BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ORISSA

Metallurgical & Materials 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
BSCP1206	Physics II	3-0-0	3				
	OR			PCMT4205	Transport Phenomenon	3-0-0	3
BSMS1209	Material Science						
BECS2212	C++ & Object Oriented Programming	3-0-0	3	PCMT4204	Materials Processing	3-1-0	4
HSSM3204	Engg. Economics & Costing	3-0-0	3	HSSM3205	Organizational Behaviour	3-0-0	3
	OR				OR		
HSSM3205	Organizational Behavior			HSSM3204	Engg. Economics & Costing		
PCMT4201	Introduction to Physical Metallurgy	3-1-0	4	PCMT4203	Principles of Extractive Metallurgy	3-1-0	4
PCMT4202	Metallurgical Thermodynamics & Kinetics	3-1-0	4		Free Elective- I (any one)	3-0-0	3
				BECS2208	Database Management System		
				BEEC2216	Analog and Digital Electronics		
				BEEE2215	Energy Conversion Techniques		
				PCME4202	Mechanics of Solids		
	Credits (Theory)		21		Credits (Theory)		21
	PRACTICALS/SESSIONALS				*PRACTICALS/SESSIONALS*		
HSSM7203	COMMUNICATION AND INTERPERSONAL SKILLS FOR CORPORATE READINESS	0-0-3	2		Free Elective- I (any one)	0-0-3	2
				BECS7208	Database Management System Laboratory		
				BEEC7216	Analog and Digital Electronics Laboratory		
				BEEE7215	Energy Conversion Techniques Laboratory		
				PCME7202	Mechanical Engineering Laboratory		
BECS7212	C++ & Object Oriented Programming Lab	0-0-3	2	PCMT7204	Materials Processing Lab	0-0-3	2
PCMT7201	Physical Metallurgy Lab	0-0-3	2	PCMT7205	Materials Characterization Lab	0-0-3	2
	Credits (Practicals / Sessionals)		6		Credits (Practicals / Sessionals)		6
	TOTAL SEMESTER CREDITS		27		TOTAL SEMESTER CREDITS		27

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

BSCP 1206 **PHYSICS-II**

This one semester physics course is divided into three (Modules). Module-I deals with some aspects of nuclear accelerators, Module-II introduces certain features of condensed matter physics and Module-III deals with certain aspects of fibre optics and different types of lasers and crystal defects.

Module-I

This unit covers the basic principles and applications of different types of accelerators and their important applications.

Need for nuclear accelerators.

D.C. Accelerators: Cockcroft-Walton, Van de Graff, Tandem accelerators.

R.F. Accelerators: Linear accelerators, cyclotrons, electron accelerator, betatron.

Application of nuclear accelerators - Production of radio isotopes, Radiation processing of materials, medical applications.

This unit covers the basic principle, properties of nanoparticles.

Nanoparticles.

Properties, Classification & characterization of nanoparticles, fabrication of nanoparticles, Structure of carbon nanotubes, types of carbon nanotubes, Properties of (Electrical, thermal) carbon nanotubes, Quantum Dots.

Module-II

Study of crystal structure by diffractions methods, Bragg's condition for crystal diffraction, Laue's Condition, Miller indices, Reciprocal laltice, Geometrical Structure factor, Atomic form factor.

Energy bands in solids: Kronig-Penney model, allowed bands and forbidden gaps, elemental and compound semiconductors.

Superconductivity: Superconductors and their properties, Meisner's effect, Type-I and Type-II superconductors, thermodynamic properties of superconductors, London equation, Application of superconductors

Module-III

Defects in crystal:-Schottky and Frenkel defects, color centres, dislocation.

Laser: - Principle of lasing, Properties of laser, Ruby laser, He-Ne laser, semiconductor laser(construction and working). Application of laser.

LED: Principle, construction of operation and application, Introduction to fiber optics, basic characteristics of optical fibers, optical fibre communication system.

Books Recommended

Text books

(1) Concepts in Engineering Physics,Md.N.Khan
(2) Physics-II, B.B.Swain, P.K.Jena.

Reference Books

(3).Principles of Nanotechnology, Phani Kumar
(4) Physics-II, Randhir Singh, Shakti Mohanty,
(5) Physics-II, A.Serway,W.Jewett
(6) Solid state Physics, W.Ashcroft, N.David Mermin,
(7) Introduction to Solid State Physics, C.Kittel,
(8) Solid State Physics, Dan Wei

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.

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)
6. “Object Oriented Programming with C++”, David Parsons, Cengage Learning.

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. M.D. Mithani, Principles of Economics.

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 : Defination and Meaning, Why Study OB
Learning – Nature of Learning, How Learning occurs, Learning and OB.
Foundations of Individual Behaviour : Personality – Meaning and Defination, 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 Followership, How to be an effective Leader, Confict-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

PCMT4201 **Introduction to Physical Metallurgy**

Module I **(14 Hours)**

1. Characteristic property of Metals, bonding in solids, primary bonds like ionic, covalent and metallic bond, crystal systems, common crystal structure of metals, representations of planes and directions in crystals, atomic packing in crystals, calculation of packing density, voids in common crystal structures and imperfections in crystals.
2. Solidification of pure metals, homogeneous and heterogeneous nucleation processes, cooling curve, concept of supercooling, microstructures of pure metals, solidification of metal in ingot mould.
3. Concept of plastic deformation of metals, critical resolve shear stress, dislocation theory, deformation by slip and twin, plastic deformation in polycrystalline metals, yield point phenomenon and related effects, concept of cold working, preferred orientation. Annealing: recovery; recrystallization and grain growth; hotworking.

Module II **(14 Hours)**

1. Concept of alloy formation, types of alloys, solid solutions, factors governing solid solubility viz. size factor, valency factor, crystal structure factor and chemical affinity factor; order- disorder transformation.
2. Binary phase diagrams: (a) Isomorphous system, (b) Eutectic system, (c) Peritectic system, (d) Eutectoid system and (e) Peritectoid system. Allotropic transformation. Lever rule and its application, Interpretation of solidification behaviour and microstructure of different alloys belonging to those systems, Effect of non-equilibrium cooling, coring and homogenization.
3. Iron-cementite and iron-graphite phase diagrams, microstructure and properties of different alloys (both steels and cast irons), types of cast iron, their microstructures and typical uses.

Module III **(14 Hours)**

1. T-T-T diagram: Concept of heat treatment of steels i.e. annealing, normalizing, hardening and tempering; microstructural effects brought about by these processes and their influences on mechanical properties.
2. Effect of common alloying elements on the equilibrium and T-T-T diagrams, concept of hardenability, factors affecting hardenability.
3. Common alloy steels, stainless steel, tool steel, high speed steel, high strength low alloy steel, microalloyed steel, specification of steels.
4. Physical metallurgy of common nonferrous alloys: Cu-Zn, Cu-Sn, Cu-Al systems, Microstructures and heat treatment of common alloys of these systems.

References:

1. Physical Metallurgy Principles by Robert E Reed-Hill, East West Press.
2. Materials Science and Engineering by W.D.Callister, Wiley and Sons Inc.
2. Introduction to Physical Metallurgy by S.H. Avner, McGraw Hill Publishing Co. Ltd.
3. Engineering Physical Metallurgy and Heat Treatment by Y.Lakhtin, Mir Publisher, Moscow.
4. Material Science & Metallurgy, C.D. Yesudian & D.G.Hassis Samuel, SCI Tech.
5. Principles of Materials Science and Engineering by W.F.Smith, McGraw Hill.
6. Materials Science and Engineering by V.Raghavan, Prentice Hall of India Pvt. Ltd.
7. Introduction to Physical Metallurgy by Raghavan, Prentice Hall of India Pvt. Ltd.
8. An Introduction to Metallurgy, Sir Alan Cottrell, University Press.
9. Engineering Materials by Murthy, Jena, Gupta, Tata McGraw Hill.

PCMT4202 Metallurgical Thermodynamics & Kinetics

Module I **(15 Hours)**

Importance of Thermodynamics, definition of thermodynamic terms; concept of states, simple equilibrium. Equation of states, extensive and intensive properties, homogeneous and heterogeneous systems. Phase diagram of a single component system. Internal energy, heat capacity, enthalpy, isothermal, and adiabatic processes.

Second law of thermodynamics, entropy, degree of reversibility and irreversibility, criteria of equilibrium, auxiliary functions, combined statements, Maxwell's relations, transformation formula, Gibbs-Helmoltz equation.

Concept of Third law of thermodynamics, temperature dependence of entropy, statistical interpretation of entropy, Debye and Einstein concept of heat capacity, relation between C_p and C_v, consequences of third law.

Module II **(13 Hours)**

Fugacity, activity, equilibrium constant, use of S-functions, controlled atmospheres, homogeneous and heterogeneous equilibria.
Ellingham – Richardson diagrams, phase stability diagrams.

Solutions: partial molal quantities, ideal and non-ideal solutions, Henry's law, Gibbs – Duhem equation, regular solution, quasi-chemical approach to solution, statistical treatment. One weight percentage standard state, chemical potential, phase relations and phase rule – its applications.

Module III **(15 Hours)**

Free energy – composition diagrams for binary alloy systems, determination of liquidus, solidus and solvus lines. Effect of pressure on phase transformation and phase equilibria.

Thermodynamics of electrochemical cells, solid electrolytes. Thermodynamics of point defects in solids.

Introduction to metallurgical kinetics: heterogeneous reaction kinetics: gas-solid, solid – liquid, liquid – liquid and solid-solid systems. Empirical and semi-empirical kinetics, concept of Johnson – Mehl equation, thermal analysis.

References

1. Introduction to the Thermodynamics of Materials by D.R.Gaskell; Taylor and Francis.
2. Physical Chemistry of Metals by L.S.Darken & R.W. Gurry; McGraw Hill Book Company Inc.
3. Problems in Applied Thermodynamics by C. Bodsworth & A.S. Appleton; Longmans, Green and Co. Ltd.
4. Introduction to Metallurgical Thermodynamics by R.H.Tupkary; tu publishers, Nagpur.
5. Problems in Metallurgical Thermodynamics & Kinetics by G.S. Upadhyay & R.K.Dube; Pergamon Press.
6. Chemical and Metallurgical Thermodynamics – Part I & II by M.L.Kapoor.
7. Kinetics of Metallurgical Reactions by H.S.Ray; Oxford and IBH Publishing Co.
8. Textbook of Materials and Metallurgical Thermodynamics by A. Ghosh; Prentice Hall of India Pvt. Ltd.

HSSM7203 Communication & Interpersonal skills for Corporate Readiness 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

BECS7212 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)

PCMT7201 Physical Metallurgy Lab

Suggested experiments:

1. Preparation of metallurgical sample for microscopic observation.
2. Study of Metallurgical Microscope and familiarity with its components.
3. Determination of cooling curves of pure metals like Pb, Zn and Sn. Also acquaintance to differential cooling curves.
4. Microstructure of pure metals.
5. Microstructure of isomorphous alloys belonging to Cu-Zn, Cu-Sn and Cu-Ni systems..
6. Effect of cold working on hardness and microstructures of metals like Cu.
7. Recrystalization and grain growth in cold worked and annealed Cu.
8. Microstructure of plain carbon annealed steels with variation in carbon content

4th Semester

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

PCMT4205 **Transport Phenomenon**

Module I **(13 hours)**

Momentum transfer (fluid flow): Physical Properties of Fluid, Fluid static, Newtonian and non-Newtonian fluids, factors affecting viscosity, estimation of viscosity of gases, gas mixtures, liquid metals and slags; equations of fluid flow and their metallurgical applications, overall energy balance approach for turbulent flow, friction factor; flow through packed and fluidized beds, interaction of gas jets and liquid metals; theory of similarity, dimensional analysis.

Module II **(12 hours)**

Heat transfer: Factors affecting thermal conductivity of gases, liquids, solid metals and alloys and composites; equations and correlations of convective heat transfer and their metallurgical applications, laws of radiative heat transfer, view factor, radiative heat exchange in furnaces containing transparent and absorbing media; conductive heat transfer in solid materials under steady state and unsteady state conditions, heat transfer with change of state (melting/solidification).

Module III **(15 hours)**

Mass transfer: Mass transfer by diffusion, factors affecting diffusivity in solid and liquid metals and gases, diffusion through porous materials; general equation of mass transfer with diffusion, convection and chemical reaction, mass transfer co-efficient and its models, mass transfer correlations and their applications; gas-solid reaction.

Application of transport phenomena in modeling and simulation: theory of similarity and dimensional analysis, case studies; some case studies of mathematical modeling in metallurgical systems – gas stirred ladle, continuous casting etc…

Books for Reference:-

1. Transport Phenomena by R. B. Bird, W. E. Stewart and E. N. Lightfoot, Wiley, 1960
2. Transport Phenomena in Metallurgy by G. H. Geiger and D. R. Poirier, Addison-Wesley, 1973.
3. Rate Phenomena in Process Metallurgy by J. Szekely and N. J. Themelis
4. Rate Processes in Metallurgy by A. K. Mohanty, PHI

PCMT4204 **Materials Processing**

Module I **(16 hours)**

Introduction to metal casting, Moulding methods, materials and processes, with special reference to patterns, sand and binders. Solidification of short & long freezing range alloy castings, Gating and Risering of castings.

Melting practices for ferrous and non-ferrous alloys-Cupola, rotary furnace, induction furnace, crucible furnace melting.

Casting defects and remedy. Special casting processes.

Module II **(13 hours)**

Introduction to metal joining processes. Theory and classification of welding processes. Metallurgical principles involved in welding of carbon and alloy steels and important nonferrous alloys. Welding defects and their remedies.

