools (old) & 7 Tools (new), Conditions for Success of TQM

Module – III (11 hours)
Overview of some other initiatives of process improvement: Six Sigma, TPM, Lean Manufacturing
Some tools for analysis: Quality Benchmarking, Quality Function Deployment (QFD), Failure Mode and Effect Analysis (FMEA)
Quality Management Systems: Product vs Process Quality Standard, ISO 9000 series of standards, ISO 9001 Requirements, Implementation, Documentation, Audits, and Registration; Benefits of ISO.

Books:

1. Mukherjee - "Total Quality Management", PHI
2. Evans J.R. – "Total Quality Management", Cengage
3. Besterfield et al, - "Total Quality Management", Pearson
4. Gryna, Chua,& Defeo-"Quality Planning & Analysis for Enterprise Quality", TMH
5. Montogomery, -"Introduction to Statistical Quality Control", John Wiley & Sons
6. Zaidi A.- "SPC Concepts, Methodologies and Tools", Pearson

INTERNET TECHNOLOGY AND APPLICATIONS

Module – I (12 Hour)

The Internet and WWW

Understanding the WWW and the Internet, Emergence of Web, Web Servers, Web Browsers, Protocols, Building Web Sites

HTML

Planning for designing Web pages, Model and structure for a Website, Developing Websites, Basic HTML using images links, Lists, Tables and Forms, Frames for designing a good interactive website

Module – II (12 Hour)

JAVA Script

Programming Fundamentals, Statements, Expressions, Operators, Popup Boxes, Control Statements, Try…. Catch Statement, Throw Statement, Objects of Javascript: Date object, array object, Boolean object, math object

CSS

External Style Sheets, Internal Style Sheets, Inline Style, The class selector, div & span tag

DOM

HTML DOM, inner HTML, Dynamic HTML (DHTML), DHTML form, XML DOM

Module – III (12 Hour)

CGI/PERL

Introduction to CGI, Testing & Debugging Perl CGI Script, Using Scalar variables and operators in Perl

Java Applet

Introduction to Java, Writing Java Applets, Life cycle of applet

Textbooks

1. Web Warrior Guide to Web Design Technologies, Don Gosselin, Joel Sklar & others, Cengage Learning

Reference Books

1. Web Programming: Building Internet Applications, Chris Bates, Wiley Dreamtech
2. Programming the World Wide Web, Robert W Sebesta, Pearson
3. Web Technologies, Uttam K Roy, Oxford
4. Web Technology: A developer perspective, Gopalan & Akilandeswari, PHI

PRODUCTION & OPERATION MANAGEMENT

Objective : The course aims at acquainting all engineering graduates irrespective of their specializations the basic issues and tools of managing production and operations functions of an organization.

Module I

1. Operations Function in an Organization, Manufacturing Vrs Service Operations, System view of Operations, Strategic Role of Operations, Operations Strategies for Competitive Advantage, Operations Quality and Productivity Focus, Meeting Global Challenges of Production and Operations Imperatives. **(3 Hours)**

2. Designing Products, Services and Processes: New Product Design- Product Life Cycle, Product Development Process, Process Technology : Project, Jobshop, Batch, Assembly Line, Continuous Manufacturing; Process Technology Life Cycle, Process Technology Trends, FMS, CIM, CAD, CAM; Design for Services, Services Process Technology. **(4 Hours)**

3. Work Study: Methods Study- Techniques of Analysis, recording, improvement and standardization; Work Measurement : Work Measurement Principles using Stopwatch Time Study, Predetermined Motion Time Standards and Work Sampling, Standard Time Estimation. **(4 Hours)**

Module II

4. Location and Layout Planning : Factor Influencing Plant and Warehouse Locations, Impact of Location on cost and revenues. Facility Location Procedure and Models : Qualitative Models, Breakeven Analysis, location Model, centroid method.
Layout Planning: Layout Types : Process Layout, Product Layout, Fixed Position Layout Planning, block diagramming, line balancing, computerized layout planning- overview.
Group Technology **(4 Hours)**

5. Forecasting : Principles and Method, Moving Average, weighted Moving Average, Exponential Smoothing, Winter's Method for Seasonal Demand, Forecasting Error.**(4 Hours)**

6. Manufacturing Planning and Control : The Framework and Components : Aggregate Planning, Master Production Scheduling, Rough-cut-Capacity Planning, Material Requirements Planning, Capacity Requirements Planning. **(5 Hours)**

Module III

7. Sequencing and Scheduling : Single Machine Sequencing : Basics and Performance Evaluation Criteria, Methods for Minimizing Mean Flow Time, Parallel Machines : Minimization of Makespan, Flowshop sequencing : 2 and 3 machines cases : Johnson's Rule and Jobshop Scheduling : Priority dispatching Rules. **(3 Hours)**

8. Inventory Control : Relevant Costs, Basic EOQ Model, Model with Quantity discount, Economic Batch Quantity, Periodic and Continuous Review Systems, Safety Stock, Reorder Point and Order Quantity Calculations. ABC Analysis. **(4 Hours)**

9. Modern Trends in Manufacturing : Just in Time (JIT) System : Shop Floor Control By Kanbans, Total Quality Management, Total Productive Maintenance, ISO 9000, Quality Circle, Kaizen, Poka Yoke, Supply Chain Management. **(4 Hours)**

Reference Book:

1. S.N.Chary, "Production and Operations Management", Tata McGraw Hill.
2. R. Paneerselvam, "Production and Operations Management, Prentice Hall of India.
3. Aswathappa & Bhatt – Production & Operations Management, HPH.
4. Gaither & Frazier - Operations Management, Cengage Publication
5. Russell & Taylor - Operations Management, PHI Publication
6. Chase, Aquilanno, Jacob & Agarwal - Operations Management, TMH Publication.
7. E.E. Adam and R.J. Ebert "Production and Operations Management", Prentice Hall of India

ENTREPRENEURSHIP PROJECT

1) The project will be for 2 credits and 3 periods per week is to be devoted for the project.
2) The teacher has to give elementary idea about entrepreneurship through classroom teaching before a project report is prepared by the student.
3) The teacher will first cover the following topics through lecturer and exercises on motivation and games.
    (a) Entrepreneurship concept, EDP in India, Indian middle class value.
    (b) Entrepreneurial qualities, motivation perception, risk taking etc.
    (c) Market survey, Business opportunity guidance, Role of DIC, SFC, Bank etc.
    (d) Working capital assessment, Balance Sheet, Costing, Book keeping.
    (e) Decision making, Leadership, Communication skill
    (f) Preliminary
4) Project Report, preparation for a specific product and submission of the report.
5) Evaluation
    - The teacher has to conduct tests/ motivational exercises to assess entrepreneurial capability of the student (20%)
    - The teacher has to test the knowledge of the student on the above topic through a written test. (20%)
    - The teacher has to evaluate the report submitted by the student (i.e. Project report within 50 pages) (60%).

REFERENCE BOOKS :

1. Entrepreneurship of Small Industries, M. V. Deshpande, Deep and Deep Publication
2. Management of Small Scale Industry, Vasant Desai, Himalaya Pub. House

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