Module III **(13 hours)**

Basic processes in Powder Metallurgy, Characteristics of powders. Compaction in rigid dies. Sintering of metal powders. Application of powder metallurgy products-their relative advantages.

Books for reference:

1. Casting by J. Campbell , Butterworth - Haneman, London, 1993
2. Solidification Processing by M.C. Flemings, McGraw Hills, 1974.
3. Principles of Metal Casting by Heine, Loper, Rosenthal,.
4. Welding by Little, TMH.
5. Welding by A.C. Davies, Cambridge University Press.
6. Metallurgy of Welding, Brazing and Soldering by J.F.Lancaster.
7. Metallurgy of Welding by Sefarin, John Wiley.
8. Welding Hand Book, Vol-I &II.
9. Introduction to Powder Metallurgy by F.V.Lenel
10. Powder Metallurgy Science by R.M.German
11. Treaties on Powder Metallurgy by Goetzel, Vol-I&II
12. Powder Metallurgy by R.Lsande & C.R.S.Shakespere
13. Powder Metallurgy by A.K.Sinha, Dhanpat Rai
14. Powder Metallurgy, ASM Metals Handbook Vol-7

PCMT4203 **Principles of Extractive Metallurgy**

Module I **(12 hours)**

Mineral Dressing: Importance of mineral dressing, comminution processes, principles and methods of separation and classification, principles of flotation with case study.

Module II **(12 hours)**

Unit processes in pyrometallurgy: Calcination and roasting, sintering, smelting, converting, reduction, smelting-reduction, metallothermic and hydrogen reduction; distillation and other physical and chemical refining methods – their thermodynamic and kinetic treatment with appropriate examples.

Module III **(16 hours)**

Unit processes in hydrometallurgy: Leaching, purification of leach liquor, solvent extraction, ion-exchange process, potential-pH diagrams, different metal recovery processes from aqueous phase, bacteria leaching.

Electrometallurgy: Faraday's Laws of Electrolysis, concept of overvoltage, limiting current density, total cell voltage, series and parallel electrical circuits in refining, aqueous and fused salt electrolysis, electro refining of common metals like Cu, Zn, Ag, Au, Ni, Mn, Al, Mg etc…

Numerical problems relevant to different pyro- , hydro- and elctrometallurgical processes.

Books for Reference:-

1. Principles of Extractive Metallurgy by T. Rosenqvist.
2. Principles of Extractive Metallurgy by Ahindra Ghosh and H. S. Ray.
3. Unit Processes of Extractive Metallurgy by R. D. Pehlke.
4. Fundamentals of Metallurgical Processes by L. Coudurier, D. W. Hopkins and I. Wilkomirsky.
5. Metallurgical Problems by A. Butts.
6. Electrochemical Engineering by C. L. Mantell.
7. Principles of Mineral Dressing by A. M. Gaudin.
8. Text Book of Ore Dressing by R. H. Richards and C. E. Locks.
9. Element of Ore Dressing by A.E. Taggart.
10. Handbook of Mineral Dressing- Ores and Industrial Minerals by A.E. Taggart.
11. Textbook of Ore Dressing by S.J. Trusscott.
12. Ore Dressing by S.K. Jain.
13. Mineral Processing Technology by Berry A Willis.

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

BEEC2216 **Analog and Digital Electronics**

MODULE – I (9 Hurs)

1. **Diode Circuits:** Zener Diode Voltage Regulator, Diode Circuits with Time-Varying Sources, Switching Characteristics of a Diode, Special Purpose Diodes , Rectifiers and Filters. (4 Hours)
2. **Small Signal Amplifier:** Transistor Hybrid Model, Transistor Biasing, Bias Design, AC Gain, Input and Output Impedances, Some Special Circuits, Darlington Pairs and Feedback Pairs, Frequency Response of Single Stage RC Coupled Amplifiers and Multistage Transistor Amplifiers. (5 Hours)

MODULE – II (12 Hours)

3. **Large Signal Amplifiers:** Classification, Class-A and Class-B Power Amplifiers Complimentary and Symmetry Amplifiers, Class-C Amplifiers. . (4 Hours)
4. **Feed Back Amplifiers and Oscillators:** Feedback Concepts, Types of Feedback Circuits, Effects of Negative Feedback Circuits, Unijunction Oscillator and PLL. (4 Hours)
5. **Operational Amplifier:** Basic Operational Amplifier, Differential Amplifier, Basic Operational Amplifier Circuits, Application of OPAMPs, Linear Application of OPAMPs, OPAMP Filters. (4 Hours)

MODULE – III (13 Hours)

6. **Conditional Circuits:** Introduction to Digital Electronics Circuits, K-maps and their Simplification, Adder, Subtractors, Digital Comparator Circuits, Parity Checkers/Generators, Multiplexers and Decoders, Demultiplexers/Decoders, Programmable Logic Arrays. (5 Hours)
7. **Sequential Circuits and Systems:** Introduction, Memory Cells and Flip-Flops, Resistors, Counters, Asynchronous Counters, State Diagrams, Memories, ROM and RAM, Digital to Analog and Analog to Digital Converters (DAC and ADC). (5 Hours)
8. **Multivibrators and Switching Regulators:** Multivibrators, Analog Multivibrators, 555 Timer, Power Supply and Regulators (3 Hours)

Text Books:

1. Electronics: Analog and Digital, I.J. Nagrath (Selected portions of Chapter 1, 3, 4, 5, 6, 7, 9, 10, 11), PHI Learning Pvt. Ltd., New Delhi.

Reference Books:

1. Millman's Electronic Devices and Circuits, 2nd Edition, J. Millman, C. Halkias, and S. Jit, Tata McGraw Hill Education Pvt. Ltd., New Delhi.
2. Electronic Devices and Circuit Theory, 9th/10th Edition, R.L. Boylestad and L. Nashelsky, Pearson Education, New Delhi.
3. Digital Fundamentals, 5th Edition, T.L. Floyd and R.P. Jain, Pearson Education, New Delhi.
4. Fundamentals of Digital Circuits, 2nd Edition, A. Anand Kumar, PHI Learning Pvt. Ltd., New Delhi.

BEEE2215 **Energy Conversion Techniques**

MODULE- I (10 Hrs)

1. DC GENERATORS: Constructional features and operating principles, EMF equation, No Load Characteristics for Separately Excited DC Generator and DC Shunt Generator, Conditions for Self Excitation, Critical Resistance and Critical Speed, Losses and Efficiency.

2. DC MOTORS: Speed~Armature Current, Torque~Armature Current and Speed~Torque Characteristic for (i) Separately Excited DC Motor, (ii) DC Shunt Motor, (iii) DC Series Motor, Starting, Speed control and application of DC motor.

MODULE- II (10 Hrs)

3. SINGLE PHASE TRANSFORMERS: Constructional Features, EMF Equation, Turns Ratio, Open Circuit Test and Short Circuit Test, Losses and Efficiency, Introduction to Three Phase Transformers: Three Single Phase Transformers Connected as a Bank of Three Phase Transformer.

4. INDUCTION MOTORS: (a) Three Phase Induction Motors: Constructional Features of Squirrel Cage Rotor type and Slip Ring/Wound Rotor type of Induction Motors, Principle of Operation, Concept of Slip, Slip~Torque Characteristics, Starting of Squirrel Cage Rotor type and Slip Ring/Wound Rotor type of Induction Motors, Speed Control of Induction Motors.

   (b) Introduction to Single Phase Induction Motors: Construction, Principle of Operation and Application.

MODULE- III (10 Hrs)

5. THREE PHASE SYNCHRONOUS GENERATORS: Constructional Features, Principle of operation as Alternator, Synchronous reactance, Equivalent circuit of alternator, Power-Angle curve, Synchronization of alternators.

6. THREE PHASE SYNCHRONOUS MOTORS: Constructional Features, Principle of Operation, Torque Expression and Phasor Diagram for Synchronous Motor, Electrical Power and Mechanical Power, Starting and application of Synchronous Motor.

Text Book :

1. Electric Machines – D P Kothari & I J Nagrath – Tata McGraw Hill.

Reference Book(s):

2. The Performance and Design of DC Machines – A E Clayton.
3. Theory and Performance of AC Machines – M G Say
4. Electrical Machinery – P S Bimbhra – Khanna Publishers.
5. Electrical Machines – P K Mukherjee and S Chakravorti – Dhanpat Rai Publications.
6. Electric Machinery – Fitzgerald, Charles Kingsley Jr., S. D. Umans – Tata Mc Graw Hill.
7. Electric Machinery And Transformers – Guru & Hiziroglu – Oxford University Press.
8. Electric Machines – Charles Hubert – Pearson Education.

PCME4202 **Mechanics of Solids**

MODULE - I (14 Lectures)

1. Load, Stress, Principle of St.Venant, Principle of Superposition, Strain, Hooke's law, Modulus of Elasticity, Stress-Strain Diagrams, Working Stress, Factor of safety, Strain energy in tension and compression, Resilience, Impact loads, Analysis of Axially Loaded Members : Composite bars in tension and compression - temperature stresses in composite rods, Statically indeterminate problems. Shear stress, Complimentary shear stress, Shear strain, Modulus of rigidity, Poisson's ratio, Bulk Modulus, Relationship between elastic constants.
2. Members in Biaxial State of Stress :Stresses in thin cylinders, thin spherical shells under internal pressure - wire winding of thin cylinders. Analysis of Biaxial Stress. Plane stress, Principal stress, Principal plane, Mohr's Circle for Biaxial Stress.
3. Strain Deformation :Two dimensional state of strain, Mohr's circle for strain, Principal strains and principal axes of strain measurements, Calculation of principal stresses from principal strains.

MODULE - II (13 Lectures)

4. Shear Force and Bending Moment for Simple Beams :
   Shear force and bending moment. Types of load and Types of support. Support reactions, Relationship between bending moment and shear force, Point of inflection. Shear Force and Bending Moment diagrams.
5. Simple Bending of Beams :Theory of simple bending of initially straight beams, Bending stresses, Shear stresses in bending, Distribution of normal and shear stress, beams of two materials, Composite beams.
6. Deflection of Beams :Differential equation of the elastic line, Slope and deflection of beams by integration method and area - moment method.

MODULE - III (12 Lectures)

7. Theory of Columns:Eccentric loading of a short strut, Long columns, Euler's column formula, Lateral buckling, Critical Load, Slenderness ratio
8. Torsion in solid and hollow circular shafts, Twisting moment, Strain energy in shear and torsion, strength of solid and hollow circular shafts. Stresses due to combined bending and torsion, Strength of shafts in combined bending and twisting.
9. Close - Coiled helical springs.

Text Books:

1. Elements of Strength of Materials by S.P.Timoshenko and D.H.Young, Affiliated East-West Press
2. Strength of Materials by G. H. Ryder, Macmillan Press
3. Strength of Materials by James M. Gere and Barry J. Goodno, Cengage Learning

Reference Books:

1. Mechanics of Materials by Beer and Johnston, Tata McGraw Hill
2. Mechanics of Materials by R.C.Hibbeler, Pearson Education
3. Mechanics of Materials by William F.Riley, Leroy D.Sturges and Don H.Morris, Wiley Student Edition
4. Mechanics of Materials by James M. Gere, Thomson Learning
5. Engineering Machanics of Solids by Egor P. Popov, Prentice Hall of India
6. Strength of Materials by S.S.Rattan, Tata Mc Graw Hill
7. Strength of Materials by R.Subramaniam, Oxford University Press
8. Strength of Materials by Sadhu Singh, Khanna Publishers

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)

BEEC7216 Analogue & Digital Electronics Lab

List of Experiments

(At least 10 out of 13 experiments should be done)

1. BJT bias circuit – Design, assemble and test.
2. JEET/MOSFET bias circuits – Design, assemble and test.
3. Design, assemble and test of BJT common-emitter circuit – D.C and A.C performance: Voltage gain, input impedance and output impedance with bypassed and un-bypassed emitter resistor.
4. Design, assemble and test of BJT emitter-follower – D.C and A.C performance: A.C. voltage gain, input impedance and output impedance.
5. Design, assemble and Test of JFET/MOSFET common-source and common-drain amplifiers – D.C and A.C performance: Voltage gain, input impedance and output impedance.
6. Frequency response of a common-emitter amplifier: low frequency, high frequency and mid frequency response.
7. Differential amplifiers circuits: D.C bias and A.C operation without and with current source.
8. Study of Darlington connection and current mirror circuits.
9. OP-Amp Frequency Response and Compensation.
10. Application of Op-Amp as differentiator, integrator, square wave generator.
11. Square wave testing of an amplifier.
12. R.C phase shift oscillator/Wien-Bridge Oscillator using OP-Amp/Crystal Oscillator.
13. Class A and Class B Power Amplifier.

BEEE7215 **Energy Conversion Techniques Lab**

Select any 8 experiments from the list of 10 experiments

1. Determination of critical resistance and critical speed from no load test of a DC shunt generator.
2. Plotting of external and internal characteristics of a DC shunt generator.
3. Starting of DC shunt motors by 3-point/ 4-point starter.
4. Speed control of DC shunt motor by armature control and flux control method.
5. Determination of Efficiency by Open Circuit and Short Circuit test on single phase transformer.
6. Polarity test and Parallel operation of two single phase transformers.
7. Open circuit and Short circuit test of an alternator.
8. Load test of three phase induction motors.
9. Calculation of slip and efficiency of three phase squirrel cage induction motor at full load.
10. Starting of single phase induction motors

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.

PCMT7204 **Materials Processing Lab**

Suggested experiments:

1. Examination of the various zones of the arc in arc welding process.
2. Effect of increasing amperage on the quality of weld bead.
3. Microstructural investigation of the welded and heat affected zones.
4. Brazing of steel/ cast iron and observation of the relevant joined microstructures.
5. Preparation of standard samples for common sand testing.
6. Measurement of green compression strength, permeability and moisture content in the moulding sand.
7. Determination of compressive strength in sodium silicate/C02 mould as a function of gassing time and pressure.
8. Determination of the tensile strength of oil/resin bonded core sand.
9. Experiments on mechanical working processes like rolling, forging, extrusion, wire drawing, forming.

PCMT7205 **Materials Characterization Lab**

Suggested experiments:

1. Determination of Cu in Brass Sample.
2. Determination of Fe in Iron Ore.
3. Determination of Mn in Steel.
4. Determination of Cr in steel.
5. Determination of Si in cast iron.
6. Determination of carbon and sulphur in steel.
7. Determination of Ca in Limestone.
8. To determine the hardness of different phases / constituents in multiphase structures using micro hardness tester.
9. To determine the thickness of a steel sample using ultrasonic technique.
10. To determine electrical resistivity of alloy / semiconductor.
11. To determine electrical conductivity of ionic solid.
12. To find out the size distribution of metal powders.
13. To determine the apparent density, tap density and flow rate of powders.
14. To determine the compressibility of powders.

BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ORISSA

Metallurgical and Materials Engineering

(2008 Admission Batch)

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 OR HSSM3302 Optimization in Engineering	3-0-0	3	HSSM3302	Optimization in Engineering OR HSSM3301 Principles of Management	3-0-0	3
PCMT4302	Deformation Behaviour of Materials	3-0-0	3	PCMT4303	Iron Making	3-0-0	3
PCMT4301	Phase Transformations and Heat Treatment	3-0-0	3	PCMT4304	Mechanical Working and Testing of Materials	3-0-0	3
	Professional Elective – I (Any one)	3-0-0	3	PCMT4305	Solidification and Casting Processes	3-0-0	3
PEMT5301	Characterization of Materials						
PEMN5301	Fuel Technology						
	Professional Elective – II (*Any One*)	3-0-0	3		Professional Elective – III (*Any One*)	3-0-0	3
PEMT5302	Mineral Processing			PEMT5303	Nano Materials		
PEMT5304	Refractories and Furnaces			PEMT5305	Composite Materials		
	Free Elective – II (*Any One*)	3-0-0	3		Free Elective – III (*Any One*)	3-0-0	3
FESM6302	Advance Numerical Methods			FEME6301	Finite Element Method		
PCEC4301	Microprocessors			FEEE6301	Industrial Process Control & Dynamics		
PEEC4302	Fiber Optics & Optoelectronics Devices			PCCS4304	Operating Systems		
				PEME5308	Non Conventional Energy Sources		
	Credits (Theory)		18		Credits (Theory)		18
	PRACTICALS/SESSIONALS				*PRACTICALS/SESSIONALS*		
PCMT7302	Mineral Processing Lab.	0-0-3	2	PCMT7305	Process Metallurgy Lab .	0-0-3	2
PCMT7303	Fuel Testing Lab	0-0-3	2	PCMT7304	Testing of Materials Lab..	0-0-3	2
PCMT7301	Phase Transformations & Heat Treatment Lab	0-0-3	2	PCMT7306	Computer Applications in Metallurgical Engineering Lab	0-0-3	2
	Credits (Practicals / Sessionals)		**6**		**Credits (Practicals/Sessionals)**		**6**
	TOTAL SEMESTER CREDITS		**24**		**TOTAL SEMESTER CREDITS**		**24**
	TOTAL CUMULATIVE CREDITS		**134**		**TOTAL CUMULATIVE CREDITS**		**158**

HSSM3301 **PRINCIPLES OF MANAGEMENT**

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.*

6.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.

PCMT4302 **DEFORMATION BEHAVIOUR OF MATERIALS**

(3-0-0)

Module-I **(14 Hours)**

Introduction: Elastic, plastic and visco-elastic deformation.
Continuum mechanics: Concepts of stress and strain in 3D stress and strain tensor, principal stresses and strains and principal axes, mean stress, stress deviator, maximum shear, equilibrium of stresses, equations of compatibility.
Elastic behaviour of materials: Constitutive equations in elasticity for isotropic and anisotropic materials, strain energy, elastic stiffness and compliance tensor, effect of crystal structure on elastic constants.
Plastic response of materials: a continuum approach: classification of stress-strain curves, yield criteria.
Plastic deformation of single crystals: Concepts of crystal geometry, lattice defects, deformation by slip, slip in a perfect lattice, slip by dislocation movement, critical resolved shear stress, deformation by twinning, stacking faults, deformation band and kink band, strain hardening of single crystal; stress-strain curves of fcc, bcc and hcp materials.

Module- II **(12 Hours)**

Dislocation Theory: Elements of dislocation theory, movement of dislocation, elastic properties of dislocation, intersection of dislocation, dislocation reactions in different crystal structures, origin and multiplication of dislocations, dislocation pile-ups.
Plastic deformation of polycrystalline materials: Role of grain boundaries in deformation, strengthening by grain boundaries, yield point phenomenon, strain ageing, strengthening by solutes, precipitates, dispersoids and fibres.

Module- III **(12 Hours)**

Fracture: Types of fracture in metals, theoretical cohesive strength of metals, Griffth theory of brittle fracture, fracture of single crystals, metallographic aspects of fracture, dislocation theories of brittle fracture, ductile fracture.
Tension test: Engineering & true stress-strain curves, evaluation of tensile properties, Tensile instability, Effect of strain-rate & temperature on flow properties.
Deformation in non-metallic materials: structure and deformation of polymers, concept Super-lattice dislocations in intermetallics, concept of charge associated with dislocations in ceramics.
Books for reference:

1. Mechanical Metallurgy by G. E. Dieter, McGraw-Hill.
2. Deformation and Fracture Mechanics of Engineering Materials by R.W. Hertzberg, John Wiley.
3. Mechanical Behaviour of Materials by M. A. Meyers and K. K. Chawla
4. Mechanical Behaviour of Materials by T.H. Courtney

PCMT4301 **PHASE TRANSFORMATIONS AND HEAT TREATMENT** (3-0-0)

Module I (14 Hours)

Introduction: Thermodynamics of phase equilibrium and phase changes; Definition, utility, order and classification of phase transformations.

Diffusion: Definition of Fick's law on steady and non-steady state diffusion and their solutions; Mechanism of diffusion in solids; Chemical diffusion and Darken's equation; Kirkendall effect; Effect of pressure and temperature on diffusivity.

Nucleation and growth: Formation of nucleus; Homogeneous and Heterogeneous nucleation; Mechanism and kinetics of thermally activated growth; Interface and diffusion control growth regimes.

Phase equilibrium and phase diagrams: Important phase changes in unary and binary systems; Types and interpretation of phase diagram; Utility of phase diagrams, Lever rule; Important phase diagrams in metallic and ceramic systems; Free energy Composition diagrams; Ternary phase diagrams; Isomorphous and eutectic Systems.

Module II (12 Hours)

Liquid-solid transformation: Solidification, nucleation and growth mechanisms and kinetics; Alloy solidification – cellular and dendritic morphology; Eutectic and peritectic solidification. Application of solidification.

Solid state diffusive transformation: Classification of solid-solid transformations; Nucleation in solids; Precipitate growth; Age hardening; Spinodal decomposition; Precipitate coarsening. Order-disorder change, polymorphic change. Recrystallization, grain growth. Eutectoid transformation. Application of solid state precipitation. Pearlitic and bainitic transformations in steel; Martensite and martensitic changes in ferrous materials.

Module III (12 Hours)

Review of Iron-carbon alloy system: Iron-cementite and iron-graphite phase diagrams, cooling of hypo-eutectoid, eutectoid and hyper-eutectoid steels, hypo-eutectic, eutectic and hyper-eutectic cast irons, nucleation and growth of pearlite.

Heat treatment of steels: TTT and CCT diagrams, conventional heat treatment processes – annealing, normalizing, hardening and tempering. Hardenability, role of alloying elements in steels. Surface hardening and chemical treatment in steels. Thermo-mechanical treatment of steels; High temperature and low temperature Thermo-Mechanical treatment. Heat treatment of some Cu, Al and Ti based alloys.

Books for reference

1. Phase Transformations in Metals and Alloys by D. A. Porter and K. E. Easterling, CRC Press.
2. Phase Transformations in Materials by R. C. Sharma
3. Solid State Phase Transformations by Raghavan, PHI.
4. Steel and its Heat treatment by K E Thelning, Butterworth.
5. Heat Treatment by Rajan and Sharma, PHI.
6. Principles of Heat Treatment of Steels, ASM
7. Physical Metallurgy Principles by R. E. Reed-Hill, East West Press.
8. Theory of Transformations in Metals and Alloys by J.W.Christian, Pergamon Press.

PEMT5301 **CHARACTERIZATION OF MATERIALS**(3-0-0)

Module I (12 Hours)

Introduction: Scope of subject, classification of techniques for characterization, macro and micro-characterization structure of solids. Bulk averaging techniques:
Thermal analysis: DTA, DSC, TGA, dilatometry, resistivity/ conductivity.
Optical & X-ray spectroscopy: Atomic absorption spectroscopy, X-ray spectrometry, infrared spectroscopy and Raman spectroscopy.
Mass spectroscopy: Principles and brief account.
Metallographic techniques: Optical metallography, image analysis, quantitative phase estimation.

Module II (14 Hours)
Diffraction methods: X-ray diffraction, X-ray topography, residual stress measurement techniques, small angle X-ray and neutron scattering.
Electron optical methods: (a) Scanning electron microscopy and X-ray microanalysis including electron probe microanalysis, electron optics, electron beam specimen interaction, image formation in the SEM. X-ray spectral measurements: WDS and EDS, quantitative X-ray analysis; application of SEM and EPMA to solid samples and biological materials; type of data base required to process the results.

Module III (14 Hours)
(b) Analytical transmission electron microscopy: Electron diffraction, reciprocal lattice, analysis of SAD patterns; different electron diffraction techniques, atomic resolution microscopy, analytical devices with TEM, field ion microscopy, scanning tunneling microscopy, advanced techniques.
Methods based on sputtering or scattering phenomena: Field ion microscopy, atom probe microanalysis, low energy ion scattering spectroscopy, Rutherford back scattering spectroscopy, ion channeling and secondary ion mass spectroscopy.
Chromatography: Principles of gas chromatography, mass spectrometry, liquid and ion chromatography.

Books for reference:

1. Materials Characterization, Metals Handbook, Vol 10, ASM
2. Characterization of Materials, by E N Kaufman, Wiley Publishers
3. Structure of Metals, by Barett, C.S. and Massalski, T.B., Pergamon Press, Oxford.
4. Elements of X-ray Diffraction, by Cullity B.D., Addison-Wesley, 1978
5. Transmission Electron Microscopy by Williams, D.B. and Barry Carter C., Plenum Press.
6. Scanning Electron Microscopy and X-Ray Microanalysis, by J.I. Goldstein, C. E. Lyman
7. Differential Thermal Analysis by R.C.Machenzie
8. Modern Metallographic Techniques and their application by Victor A.Phillips

PEMN5301 **FUEL TECHNOLOGY** (3-0-0)

Module I (14 Hours)

Primary energy resources of the world and India (Coal, Petroleum and Natural Gas). Classification of fuels; solid, liquid and gaseous, primary and secondary fuels.
Coal: Rank, coking and non-coking coals; Characterization of coal properties (caking and swelling indices, calorific value, proximate and ultimate analyses, etc.); Selection of coal for metallurgical industries and thermal power plants, coal washing and blending, washability curves; Coal carbonization, operational features of modern coke ovens. Testing and properties of coke, char and graphite.

Module II (12 Hours)

Fuel calorimetry; Testing of fuels; Definition and principle of combustion of fuels; Combustion calculations.
Alternative sources of energy - ferrocoke, formed coke, charcoal, solar, wind, tidal, etc., and their suitability for metallurgical and power industries; Renewable and non-renewable sources of energy; Activated carbon and its uses.

Module III (12 Hours)

Properties and uses of gaseous fuels like coke oven gas, blast furnace gas, basic oxygen furnace gas, producer gas, etc
Petroleum coke and its utilization in metallurgy; Solid energy wastes and their possible industrial applications.

Books for reference

1. Fuels and Combustion by M.L. Smith and K.W. Stinson, McGraw-Hill.
2. Fuels and Combustion by S. Sarkar, Orient Longman Ltd., Mumbai.
3. Elements of Fuel Technology by G.W. Himus.
4. Fuels-solid, liquid and gaseous by J.S.S. Brame and J.C. King Edward.
5. Fuels and Combustion by S.P. Sharma and C. Mohan, Tata McGraw-Hill.
6. Fuels, Furnaces and Refractories by J.D. Gilchrist.

PEMT5302 **MINERAL PROCESSING** (3-0-0)

Module I (14 Hours)

Introduction to mineral beneficiation, sampling, liberation studies and its importance.

Comminution: Fundamentals of comminution, crushing -- construction and operational features of jaw, gyratory, cone and roll crushers.

Grinding: Theory of ball mill, rod mill, critical speed of the mill, open circuit and closed circuit, circulating load.

Size separation: Sieving and screening, laboratory sizing and its importance, representation and interpretation of size analysis data, industrial screening.

Classification: Movement of solids in fluids, free setting and hindered settling of particles, different types of classifiers, e.g. sizing and sorting classifiers used in mineral industry.

Module II (12 Hours)

Concentration: Gravity separation, concentration criteria, jigging, flowing film concentration and tabling, dense media separation.

Froth flotation: Theory, reagents used in floatation processes, machines and practice.

Magnetic and electrostatic separation: Theory and application of magnetic and electrostatic separation techniques in mineral industry.

Dewatering and drying: Theory and practice of thickening; filtration and drying.

Module III (12 Hours)

Flow sheets: Typical flow sheets for beneficiation of iron, gold, copper, lead-zinc sulphide ores, rock phosphate, beach sand, uranium and other industrial minerals.

Agglomeration techniques: Sintering, palletizing, briquetting and their applications in ferrous and non-ferrous metal industries, testing of agglomerates.

Important mineral deposits in India.

Books for reference

1. Principle of Mineral Dressing by A. M. Gaudin.
2. Text Book of Ore Dressing by R. H. Richards and C. E. Locks.
3. Element of Ore Dressing by A.E. Taggart.
4. Handbook of Mineral Dressing- Ores and Industrial Minerals by A.E. Taggart.
5. Textbook of Ore Dressing by S.J. Trusscott.
6. Ore Dressing by S.K. Jain.
7. Mineral Processing Technology by Berry A Willis.

PEMT5304 **REFRACTORIES & FURNACES** (3-0-0)

Module I **(12 Hours)**

Refractories:

Classification of refractories, raw materials, manufacture, testing and properties of heavy and special refractories, silica, silicous aluminosilicate, high alumina, magnesite, chrome, chrome-magnesite, dolomite, forsterite, chemically bonded basic, carbon and insulating refractories and special purpose oxides, carbide nitride refractories.

Binary phase diagrams of Al_2O_3-SiO_2, CaO-MgO, CrO_3-MgO and MgO-SiO_2 systems.

Refractory mortars and cements, Refractory castables, selection of refractories for coke oven ,iron blast furnace, copper convertor ,soaking reheating furnaces and heat treatment furnaces, electric are furnace.

Module II **(14 Hours)**

Furnace Technology:

Classification of furnaces: basis and uses.

Mechanism of combustion, ignition temperature.

Flames: Flame propagation, flame speed and inflammability limits, types of flames; premixed and diffusion flames and their characteristics. Combustion control; variables of control, viz.: temperature, pressure and gas ratio control, modes or combustion control. Theoretical, adiabatic & true flame temperature.

Available heat and factors affecting it.

Heat losses in furnaces: Heat balance and furnace efficiency.

Liquid and gaseous fuel burners: methods of atomization, types of liquid fuel burners and principle of design. Low pressure, high pressure and injection type gaseous fuel burners and principles of their design.

Waste heat recovery:

Recuperators; types and availability. Temperature distribution in different types of recuperators, AMTD and LMTD. Heat transfer and principle of design.

Regenerators: Temperature distribution heat transfer and principles of design.

Module III **(12 Hours)**

Electric heating: Principles of resistance, arc and induction heating. Principles of resistor design. Selection of power for arc furnace and frequency for induction furnaces.

Basic design for generation of low pressure, rotary mechanical pumps and diffusion pumps. Pressure measuring gauges.

Laboratory furnaces; oil fired furnaces, muffle furnaces, salt and lead bath furnaces. Heating of bodies in furnaces.

Types of drafts, natural, induced and forced. Chimney calculations.

Description, operation, instrumentation and control of soaking pits, reheating furnaces, and annealing furnaces (hood annealing and continuous annealing).

Books for reference:

1. Fuels, Furnaces and Refractories by J.D. Gilchrist.
2. Refractories manufacture properties and uses by M.L.Mishra
3. Refractories manufacture properties and application by A.R.Chesti
4. Steel Plant Refractories by Chester
5. Refractories by Norton
6. Industrial Furnace, Vol –I & II, by Trinks & Mawhinney
7. Modern Furnace Technology by Erthrington
8. Science of Flames and Furnaces by Thring
9. Industrial Electric Furnaces and Applications by Pasckis & Pearson
10. Vacuum Equipment and Techniques by Gutheris & Wakerins

FESM6302 **ADVANCE NUMERICAL METHODS** (3-0-0)

Unit-I : **(10 Hr)**

Interpolation: Piecewise Linear Interpolation, Piecewise Quadratic Interpolation, Piecewise Cubic Hermite Interpolation, Piecewise Spline Interpolation.

Numerical Differentiation: First Derivative, Higher Derivatives, Partial Derivative, Richardson's Extrapolation.

Romberg algorithm for numerical integration.

Unit-II **(10 Hr)**

Eigen values and Eigen Vectors: Basic power method, Rayleigh Quotient, Shifted power method, Accelerating convergence, Inverse power method, Basic QR method, Better QR method, Finding eigen vectors, Accelerating convergence

Fourier methods: Discrete Fourier Transforms, Fast Fourier Transforms, Matrix form of FFT, Algebraic form of FFT, Mixed-Radix FFT

Unit-III **(10 Hr)**

Ordinary Differential Equations: Adams-Bashforth Methods, Adams-Moulton Methods, Adams Predictor-Corrector methods, Other Predictor-Corrector methods (Simpson's method and Milne's method)

Parabolic Partial Differential Equation: Explicit Method, Implicit method, Crank-Nicolson method

Hyperbolic Partial Differential Equation: Explicit Method, Implicit method.

Elliptic Partial Differential Equation: Finite-Element method.

Text Book:

1. L.V. Fausett," Applied Numerical Analysis Using MATLAB", Pearson Education

Reference Books:

1. W.Cheney and D. Kincaid,"Numerical Mathematics and Computing", Fifth Edition, Thomson/CENGAGE Learning
2. S.C.Chapra,"Applied numerical methods with MATLAB", second edition, Tata McGraw Hills
3. R.J. Schilling and S.L.Harris,"Applied Numerical Methods for Engineering", CENGAGE learning

PCEC4301 **MICROPROCESSORS**

Unit I:

Organization of Microprocessor

Introduction to the general concept of microprocessor organization, I/O sub-systems, programming the system, ALU, instruction execution, instruction word format, addressing modes, address/data/control bus, tristate bus, interfacing I/O devices, data transfer schemes, architectural advancements of microprocessor, evolution of microprocessors.

Unit II:

Intel 8086- Hardware Architecture:

Introduction, Bus interface unit(BIU), Execution unit(EU), pin description, register organization, instruction pointer, data register, pointer and index registers, status register, stack, external memory addressing, bus cycle (minimum mode):memory or I/O read/write for minimum mode, clock generator Intel- 8284A, bidirectional bus trans-receiver 8286/8287, bus controller 8288, bus cycle memory read/write for minimum mode, 8086 system configuration (minimum mode as well as maximum mode), memory interfacing, interrupt processing; software interrupts, single step interrupt, non-maskable interrupt, maskable interrupt, interrupt priority, DMA, Halt State, Wait for Test state, comparison between 8086 an 8088.

Unit III:

Instruction set and programming:

Programmer's model of Intel 8086, operand type, addressing modes 8086 assembler directives, instruction set, programming examples on data transfer group, arithmetic-logical groups, control transfer groups (loop and loop handling instruction), conditional and unconditional group, procedures and stack operations, string instructions.,branch program structure like IF-THEN-ELSE REPEAT-UNTIL and WHILE-DO,

I/O Interfacing ;

8-bit input- output port 8255 PPI, memory mapped i/o ports,8254 programmable Interval Timer, 8273 Programmable Direct Memory Access Controller, 8251 USART, 8279 Programmable Keyboard/Display Controller.

Text Books:

1.The 8088 and 8086 Microprocessors Programming, Interfacing, Softw, Hardware and Application; by Walter A. Triebel & Avtar Singh ; Pearson India.

2. Microprocessors and Interfacing; by Douglas V Hall ; McGraw Hill.

Reference Book:

1. Microprocessors and Micro controllers Architecture, programming and system Design 8085, 8086, 8051, 8096: by Krishna Kant; PHI.

2. The 8086 Microprocessor: Programming & Interfacing the PC- Kenneth J. Ayala, Delmar Cengage Learning, Indian Ed.

PEEC4302 FIBER OPTICS AND OPTOELECTRONICS DEVICES

Module I (10 hours)

Fundamental of fiber optics, Different generations of optical fiber communication systems. Optical fiber structure, Fiber types, step index fiber and graded index fiber, ray propagation, total internal reflection, Numerical Aperature, acceptance angle. Wave propagation in a cylindrical wave guides, modal concept, V-number, power flow in step index fiber and graded index fiber, attenuation (absorbtion, scattering and bending) and dispersion (inter and intramodal, chromatic, wave guide and polarization) in fiber, dispersion shifted and dispersion flattened fiber

Module II (12 hours)

Fiber fabrication, Double crucible method, Fiber optic cables, Connector and splice. Losses during coupling between source to fiber, fiber to fiber. Schemes for coupling improvement.

Optoelectronic Sources, LED, ILD,light source materials, Radiation Pattern modulation capability.

Module III (13 hours)

Optoelectronic Detector, PIN AND APD, Responsivity,Band width, Detector noise ,equivalent circuit and SNR calculation.

Optoelectronic Modulators, Basic principle, Electro optic and Acousto optic modulators, Optical Amplifier, Semiconductor optical Amplifier and Erbium Doped Fiber Amplifier, Solar cells, basic principle,heterojunction,cascadedsolar cell,Schottky Barrier cells,WDM components-couplers, isolators ,circulators, filters. Optical switching-self electro optic effect Device, switching speed and energy

Text Books

1. Fiber optics and Optoelectronics, R.P.Khare, Oxford University Press(selected sections from chapters 1,2,3,4,5,6,7,8,9and10)
2. Semiconductor Optoelectronic Devices, Pallab Bhatttacharya, second edition, Pearson Education (selected sections from chapters 10 and 11)

Reference Books

1. Fiber optic communications, Joseph C Palais, fourth edition, Pearson Education.
1. Optical Fiber Communications, Keiser G, 4th Edition Tata McGraw Hill Education Private Limited.
3. Optical Fiber Communication Principles and practice,Senior J,Prentice Hall of India.

PCMT7302 **MINERAL PROCESSING LAB.** (0-0-3)

Suggested list of experiments:

1. Physical examination and identification of minerals.
2. Crushing of ore/ coal in a jaw crusher and to study the size analysis of the product.
3. To study the jaw crusher and determine the actual capacity and reduction ratio.
4. Verification of Rittinger's Law of crushing in a jaw crusher.
5. Crushing of ore/ coal in a roll crusher and to study the size analysis of the product.
6. Crushing of ore/ coal in a gyratory crusher / pulveriser and to study the size analysis of the product.
7. Crushing of ore/ coal in a cone crusher and to study the size analysis of the product.
8. To study the effect of grinding with grinding time in cylindrical ball mill and rod mill.
9. To separate coal from a mixture of coal and stones or quarts by zigging and determine the weight fractions of the products.
10. To separate a mixture of two minerals of different densities by gravity concentration using Wilfley Table and determine the weight and density of each fraction of the products.
11. Beneficiation of ore pulp mix using flotation cell.
12. To separate a mixture of iron and sand using magnetic separator and determine its efficiency.
13. Screening of ore/ coal using vibrating screen and determine its effectiveness.

PCMT7303 **FUEL TESTING LAB.** (0-0-3)

1. Proximate analysis of coal and coke.
2. To determine calorific value of coal and coke using bomb calorimeter.
3. To determine bulk density of coal sample.
4. To determine true density of coal sample.
5. To determine shatter and abrasion indices of coal and coke.
6. To determine flash point and fire point of a given sample such as kerosene oil, diesel, petrol by Pensky-Marten's apparatus or Cleveland open cup apparatus.
7. To determine viscosity of oil by Engler viscometer and the water number in the apparatus.
8. To determine effect of temperature on kinematic viscosity of glycerene by Redwood viscometer.

PCMT7301 **PHASE TRANSFORMATIONS AND HEAT TREATMENT LAB.** (0-0-3)

1. Annealing treatment of a cold worked steel and comparison of the annealed microstructure with the cold worked structure.
2. Normalizing treatment of steel and comparison of the microstructure with annealed structure.
3. To study the quenched structures of steel – quenched in oil, water and brine solution.
4. To study the quenched and tempered structures of steel –
    ( ) low temperature tempering.
    ( ) medium temperature tempering.
    ( ) high temperature tempering.
5. To study the recrystallization behaviour of pure metal (iron / copper).
6. To study the effect of time and temperature on grain size of a metal (grain growth) (iron/ copper).
7. To study the nucleation rate and growth rate of pearlite in eutectoid steel.
8. To study the susceptibility of a steel to harden by quenching (hardenability) by Jominy test.
9. Pack carburizing of 0.2% carbon steel and to measure the diffusion coefficient of carbon in steel.
10. To study the microstructure of tool steels, stainless steels and other high alloy steels.
11. Austempering of steels and S G cast irons.
12. To carry out age hardening of non ferrous alloys.
13. Determination of hardenability of steels.

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6th SEMESTER

PCMT4303 IRON MAKING (3-0-0)

Module I (14 Hours)

Raw materials and their properties: Iron ores, Limestones, Agglomerates and Coke. Preparation of ores: sintering and palletizing, blast furnace burdening and distribution, testing of raw materials for blast furnace.

Design: Blast furnace profile, stove and gas cleaning units; instrumentation, refractory used in blast furnace and stove.

Module II (14 Hours)

Reactions: Fe-C-O, Fe-O-H phase equilibria, Reactions in stack, bosh and hearth; formation of primary slag, bosh slag and hearth slag. Slag composition and its control, Metal-slag reactions, Control of hot metal composition.

Process Control: Factors affecting fuel consumption and productivity, Recent developments in Blast furnace operations like, Bell-less top charging system, High top pressure, Humidified & Oxygen enriched blast and Auxiliary fuel injection through tuyers.

Module III (12 Hours)

Irregularities in blast furnace operation and their remedies.

Alternative routes of iron making: Introduction, Processes of Sponge Iron production; SL/RN, MIDREX, HyL processes. Smelting Reduction Processes; COREX, ROMELT, Hismelt.

Text Book:

1. A. K. Biswas, Principles of Blast Furnace Iron Making, SBA publication, Calcutta, 1999

Reference Book:

1. Ahindra Ghosh and Amit Chatterjee: Ironmaking and Steelmaking Theory and Practice, Prentice-Hall of India Private Limited, 2008
2. G. R. Bashforth, The Manufacture of Iron and Steel, vol.I, Chapman, London, 1962.
3. David H. Wakelin (ed.): The Making, Shaping and Treating of Steel (Ironmaking Volume), The AISE Steel Foundation, 2004.

PCMT4304 **MECHANICAL WORKING AND TESTING OF MATERIALS** (3-0-0)

Module I (14 Hours)

Classification of forming processes.

Fundamentals of metal working – Effect of temperature, strain rate, metallurgical structure, friction & lubrication, workability and residual stress.

Rolling - Classification & processes, load, torque, power, variables controlling process, forward slip. Fundamentals of roll pass design, mill type. Rolling defects and their control.

Forging - Classification & processes, load for circular & rectangular plate.

Extrusion - Classification & processes, force & variables affecting it.

Module II (12 Hours)

Drawing of Wires and Tubes- Processes, drawing stress.

Sheet Metal Forming- Forming methods, Forming limit criterion, Special Forming techniques and defects in formed products

National and International Standards for Mechanical tests

Hardness Tests- Brinell, Rockwell, Vickers, Meyer, Knoop, etc., relationship with flow curve.

Compression Test- Comparison with tension, phenomenon of buckling & barreling.

Torsion Test- Stresses for elastic & plastic strain, Torsion vs. Tension.

Bend Test- Pure bending & flexure formula.

Impact Test- Notched bar impact tests, transition temperature & metallurgical factors affecting it.

Module III (14 Hours)

Fracture- Energy based criterion, Strain energy release rate, stress intensity factor, fracture toughness estimation and design of engineering component.

Fatigue – Stress cycles & S-N curve, effect of mean stress, stress concentration, surface, size, metallurgical factors etc. on endurance limit, Cyclic stress-strain curve, Low cycle fatigue, Paris law.

Creep- Creep & Stress rupture tests, Mechanism of creep deformation, Deformation mechanism Maps, Development of creep resistant alloys, Prediction of long time properties.

Non Destructive Testing: Scope and significance of non destructive testing. Principles, equipment, specifications and limitations of liquid penetrant, Magnetic particle, Eddy current, Ultrasonic and Acoustic emissions, and Radiography (X-Ray and Gamma Ray).

Books for reference:

1. Mechanical Metallurgy by G. E. Dieter, McGraw-Hill.
2. Roll Pass Design, The United Steel Companies Ltd., U.K.
3. Testing of Metallic materials by C. Suryanarayana.
4. Principles of Industrial Metal Working Processes by C. Russak, G. W. Rowe**.**
5. Practical Non Destructive Testing by Baldev Raj.

PCMT4305 SOLIDIFICATION AND CASTING PROCESSES

(3-0-0)

Module I (14 Hours)

1. **Introduction:** Casting as a process of Manufacturing. Advantages of casting over other forming processes. A brief mention about mould and its components etc. with special reference to mould factors in metal flow and moulding factors in casting design.

2. **Special Casting Methods:** Investment casting, Die casting, Centrifugal casting, Full mould casting, Vacuum sealed casting etc.

3. **Melting Practices for Casting Purposes:** Role of Ellingham diagram in melting of Metals for casting purposes; melting and post-melting treatments; Industrial melting practices as adopted for a few metals and alloys such as; Cast-iron; Steel; Copper; Aluminium, etc.

Module II (14 Hours)

4. **Solidification of Metals and Alloys:** Crystallisation, Liberation of energy and solute redistribution. Nucleation and growth processes; planar growth and factors hindering planar growth; Dendritic growth; Cellular growth; Independent nucleation; Eutectic freezing, Peritectic reactions.

5. **Structure of Casting:** Additional influences on structure.

6. **Practical Control of Cast Structure:** Grain shape and orientation; grain size consideration. Brief discussions on refinement and modification of cast structure.

Module III (12 Hours)

7. **Principles of Gating and Risering:** Types of gates and Risers; Chowrinov rule; Gating ratio, Wlodawer system of determining feeder head requirements.

8. **Casting Yield:** Various considerations for improving casting yield.

9. **Casting Defects and Their Remedies:** Various casting Defects; Their causes and remedial measures.

Books for reference:

1. Solidification Processing by M.C. Flemings, McGraw Hill.
2. Physical Metallurgy edited by R.W.Cahn and P.Hassen, North Holland.
3. Casting by J. Campbell, Butterworth - Haneman, London.
4. Principles of Metal Casting by Hein R.W., Loper C. R. & Rosenthal P.C, T.M.H.
5. Foundry Engineering by Taylor H.F., Flemming M.C. & Wulff, Wiley Eastern.
6. Foundry Technology by Beeley P.R., Butterworth, London.

PEMT5303 **NANO MATERIALS** (3-0-0)

Module – 1 (12 hours)

Introduction: Emergence and challenges of nanotechnology, Types of nanomaterials.

Synthesis and Characterization: Bottom-up and top-down approaches, Solid, Liquid, Gas phase synthesis, Hybrid Phase synthesis.

Module – II (12 hours)

Structural characterization by XRD, SAXS, SEM, TEM, SPM, gas adsorption; Chemical characterization by spectroscopy techniques.

Module – III (16 hours)

Properties and application of nanomaterials: Stability of nanomaterials, Mechanical properties, Optical, Electrical and Magnetic properties, Diffusion. Application of nanomaterials: Electronics and optoelectronics applications, Nanobots, Biological applications, Catalytic applications, Quantum devices, Application of carbon nanotubes, Nanofluids.

Books for reference:

1. Nanostructures and Nanomaterials: Synthesis, Properties and Applications by G. Cao, Imperial College Press.
2. Nanomaterails Handbook, (Ed.) by Y. Gagotsi, Taylor and Francis.
3. Introduction to Nanotechnology by C. P Poole and F. T. Owee, Willey Press.
4. Nano Materials Synthesis, Properties and Applications, by Edlstein and Cammarate.
5. Nano Materials, by A.K. Bandyopadyay, New age Publications.
6. Nano - The Essentials, by T. Pradeep, TMH.
7. Nanostructured Materials: Processing, Properties and applications, by C. Koch, William Andrew Publishing.

PEMT5305 **COMPOSITE MATERIALS** (3-0-0)

Module I (14 Hours)

Introduction: definitions and classifications; natural composites; role of matrix and reinforcement; factors which determine properties; the benefits of composites.

Reinforcements and the reinforcement matrix interface: natural fibers; synthetic organic fibers – aramid, polyethylene; and synthetic inorganic fibers – glass, alumina, boron, carbon, silicon based fibers; particulate and whisker reinforcements, reinforcement-matrix interface – wettability, interfacial bonding, methods for measuring bond strength.

Metal matrix composites: Introduction, important metallic matrices; metal matrix composite processing: solid state processing – diffusion bonding, powder metallurgy; liquid state processing – melt stirring, compocasting (rheocasting), squeeze casting, liquid infiltration under gas pressure; deposition – spray co-deposition and other deposition techniques like CVD and PVD; in situ processes. Interface reactions. Properties of MMCs – physical properties; mechanical properties like elastic properties, room temperature strength and ductility, properties at elevated temperatures, fatigue resistance. Processing, structure of multifilamentary superconductors, properties of aluminium reinforced with silicon carbide particles.

Module II (12 Hours)

Ceramic matrix composites: Introduction; processing and structure of monolithic materials – technical ceramics, glass-ceramics. Processing of ceramics: conventional mixing and pressing – cold pressing and sintering, hot pressing, reaction bonding processes, techniques involving slurries, liquid state processing – matrix transfer moulding, liquid infiltration, sol-gel processing, vapour deposition techniques like CVD, CVI, liquid phase sintering, lanxide process and in situ processes. Processing, properties and applications of alumina matrix composites - SiC whisker reinforced, zirconia toughened alumina; Glass-ceramic matrix composites; Carbon-carbon composites - porous carbon-carbon composites, dense carbon-carbon composites.

Polymer matrix composites: Introduction; polymer matrices – thermosetting, thermoplastic, rubbers. Processing of PMCs: Hand methods – hand lay-up, spray-up methods; Moulding methods – matched die moulding, bag moulding processes (autoclave moulding), resin transfer moulding, pultrusion; Filament winding; Injection moulding. Processing, properties and applications of fibre-reinforced epoxies, PEEK matrix composites, rubber matrix composites. Damping characteristics. Environmental effects in polymer matrix composites. Recycling of PMCs.

Module III (12 Hours)

Sandwich structures, foam core type arrangements; Honey comb structures.

Micromechanics of unidirectional composites: micromechanics models for stiffness – longitudinal stiffness, transverse stiffness, shear modulus, poisson’s ratio. Micromechanics models for strength – longitudinal tensile strength, longitudinal compressive strength, transverse tensile strength, transverse compressive strength, inplane shear failure, thermal and moisture effects.

Short fibre composites: reasons for using short fibre composites, fibre length, fibre orientation, stress and strain distribution at fibres, critical fibre length and average fibre stress, stiffness and strength: stiffness of aligned systems, non-aligned systems and variable fibre orientation, strength of aligned systems, 2-D composites, variable fibre orientation.

Toughening mechanisms in composite materials: crack bowing, crack deflection, debonding, pull-out, wake toughening, microcrack toughening, transformation toughening.

Books for reference:

1. Composite Materials: Engineering and Science, by Matthews and Rawlings, CRC Press.
2. Composite Materials Science and Engineering, K.K.Chawla, Springer.
3. An Introduction to composite material, by D.Hull and T.W. Clyne, Cambridge University press.
4. Metal Matrix Composites, Thermomechanical Behaviour by M.Taya, and R.J.Arsenault, Pergamon Press, Oxford.
5. Fundamentals of Metal Matrix Composites by S.Suresh, A.Martensen, and A.Needleman, Butterworth, Heinemann

FEME6301 **FINITE ELEMENT METHOD** (3-0-0**)**

Module – I **(12 hours)**

Review of 2-D and 3-D stress analyses, vibration, fluid flow and heat conduction problems.
FEM fundamental concepts, Variational principles, Rayleigh Ritz and Galerkin Methods.
Finite Element Modeling of one dimensional problems.
Finite Element Analysis of 2-D and 3-D framed structures.

Module – II **(12 hours)**

FEM formulation of 2-D and 3-D stress analysis problems.
Axisymmetric solids subjected to axisymmetric loadings.
Two-dimensional isoparametric elements and numerical integration.

Module – III **(12 hours)**

FE modeling of basic vibration problems
Finite element modeling of fluid flow and heat conduction problems
Computer programs: preprocessing and post processing.
Exposure to commercial FE codes such as ANSYS, NASTRAN and IDEAS etc.

Text Books

1. Finite Elements in Engineering, T.R.Chandraputla and A.D.Belegundu, PHI
2. The Finite Element Method – Its Basis & Fundamentals, Zienkiewicz, Taylor and Zhu, Elsevier, 6th Edn

Reference

1. Introduction to Finite Element Method, C.Desai and J.F.Abel, CBS publishers
2. Introduction to Finite Element Method, J.N.Reddy, Tata McGraw Hill
3. Numerical Methods in Finite Element Analysis, K.J.Bathe and E.L.Wilson, PHI
4. Concepts & Applications of Finite Element Analysis,Cook, D.S.Malkus & M.E.Plesha, Wiley
5. The Finite Element Method in Engineering, S.S.Rao, Elsevier
6. A First Course in the Finite Element Method, D.L.Logan, Cengage Learning
7. Fundamentals of Finite Element Analysis, David V. Hutton, Tata McGraw Hill

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

PCCS4304 **OPERATING SYSTEM** (3-0-0)

MODULE-I **12 Hours**

INTRODUCTION TO OPERATING SYSTEM:

What is an Operating System? Simple Batch Systems, Multiprogramming and Time Sharing systems. Personal Computer Systems, Parallel Systems, Distributed Systems and Real time Systems.

Operating System Structures: Operating System Services, System components, Protection system, Operating System Services, system calls

PROCESS MANAGEMENT:

Process Concept, Process Scheduling, Operation on Processes, Interprocess communication, Examples of IPC Systems, Multithreading Models, Threading Issues, Process Scheduling Basic concepts, scheduling criteria, scheduling algorithms, Thread Scheduling.

MODULE-II **12 Hours**

PROCESS COORDINATION: Synchronization: The Critical section problem, Peterson's solution, Synchronization hardware, Semaphores, Classical problems of synchronization, Monitors.

Deadlocks: System model, Deadlock Characterization Methods for Handling Deadlocks, Deadlock Prevention, Deadlock avoidance, Deadlock Detection, recovery from Deadlock.

MEMORY MANAGEMENT: Memory Management strategies, Logical versus Physical Address space, swapping, contiguous Allocation, Paging, Segmentation.

Virtual Memory: Background, Demand paging, performance of Demand paging, Page Replacement, Page Replacement Algorithms. Allocation of frames, Thrashing, Demand Segmentation.

MODULE-III **11 Hours**

STORAGE MANAGEMENT:

File System Concept, Access Methods, File System Structure, File System Structure, File System Implementation, Directory implementation, Efficiency and Performance, Recovery, Overview of Mass Storage Structure, Disk Structure, Disk Scheduling, Disk Management, Swap-Space Management, I/O System Overview, I/O Hardware, Application I/O Interface, Kernel I/O Subsystem, Transforming I/O Request to Hardware Operation.

CASE STUDIES: The LINUX System, Windows XP, Windows Vista

TEXT BOOK:

1. **Operating System Concepts –** Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, 8th edition, Wiley-India, 2009.
2. **Mordern Operating Systems –** Andrew S. Tanenbaum, 3rd Edition, PHI
3. **Operating Systems:** A Spiral Approach – Elmasri, Carrick, Levine, TMH Edition

REFERENCE BOOK:

1. **Operating Systems –** Flynn, McHoes, Cengage Learning
2. **Operating Systems –** Pabitra Pal Choudhury, PHI
3. **Operating Systems –** William Stallings, Prentice Hall
4. **Operating Systems –** H.M. Deitel, P. J. Deitel, D. R. Choffnes, 3rd Edition, Pearson

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

PCMT7305 **PROCESS METALLURGY LABORATORY** (0-0-3)

1. Kinetic studies of oxidation of copper.
2. Kinetic studies of reduction of iron ores.
3. Kinetic studies of decomposition of calcium carbonate.
4. Kinetic studies of decomposition of magnesium carbonate.
5. To study the flow of gases through beds of solid particles.
6. Determination of heat transfer coefficient by using Newton's Law of cooling.
7. Leaching of sulphide ores.
8. Press moulding of polymers and polymer based composites.
9. Compaction of metal powders and determination of green density.
10. Sintering of metal powders and determination of sintered density.

PCMT7304 **TESTING OF MATERIALS LAB.** (0-0-3)

1. To determine the Vickers Hardness Number of the given Samples.
2. To determine the Brinell Hardness Number of the given Samples.
3. To determine the Rockwell Hardness of the given samples.
4. To determine the impact strength of the given samples by Charpy and Izod Impact Tests.
5. To determine the tensile properties of the given materials using Universal Testing Machine (UTM) – yield strength, tensile strength, % elongation, % reduction of area.
6. To determine the compression strength of the given sample.
7. To determine the fatigue strength of the given sample.
8. To determine the drawability of aluminium / steel sheet by Erichsen cup test.
9. To study the ultrasonic flaw detector and determine the cracks within a sample.
10. To determine the cracks in a sample using the magnetic crack detector.

PCMT7306 **COMPUTER APPLICATIONS IN METALLURGICAL ENGINEERING LAB.** (0-0-3)

1. Numerical problems relevant to different pyro- , hydro- and elctrometallurgical processes.
2. Numerical problems based on transport phenomena in metallurgical systems – heat balance in furnaces, gas stirred ladle, continuous casting etc.
3. Numerical problems on charge calculations, materials balance and heat balance in different metallurgical processes.
4. Numerical problems on kinetic studies of reactions in different metallurgical processes.
5. Calculations based on XRD data of d values, lattice parameter, intensity of diffraction lines.

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BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ORISSA

Metallurgical and Materials Engineering

7th SEMESTER				8th SEMESTER			
Code	**THEORY Subject**	**L-T-P**	**Credits**	**Code**	**THEORY Subject**	**L-T-P**	**Credits**
PCMT4401	X-Ray and Electron Microscopy	3-0-0	3	HSSM3402	Environmental Engineering	3-0-0	3
PCMT4402	Steel Making	3-0-0	3	PCMT4404	Materials for Advanced Applications	3-0-0	3
PCMT4403	Corrosion & Degradation of Materials	3-0-0	3				
					Professional Elective – VI(Any one)		
	Professional Elective – IV(Any one)	3-0-0	3	PEMT5407	Ferroalloys Technology	3-0-0	3
PEMT5401	Non Ferrous Extractive Metallurgy			PEMT5409	Alternative Routes of Iron Making		
PEMT5402	Surface Engineering			PEMT5410	Electrometallurgy		
PEMT5403	Engineering Polymers						
		3-0-0			Free Elective – VI (Any one)	3-0-0	
	Professional Elective – V(Any one)		3	PEEI5403	Industrial Instrumentation		3
PEMT5404	Joining of Materials			HSSM3403	Marketing Management		
PEMT5405	Biomaterials			FEMT6401	Total Quality Management		
PEMT5406	Advanced casting processes			PECE5404	Process Simulation & Modeling		
		3-0-0					
	Free Elective – V (Any one)		3				
PEEE5402	Industrial Automation & Control						
PEEC5403	Biomedical Instrumentation						
HSSM3401	Entrepreneurship Development						
PEEE5401	Soft Computing	18				12	
					Theory Contact Hours		
	Theory Contact Hours						
	Theory Credits	0-0-6	18				
		0-0-3			Practical / Sessional	0-0-9	
	Practical / Sessional		4	PCMT7403	Project – II	0-0-3	
PCMT7401	Project – I	09	2	PCMT7405	Comprehensive Viva Voce	0-0-3	6
PCMT7402	Seminar – I	24		PCMT7404	Seminar –II	12	2
					Practical Contact Hours	22	2
	Practical Contact Hours				Total Contact Hours		
	Total Contact Hours						
					Practical / Sessional Credits		
	Practical / Sessional Credits		6				10
	TOTAL SEMESTER CREDITS		**24**		**TOTAL SEMESTER CREDITS**		**22**
	TOTAL CUMULATIVE CREDITS		**182**		**TOTAL CUMULATIVE CREDITS**		**204**

X-RAY AND ELECTRON MICROSCOPY (3-0-0)

Module I (12 Hours)

Introduction to x-ray and properties of x-ray: Continuous characteristics x-ray, absorption, filter, production and detection of x-rays. Diffraction of x-rays; special topics on crystallography, directions and intensities of diffracted beams.

Module II (14 Hours)

Experimental methods in x-ray analysis; Laue methods, powder photographs diffractometer and spectrometer measurements. Applications: orientation of single crystal, crystal structures of polycrystalline materials, precise lattice parameter measurements. Calculation of integrated intensity, structure factor calculation.
Application: Phase diagram, order-disorder transformation, chemical analysis, residual stress, texture.

Module III (12 Hours)

Electron optical methods: (a) Scanning electron microscopy and X-ray microanalysis including electron probe microanalysis, electron optics, electron beam specimen interaction, image formation in the SEM. X-ray spectral measurements: WDS and EDS, quantitative X-ray analysis.

(b) Analytical transmission electron microscopy: Electron diffraction, reciprocal lattice, analysis of SAD patterns; different electron diffraction techniques, atomic resolution microscopy, analytical devices with TEM, field ion microscopy, scanning tunneling microscopy, advanced techniques.

Books for reference:

1. Elements of X-Ray Diffraction by B. D. Cullity, Adison-Wesley.
2. Scanning Electron Microscopy and X-Ray Microanalysis, by J.I. Goldstein, C. E. Lyman
3. Structure of Metals by C. Barret and T. B. Massalski, Pergamon.
4. X-ray Diffraction – its Theory and Applications by S. K. Chatterjee, Prentice Hall of India.
5. Physical Metallurgy Principles by R. E. Reed-Hill.
6. Transmission Electron Microscopy by Williams, D.B. and Barry Carter C., Plenum Press.
7. Materials Characterization, Metals Handbook, Vol. 10, ASM
8. Characterization of Materials, by E N Kaufman, Wiley Publishers.

STEEL MAKING (3-0-0)

Module I (12 Hours)

Introduction: History of steel making, principles of steel making reactions viz decarburization, desulphurization, dephosphorisation, silicon and manganese reactions.

Slag theories: Molecular and ionic theories; interpretation of the above reactions in terms of ionic theory of slags.

Open Hearth steel making practices.

L.D. Process: Design of converter and lance; quality of raw materials charged, operation, control of bath and slag composition, chemical reactions involved, temperature and residual bath oxygen control, use of oxygen sensor; some characteristics of L.D blow viz. emulsion formation, slopping, maneuvering lance height for dephosphorisation and decarburization. Catch Carbon technique. Recovery of waste heat.

Module II (14 Hours)

OBM/Q-BOP process: Concept and operation of the process.

Mixed / Combined blowing processes: Oxygen top blowing with inert gas purging at bottom; oxygen top blowing with inert and oxidizing gases at bottom, oxygen top and bottom: status in India.

Electric arc furnace: Advantages, charging, melting and refining practices for plain carbon and alloy steel; uses of DRI in arc furnace and its effect on performance. UHP electric arc furnace with D.C supply, single graphite electrode, oxygen lancing, oxyfuel burner, water cooled panel and computer control. Combination of blast furnace: EAF. Duplex processes of stainless steel making using VOD, AOD and CLU.

Induction Furnace: Special features, advantages and limitation.

Module III (12 Hours)

Deoxidation of liquid steel: Requirements of deoxidizers, deoxidation practice, stoke's law, use of complex deoxidizers. Inclusions and their influence on quality of steel. Killed, semi-killed and rimming steel.

Secondary refining of steel: Objectives; principles of degassing different industrial process such as DH, RH, VAD, SD, LF, and ESR; limitations and specific applications.

Continuous Casting of steel: Advantages; types of machines; mould lubrication and reciprocation. Development in C.C. Technology with respect to productivity, quality and energy conservation; Near Net Shape Casting.

Pollutant emissions from steel making processes and their control. Management of wastes from steelmaking operations.

Books for reference:

1. Ironmaking and Steelmaking Theory and Practice by A. Ghosh and A. Chatterjee, PHI.
2. Steel Making by A.K.Chakravorty, PHI

3. Physical Chemistry of Iron and Steel Manufacture by C. Bodsworth, Longman Green & Co.
4. Physical Chemistry of Iron and Steel Making by R.G.Ward, ELBS and Edward Arnold 1962.
5. The Making Shaping and Treating of Steel (Steelmaking Volume), R.J.FruehN (ed.), The AISE Steel foundation.
6. Electric Furnace Steel Making: Design, Operation & Practice, Vol. I &II, by C.E.Sims (ed), Interscience.
7. Theoretical Principles of Electric Steel Making by V.Atanseyev, Mir Publishers, Moscow
8. Introduction to Modern Steel Making by R.H.Tupkary, Khanna Publishers, New Delhi1977.
9. Principles of Secondary Processing and Casting of Liquid Steel by A.Ghosh, Oxford &IBP 1990.
10. Electrometallurgy of Steel and Ferro-Alloys , Vol I, by F.P.Edneral, Mir Publishers.
11. Proceeds of International Workshop on Environmental and Waste Management in Iron and Steel Industries, Dec 2 – 3, 1999, NML Jamshedpur.

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.

NONFERROUS EXTRACTIVE METALLURGY (3-0-0)

Module-I (12 hrs)

Fundamentals of Unit processes involved in Metal Extraction. Thermodynamic considerations and process selection in Pyro-metallurgical extraction of metals.

Kinetics of leaching of ores; effect of various operating variables on leaching process; bio leaching.
Principles involved in Electro-metallurgical extraction of metals.

Module-II (14 hrs)

Extraction of metals from oxide ores (Sn, Mg).

Extraction of metals from Sulphide ores (Cu, Ni, Pb and Zn)

Extraction of metals through halide route (Ti and Zr)

Refining involving oxidation, chemical transport reactions, zone refining, distillation, etc.

Ion exchange and solvent extraction processes and their application in extraction processes (Zr, V, Th, Nb, etc)

Module-III (12 hrs)

Electro winning and Electro refining of metals:

a) From aqueous salts (Cu, Ni, Au, Ag)

b) From fused salts (Al and Mg)

Environmental pollution and its address related to various metal extraction processes in general.

Books for reference :

1. Extraction of Non Ferrous Metals by H.S.Ray, R.Sridhar & K.P.Abraham, Affiliated East –West Press, New Delhi
2. Extraction and Refining of Metals, by C. Bodsworth, CRC Press.
3. Metallurgy of Non Ferrous Metals by W.H.Dennis, Pitman.
4. Principles of Extractive Metallurgy, by T. Rosenquist, McGraw hill, 1974
5. Non Ferrous Production Metallurgy by J.I.Bray, John Wiley, N.Y.
6. General Metallurgy by N.Severykov et al, Mir Publishers, Moscow.
7. Rare Metal Extraction by Chemical Engg. Tech. by W.D.Jamrack, Pergamon Press, Oxford.

SURFACE ENGINEERING (3-0-0)

Module – I (12 hours)

Importance and necessity of surface engineering; classification and scope of surface engineering in metals, ceramics, polymers and composites, Surface dependent engineering properties, - wear, friction, corrosion, fatigue, reflectivity, emissivity; common surface initiated engineering failures; mechanism of surface degradation.

Module – II (12 hours)

Conventional surface engineering methods: carburising, nitriding, cyaniding, diffusion coating, hot dipping, galvanizing. Scope and application of conventional surface engineering techniques in engineering materials; advantages and limitations of conventional processes. surface modification by directed energy beams like ion, electron and laser beams; energy transfer, beam configuration and modes, surface integration, heat and mass transfer (composition and temperature profile) during directed energy beam irradiation; novelty of composition and microstructure; post irradiation characterization (microstructural & compositional) and testing/evaluation of surface-properties; structure-property correlation.

Module –III (12 hours)

Recent trends in surface engineering: Coatings and Thin Films and their applications; Stress, defect formation and surface evolution; classification of Processing routes; Physical/chemical vapour deposition, plasma spray coating, plasma assisted ion implantation, Sol-gel processing, Langmuir-Blodgett films, Electrodeposition; Characterization; Thickness, residual stress, morphology, adhesion.

Books for Reference:

1. Surface engineering of metals - principles, equipments, technologies, by Tadeusz Burakowski and Tadeusz Wierzchon, CRC press.
2. ASM Handbook on Surface Engineering.
3. M. Ohring, Materials Science of Thin Films, 2nd Edition, Academic Press, 2002.
4. L. I. Tushinsky, I. Kovensky, A. Plokhov, V. Sindeyev, P. Reshedko, Coated Metal: Structure and Properties of Metal-Coating Compositions, Springer, Germany, 2002.

ENGINEERING POLYMERS (3-0-0)

Module I (14 hours)

Characteristics of Polymers

Introduction to polymers structures and polymer technical merits; structures; Physical behaviour: Crystallization, Melting, Glass Transition Phenomena and mixing behavior; Factors affecting Melting and Glass Transition Temperatures. Mechanical Behaviour: Stress–Strain Behaviour, Macroscopic Deformation, Viscoelastic Deformation – viscoelasticity; Viscoelastic Relaxation Modulus; Viscoelastic Creep, Fracture of Polymers, Impact Strength, Fatigue, Tear Strength and Hardness. Mechanisms of Deformation And Strengthening Of Polymers : Deformation of Semicrystalline Polymers- Mechanism of Elastic Deformation, Mechanism of Plastic Deformation. Factors That Influence the Mechanical Properties of Semicrystalline Polymers- Molecular Weight, Degree of Crystallinity, Predeformation by Drawing, Heat Treating. Deformation of Elastomers, Vulcanization; Chemical behaviour.

Module II (14 hours)

Polymers in advanced engineering

Polymer Matrix Composites (PMCs); Types, Manufacturing, Processing methods, Interfaces, Properties, Applications, Toughening Mechanisms, Matrix –Reinforcement Interface, Wettability, Interactions at Interface, Interfacial Bonding Types, Interfacial Strength Tests, The role of the interface. Conductive Polymers, Liquid crystal polymers, Industrial Polymer adhesive, Polymer in biomedical applications, Ultrahigh Molecular Weight Polymers, high performance polymers.

Module III (10 hours)

Synthesis and Processing of Polymers

Polymerization: Addition polymerization, Condensation Polymerization

Polymer Additives: Fillers, Plasticizers, Stabilizers, Colorants, Flame Retardants,

Forming Techniques for Plastics: Moulding – Compression and Transfer Moulding; Injection Moulding, Reaction and Reinforced Reaction Injection Moulding, Thermoforming, Extrusion, Blow Moulding, Casting. Fabrication of Elastomers. Fabrication of Fibers and Films: Spinning, Calendaring.

Books for reference:

1. Introduction to Polymers by Young and Lovell, Nelson Thomes.
2. Materials Science and Engineering - An Introduction by William D. Callister, Jr., John Wiley & Sons.
3. Plastics: Materials and Processing by Brent A Strong, Prentice Hall Inc., USA. 1997.
4. An Introduction to Polymer Chemistry by Raymond Seymour, McGraw-Hill Book Co., New York, USA,1971.
5. Handbook of Plastics, Elastomers and Composites by Charles A Harper, McGraw-Hill Publishing Co., USA, 1997.
6. Principles of Polymer Engineering by McCrum N.G., Buckley C P. and Bucknall C.B., Oxford University Press, UK, 1992.

JOINING OF MATERIALS (3-0–0)

Module I (12 Hours)

Theory and classification of welding processes Gas, arc, resistance, pressure, submerged arc, TIG, MIG, plasma arc and electron beam welding including spot welding laser welding and diffusion welding.

Mass and heat flow in fusion welding. Metallurgical effects of the weld thermal cycles.

Module II (14 Hours)

Metallurgy of welding of structural steels, HAZ. Metallurgy of fusion welding of ferritic and austenitic steels, cast iron etc. welding pool solidification.

Metallurgical principles of welding nonferrous alloys, Cu alloys, Al alloys etc., welding pool solidification, structure of welds, heat treatment and transformation.

Module III (12 Hours)

Welding stresses and stress relieving treatments.

Design of welded joints, welding defects and their remedies. Inspection and testing of weldments.

Brazing and soldering. Joining of ceramics and plastics.

Books for reference:

1. Metallurgy of Welding, by J.F.Lancaster, Allen and Unwin.
2. Welding and Welding Technology by R.L.Little, TMH.
3. Welding by A.C. Davies, Cambridge University Press.
4. Metallurgy of Welding by Sefarin, John Wiley.
5. Welding Processes Hadbook, K. Weman, Woodhead.

BIOMATERIALS (3-0-0)

Module I (12 Hours)

Introduction: Definition of Biomaterials: Performance of Biomaterials; Brief Historical Background.

Metallic Implant Materials: Stainless Steels; Co-Based Alloys; Ti and Ti-Based Alloys; Dental Metals; Other Metals; Corrosion of Metallic Implants.

Ceramic Implant Materials: Structure–Property Relationship of Ceramics; Aluminum Oxides (Alumina); Zirconium Oxides (Zirconia); Calcium Phosphate; Glass-Ceramics; Other Ceramics; Carbons; Deterioration of Ceramics.

Module II (12 Hours)

Polymeric Implant Materials: Polymerization and Properties; Effect of Structural Modification and Temperature on Properties; Polymeric Implant Materials; High-Strength Thermoplastics; Deterioration of Polymers.

Composites as Biomaterials: Structure; Mechanics of Composites; Applications of Composite Biomaterials; Biocompatibility of Composite Biomaterials.

Structure–Property Relationships of Biological Materials: Proteins; Polysaccharides; Structure–Property Relationship of Tissues.

Tissue Response to Implants: Normal Wound-Healing Process; Body Response to Implants; Blood Compatibility; Carcinogenicity.

Module III (12 Hours)

Soft Tissue Replacement: Sutures, Skin, and Maxillofacial Implants: Sutures, Surgical Tapes, and Adhesives; Percutaneous and Skin Implants; Maxillofacial and Other Soft-Tissue Augmentation.

Blood Interfacing Implants: Blood Substitutes and Access Catheters; Cardiovascular Grafts and Stents; Blood Vessel Implants; Heart Valve Implants; Heart and Lung Assist Devices; Artificial Organs.

Hard Tissue Replacement: Long Bone Repair: Wires, Pins, and Screws; Fracture Plates; Intramedullary Devices; Acceleration of Bone Healing.

Joints and Teeth: Joint Replacements; Spinal Implants; Dental Restorations and Implants; Interface Problems in Orthopedic and Dental Implants.

Books for reference:

1. Biomaterials-An Introduction, 3rd Ed., by Joon Park & R.S. Lakes, Published by Springer.
2. Biomaterials Science:An Introduction to Materials in Medicine, edited by B.D.Ratner, A.S.Hoffman, F.J.Schoen, J.E.Lemons, Academic Press.

ADVANCED CASTING PROCESSES (3-0-0)

Module I (14 Hours)

Molding materials for special casting processes and special castings. Automation and mechanization of molding, Mold and die coatings, Testing of binders and base sand.

Modes of solidification, Casting properties: fluidity, shrinkage and stresses in castings, Mechanism of grain refinement and modification/ inoculation of aluminum alloys, magnesium alloys and cast iron. Degassing and inclusion control in castings.

Module II (14 Hours)

Semi-solid casting processes, compo-casting, directional solidification, solute redistribution, zone refining and zone melting, counter pressure casting, squeeze casting, casting of single crystal turbine blades, Near net shape casting: strip casting.

Casting design, planning and selection of casting technology, Optimum pouring time and gating system design, riser design, feeding resistance, methods for improving riser efficiency, use of chills.

Module III (12 Hours)

Melting and casting of special metals and alloys, alloy cast irons and cast steels, heat and acid resistant aluminum alloys, cast magnesium alloys, zinc and lead alloys.

Casting defect analysis and remedies.

Books for reference:

1. Science and Engineering of Casting Solidification by Doru Michael Stefanescu.
2. Solidification in cast House by H. Fredrickson.
3. Metals Handbook, volume 15.
4. Casting Handbook by J. Campbell, Butterworth - Haneman, London, 1993.
5. Solidification Processing by M.C. Flemings, , McGraw Hills, 1974.

6. Principles of Metal Casting by Hein R.W., Loper C. R. & Rosenthal P.C, T.M.H.

INDUSTRIAL AUTOMATION AND CONTROL

(**Prerequisite: Control System Engineering – I**)

Module I: **(12 Hours)**

Process Control: Introduction: Process Definition, Feedback Control, PID Control, Multivariable Control. (Chapter 1 of Text Book 1)

PID Controller Tuning: Introduction, Zeigler-Nichols Tuning Method (Based on Ultimate Gain and Period, and Process Reaction Curve), Digital PID Controllers. (Chapter 13 of Text Book 2)

Module II: **(15 Hours)**

Special Control Structures: Cascade Control, Feedfroward Control, Feedfroward-Feedback Control Configuration, Ratio Control, Selective Control, Adaptive Control, Adaptive Control Configuration. (Chapter 10 and 11 of Text book 3)

Actuators: Introduction, Pneumatic Actuation, Hydraulic Actuation, Electric Actuation, Motor Actuators and Control Valves. (Chapter 8 of Text Book 1)

Module III: **(10 Hours)**

Industrial Automation: Programmable Logic Controllers: Introduction, Principles of operation, Architecture, Programming (Programming Languages, Ladder Diagram, Boolean Mnemonics) (Chapter 5 of Text Book 1)

Distributed Control: Distributed vs. Centralized, Advantages, Functional Requirements, System Architecture, Distributed Control Systems (DCS), Communication options in DCS. (Chapter 6 of Text Book 1)

Real-time Programming: Multi-tasking, Task Management, Inter-task Communication, Real-time Operating System. (Chapter 9 of Text Book 1)

Text Books:

1. Krishna Kant, “Computer-Based Industrial Control”, PHI, 2009.
2. M. Gopal, “Digital Control and State Variable Methods” Tata McGraw Hill, 2003.
3. Surekha Bhanot, Process Control: Principles and Applications, Oxford university Press, 2010

Reference Books:

1. Smith Carlos and Corripio, “Principles and Practice of Automatic Process Control”, John Wiley & Sons, 2006.
2. Jon Stenerson, “Industrial Automation and Process Control”, Prentice Hall, 2003.
3. C. Johnson, “Process Control Instrumentation Technology”, PHI, New Delhi
4. D.R. Coughnowr, “Process System analysis and Control”, McGraw Hill.

BIOMEDICAL INSTRUMENTATION

Module – I **(10 Hours)**

Fundamentals of Biomedical Instrumentation: Sources of Biomedical Signals, Basic Medical Instrumentation System, Intelligent Medical Instrumentation Systems, PC Based Medical Instrumentation Systems, General Constraints & Regulations of Medical Devices

Biomedical Signals & Electrodes: Origin of Bioelectric Signals-Repolarization, Depolarization, Resting Potential Recording Electrodes – Ag-AgCl Electrodes, Electrodes for ECG, EEG, EMG, Microelectrodes, Skin Contact Impedance, Motion Artifacts

Module – II **(13 Hours)**

Physiological Transducers: Introduction to Physiological Transducers, Classification of Transducers, Pressure Transducers, Transducers for Body Temperature Measurement, Biosensors, Smart Sensors

Biomedical Recording Systems: Basic Recording Systems, General Considerations for Signal Conditioners, Biomedical Signal Analysis Techniques, Signal Processing Techniques, Writing Systems: Direct Writing Recorders, Inkjet Recorder, Potentiometric Recorders, Digital Recorders

Biomedical Recorders: Electrocardiograph (ECG), Phonocardiograph, Electroencephalograph (EEG), Electromayograph (EMG)

Module – III **(14 Hours)**

Patient Monitoring Systems: System Concepts, Measurement of Heart Rate, Blood Pressure Measurement, Measurement of Respiration Rate

Blood Flow meters: Electromagnetic Blood Flow meter, Ultrasonic Blood Flow meter, NMR Blood Flow meter, Laser-Doppler Blood Flow meter

Patient Safety: Electric Shock Hazards, Leakage Currents, Safety Codes for Biomedical Equipment

Text Books:

1. Hand Book of Biomedical Instrumentation-2nd Edition by R.S.Khandpur, Tata McGraw Hill 2003 (Chapters 1-6,11,18)
2. Biomedical Instrumentation and Measurements-2nd Edition by Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, PHI learning Pvt Ltd 2nd Edition

Reference Books:

1. Introduction to Biomedical Equipment Technology-4th Edition by Joseph J. Carr, John M. Brown, Pearson Education 2007

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

SOFT COMPUTING (3-0-0)

MODULE-I **(12 Lectures)**

Introduction: Soft Computing Constituents and Conventional Artificial Intelligence, Neuro-Fuzzy and Soft Computing Characteristics.

Fuzzy Sets: Introduction, Basic Definitions and Terminology, Set Theoretic Operations, MF Formulation and Parameterization.

Fuzzy Rules & Fuzzy Reasoning: Extension Principle and Fuzzy Relations, Fuzzy If-Then Rules, Fuzzy Reasoning.

Fuzzy Inference Systems: Mamdani Fuzzy Models, Sugeno Fuzzy Models, Tsukamoto Fuzzy Models, Other Considerations.

(BOOK-1:- Chap-1: 1.1 to 1.3, Chap-2: 2.1 to 2.4, Chap-3: 3.2 to 3.4 & Chap-4: 4.2 to 4.5)

MODULE-II **(14 Lectures)**

Neural Networks: Neuron Abstraction, Neuron Signal Functions, Mathematical Preliminaries, Neural Networks Defined, Architectures: Feed forward and Feedback, Salient Properties and Application Domains of Neural Networks, Multi-layered Network Architectures, Back-propagation Learning Algorithm, Practical Considerations in Implementing the BP Algorithm, Structure Growing Algorithms, Universal Function Approximation and Neural Networks, Applications of Feed Forward Neural Networks, Reinforcement Learning, Radial Basis Function Networks, Regularization Theory Route to RBFNs, Generalized Radial Basis Function Network, Learning in RBFNs, Associative Learning, Hopfield Network, Content Addressable Memory, Bidirectional Associative Memory, Self Organizing Feature Maps, Applications of the Self Organizing Map.

(BOOK-2:-Chap-3: 3.1 to 3.6, Chap-6: 6.1 to 6.2, 6.5 to 6.6 & 6.8 to 6.10, Chap-8: 8.4 to 8.7,

Chap-10: 10.2 & 10.5 to 10.6 & 10.16 and Chap-12: 12.8 to 12.9)

MODULE-III **(08 Lectures)**

Regression & Optimization: System Identification: an Introduction, Least Squares Estimator, Geometric Interpretation of LSE, Recursive Least Squares Estimator.

Derivative-Free Optimization: Genetic Algorithms, Simulated Annealing, random Search, Downhill Simplex Search.

Adaptive Neuro-Fuzzy Inference Systems (ANFIS): ANFIS Architecture, Hybrid Learning Algorithm.

(BOOK-1:- Chap-5: 5.1, 5.3 to 5.5, Chap-7: 7.2 to 7.5 and Chap-12: 12.2 to 12.3)

TEXT BOOK:

1. "***Neuro-Fuzzy and Soft Computing***" By J.-S.R.Jang, C.-T.Sun & E. Mizutani, PHI
2. "***Neural Networks: A Classroom Approach***" By Satish Kumar, TMH Education

Reference Book:

1. "***Neural Networks Fuzzy Logic & Genetic Algorithms; Synthesis & Applications,*** *S.Rajasekaran & G.A. VijayaLaxmi Pai, Prentice Hall, India, May'2006- LakshmiPai*
2. Principle of Soft Computing, S.N. Sivanandan & S.N. Deepa, Wiley India Edition,2010.

8TH SEMESTER

ENVIRONMENTAL ENGINEERING (3-0-0)

Objective: This course introduces the students to the environmental consequences of Industries, development actions etc. and the methods of minimizing their impact through technology and legal systems.

Module – I

Ecological Concepts and Natural Resources: Ecological perspective and value of environment. Environmental auditing, 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, Global Perspective.

Chemistry in Environmental Engineering: Atmospheric chemistry, Soil chemistry, Material balances and Reactor configurations.

Module – II

Water Pollution: water quality standards and parameters, Assessment of water quality, Aquatic pollution, Estuarine water quality, Marine pollution, Organic content parameters, Ground water Contamination, Water table and Aquifer, Ground water recharge. Water quality parameter and standards.

Water Treatment: Water treatment processes, Pre-treatment of water, Conventional process, Advanced water treatment process.

Waste Water Treatment: DO and BOD of Waste water treatment process, pretreatment, primary and secondary treatment of waste water, Activated sludge treatment: Anaerobic digestion and its microbiology, Reactor configurations and methane production. Application of anaerobic digestion.

Air Pollution : Air pollution and pollutants, criteria pollutants, Acid deposition, Global climate change –green house gases, non-criteria pollutants, emission standard form industrial sources, air pollution metereology, Atmospheric dispersion.

Industrial Air Emission Control:

Characterization of air stream, Equipment selection, Equipment design, Special Methods: Flue gas desulphurization, NOx removal, Fugitive emissions.

Module – III

Solid Waste Management Source classification and composition of MSW: properties and separation, storage and transportation, MSW Management, Waste minimization of MSW, Reuse and recycling,

Hazardous Waste Management, Hazardous waste and their generation, Transportation and treatment of hazardous waste: Incinerators, Inorganic waste treatment, handling of treatment plant residue. Waste minimization techniques.

Noise Pollution: Physical Properties of sound, Noise criteria, Noise Standards, Noise measurement, Noise control. Environment impact Assessment, Origin and procedure of EIA, Project Screening for EIA, Scope studies, Preparation and review of EIS.

Text Book

1. Environmental Engineering Irwin/ McGraw Hill International Edition, 1997, G. Kiely,

2.Environmental Engineering & Safety by Prof B.K. Mohapatra, Seven Seas Publication, Cuttack

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.

MATERIALS FOR ADVANCED APPLICATIONS (3-0–0)

Module – I (14 hours)

Introduction: The urge for advancement in materials development and processing, Special and high temperature alloys: Ti alloys: physical and mechanical properties, thermo-mechanical treatment of Ti-alloys, Ti shape memory alloys, Fe based super alloys, Ni based alloys, Co based alloys, engineering applications at elevated temperatures.

Metallic Foams: Material Definition and Processing, Characterization of cellular metals, Material properties and applications.

Module – II (12 hours)

Carbon and alloy steels: high strength low alloy structural steels, medium-high carbon ferrite-pearlite steels, common alloy steels, Tool steels: classification, composition, structure, properties, heat treatment and uses of different types of tool steels, Special steels: heat resisting steels, Hadfield manganese steels, TRIP steels, maraging steels, dual phase steels.

Module –III (12 hours)

Composite Materials: Material definition and classifications, Advanced polymer composite, Ceramic composite, Metal matrix composite, Nanocomposite, Applications. Coatings and thin films: Definition, Classification of applications, Bio-Materials: Various types of biomaterials, Biopolymer, Bioceramics, Nanostructured bio-materials, Classes of materials used in medicine, Application of materials in medicine and dentistry, Various materials and coatings for implants.

Books for reference:

1. Engineering Materials – properties and selection by K.G. Budinski and M.K. Budinski, PHI.
2. Intermetallic Compounds, Volume 1- 4, by J. H. Westbrook (Editor), R. L. Fleischer (Editor), Wiley.
3. Structure-Property Relations in Nonferrous Metals by Alan Russell, Kok Loong Lee, Wiley.
4. Physical Metallurgy Principles by R. E. Reed-Hill
5. Structure and Properties of Alloys by R. M. Brick, R. B. Gordon and A. Phillips
6. Introduction to Materials Science and Engineering by J. F. Shackelford.
7. Physical Metallurgy of Steels by W.C.Leslie, McGraw-Hill.
8. Introduction to Physical Metallurgy by S.H.Avener, McGraw-Hill.
9. Introduction to Material Science and Engineering by Callister, Wiley.
10. Edited by B.D. Ratner, A.S. Hoffman, F.J. Sckoen, and J.E.L Emons, *Biomaterials Science, An Introduction to Materials in Medicine*, Academic Press, Second edition, 2004.

FERROALLOYS TECHNOLOGY (3-0-0)

Module I (14 Hours)

Survey of Ferro-alloy industries in India and their future prospects.
Physico-chemical principles of ferro-alloy making, principles of carbothermic and metallothermic reduction.

Ferro-alloy furnaces: Submerged arc furnaces, selection for transformer capacity, secondary voltage and current, furnace dimensions, size and spacing of electrodes, mechanical equipments, charging devices and dust collection system.

Electrodes used in ferro-alloy furnaces: graphitised and self baking electrodes, properties and uses.

Module II (12 Hours)

Production of ferro-manganese, ferrochrome, ferrosilicon and silico-calcium by carbothermy, production of FeCr, FeTi, FeB, FeNb, FeMo, and FeV by metallothermy. Recovery of vanadium from ores and production of FeV.

Module III (10 Hours)

Charge calculation in production of ferro-alloys.
Use of plasma arc for production of ferro-alloys.
Use of ferro-alloys in Iron and Steel industries (deoxidation and alloy making).

Books for reference:

1. Production of Ferro-Alloys by Riss and Khodorovasky.
2. Production of Ferro-Alloys by V.P. Elyutin.
3. Electro-metallurgy of Steel and Ferro-Alloys, Vol. 2, by F.P.Edneral.
4. Ferro-Alloy Industries in India, Symposium NML, Jamshedpur, 1962.
5. Proc. Symp. of All India Seminar on Recent Trends in Ferro-Alloys Technology, Nagpur, December, 1977.

ALTERNATIVE ROUTES OF IRON MAKING (3-0-0)

Module I (12 Hours)

Characteristics of raw materials and their preparation. Thermodynamics and Kinetics aspects.

Direct Reduction Processes:
Reduction of Iron bearing materials in shaft furnace, rotary kiln, retort and fluidized bed with special reference to reductant, energy consumption and operational problems.

Module II (14 Hours)

Commercially available processes like SL/RN, ACCAR, Krup-CODIR, Kinglon Meter, MIDREX, HyL, Purofer, Iron Carbide, etc.

Uses of DRI in steel making, iron making and foundries; effect on DRI on EAF performance and product characteristics.

Module III (12 Hours)

Smelting Reduction Processes:
COREX, ROMELT, Fluidized bed reactors, Hismelt etc. Present status of alternative methods of iron making in India.

Books for reference:

1. Alternative Routes of Iron Making by Amit Chatterjee, PHI.
2. Beyond the Blast Furnace by Amit Chatterjee.
3. Sponge Iron Production in Rotary Kiln by A.Sarangi and B.Sarangi, PHI.
4. Direct Reduction of Iron, Editiors: Jerome Feinman & Donald R.Mac Rae, Allied Publishers Ltd.

ELECTROMETALLURGY (3-0-0)

Module I (12 Hours)

Principles of Electrochemistry: Equilibrium Potential; Nernst Equation; Polarization and over voltage; EMF and Galvanic Series.

Module II (12 Hours)

Electroplating: Principles of electrodeposition of single Metals and alloys; preplating operations; plating baths; throwing power; electroless plating; electroforming; testing of electrodeposits; Anodic Electrometallurgical Processes-Anodizing, Electro-cleaning, Electro-polishing, Electrolytic etching, Electrolytic machining and grinding

Module III (12 Hours)

Electro winning and Electro refining: special features of electrochemical extraction & refining of metals and electrochemical extraction & refining of important metals like copper, zinc and aluminium.

Books for Reference:

1. Introduction to Electrochemistry, by S. Glasstone.
2. An Introduction to Electrometallurgy, by Sharan & Narain, Standard Publishers Distributors, Delhi
3. Electrochemical Engineering, by Mantell.
4. Principles of Electroplating and Electroforming, by Blum and Hogaboom. Fundamental aspects of electrometallurgy, by K.I.Popov, S.S. Djokic, B.N.Grgur, Kluwer Academic / Plenum Publishers

INDUSTRIAL INSTRUMENTATION

Module 1 **18 Hours**

Introduction: Functional Units, Classification, Performance characteristics, Dynamic Calibration, Errors: An Overview, Statistical Error Analysis, Reliability and Related Topics (Chapter 1 of Text book)

Instruments for Analysis: Introduction, Gas Analysers, Liquid Analysers, X-ray Methods, Chromatography (Chapter 8 of Text Book)

Module II: **10 Hours**

Telemetry: Introduction, Pneumatic Means, Electrical Means, Frequency Telemetring, Multiplexing, Modulation, Modulation of Digital Data, Transmission Channels, Briefing of a Telemetry System in Operation, Wireless I/O (Chapter 10 of Text Book)

Module III: **10 Hours**

Power Plant Instruments: Introduction, The Power Plant Scheme, Pressure, Temperature, Flow and Level, Vibration and Expansion, Analysis, Flue Gas Analysis (Chapter 12 of Text Book)

Hazard and Safety: Initial consideration, Enclosures, Intrinsic Safety, Prevention of Ignition, Methods of Production, Analysis Evaluation and Construction (Chapter 13 of Text Book)

Text Book:

1. Principles of Industrial Instrumentation, Third Edition, D Patranabis, Tata McGraw Hill Education Private Limited, New Delhi

Reference Books:

1. Process/Industrial Instruments and Controls Handbook, Gregory K. Mc Millian Editor-in-Chief, Douglas M. Considine Late Editor-in-Chief

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.

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

PROCESS SIMULATION AND MODELLING

Module I

Modeling: Fundamentals of mathematical models and formulation – Continuity equation, Equation of motion, Transport equations, Energy equation, Equations of state, Equilibrium, Chemical kinetics and their applications; Lumped and distributed parameter models – Fluid systems, C.S.T.R. (single, series, isothermal, constant hold up, variable hold up, gas phase pressurized and non-isothermal), Single component vaporizer, Multi-component flash drum, Batch reactor, Reactor with mass transfer, Ideal binary distillation column, Batch distillation, Heat exchanger, etc;

Module II

Optimization: Single variable optimization (analytical, dichotomous search, fibonacci, golden section, regula falsi), Multivariable optimization (analytical, geometric programming, linear programming), Convergence methods (Newton's methods, direct substitution, Wegstein's method).

Module III

Simulation:; Techniques of digital simulation – Information flow, from process to information flow diagram, From information flow diagram to numerical form, Recycles, Calculation of a recycle set, etc.

Essential Reading:

1. W. L. Luyben, *Process Modelling, Simulation and Control for Chemical Engineers,* McGraw Hill, 1990.

Suggested Readings:

1. B. V. Babu, *Process Plant Simulation*, Oxford University Press, 2004.
2. S. S. Rao, *Engineering Optimization: Theory and practice*, New Age Publishers, 1999.
3. A. Hussain and K. Gangaiah, *Optimisation Techniques for Chemical Engineers*, Macmillan, 2001.
4. B. W. Bequette, *Process Control: Modeling, Design and Simulation.* Prentice-Hall India, 2006.

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