COURSE STRUCTURE

&

SYLLABUS
(3rd – 8th SEMESTER)

FOR B.TECH PROGRAMME
IN
METALLURGICAL ENGINEERING

BIJU PATNAIK UNIVERSITY OF TECHNOLOGY ORISSA,
ROURKELA

2007 - 2008

COURSE STRUCTURE
SECOND YEAR B.TECH PROGRAMME
METALLURGICAL ENGINEERING

3rd Semester				4th Semester			
Theory		*Contact Hrs.*	*Credit*	*Theory*		*Contact Hrs.*	*Credit*
		L-T-P				**L-T-P**	
BSCM 2201	Mathematics - III	3-1-0	4	BSCM 2202	Mathematics - IV	3-1-0	4
CPME 6203	Fluid Machanics & Hydraulic Machines	3-1-0	4	CPME 6202	Mechanics of Materials-I	3-1-0	4
BSCP 2201	Physics - II	2-0-0	2	BSCC 2201	Chemistry - II / Material Science	2-0-0	2
	or				or		
BSCC 2201	Chemistry - II/ Material Science			BSCP 2201	Physics - II /		
BCSE 3201	Object Oriented Programming UsingC++	3-0-0	3	BCSE 3202	Relational Database Management System	3-0-0	3
HSSM 4201	Engineering Economics & Costing	3-0-0	3	HSSM 4202	Organisation Behaviour	3-0-0	3
	or				or		
HSSM 4202	Organisation Behaviour			HSSM 4201	Engineering Economics & Costing		
CPMT 6201	Introduction to Physical Metallurgy	3-1-0	4	CPMT 6202	Metallurgical Thermo-dynamics & Kinetics	3-1-0	4
	Total		**20**		**Total**		**20**
Practicals/Sessionals		*Contact Hrs.*	*Credit*	*Practicals/Sessionals*		*Contact Hrs.*	*Credit*
BENG 9202	Basic Electronics Laboratory	0-0-3	2	BENG 9201	Basic Electrical Engineering Laboratory	0-0-3	2
	or				or		
BENG 9201	Basic Electrical Engineering Laboratory			BENG 9202	Basic Electronics Laboratory		
BCSE 9201	Computer Lab (OOP)	0-0-3	2	BCSE 9202	Computer Lab (RDBMS)	0-0-3	2
BENG 9203	Mechanical Engineering Laboratory	0-0-3	2	CPME 9203	Workshop - III	0-0-3	2
	or				or		
CPME 9203	Workshop - III			BENG 9203	Mechanical Engineering Laboratory		
CPMT 9201	Physical Metallurgy Laboratory	0-0-3	2	CPMT 9202	Material Processing Laboratory	0-0-3	2
	Total		**8**		**Total**		**8**
			28				**28**

L-Lecture **T-Tutorial** **P-Practical**

3rd Semester

BSCM 2201 MATHEMATICS - III (3-1-0)

Module - I (9 Lectures)

Partial differential equations : The vibrating string. The wave equation & its solution.

The Heat equation and its solution

Module - II (10 Lectures)

Two - dimensional wave equation and its solution.

Laplace equation in polar, cylindrical and spherical coordinates. Potential.

Module - III (13 Lectures)

Complex analysis : Complex numbers and functions conformal mappings

Complex integration. Cauchy's Theorem Cauchy's integral formulas.

Module - IV (8 Lectures)

Taylor's and Laurent's series, Residue theorem, evaluation of real integrals.

The Course covered by : Advance Mathematics by E. Kreyszig, John Wiley & Son's (P) Ltd. (8th Edition)

Chapter 11 (except 11.6)

Chapter 12, 13, 14, 15

CPME 6203 FLUID MECHANICS & HYDRAULIC MACHINES (3-1-0)

1. Introduction : Scope of fluid mechanics and its development as a science
2. Physical property of Fluid

   Density, specific gravity, specific weight, specific volume, surface tension and capillarity, viscosity, compressibility and bulk modulus, Fluid classification.
3. Fluid static

   Pressure, Pascal's Law, Pressure variation for incompressible fluid, atmospheric pressure, absolute pressure, gauge pressure and vacuum pressure, monometer.
4. Hydrostatic process on submerged surface, force on a horizontal submerged plane surface, force on a vertical submerged plane surface.

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

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

   Fluid dynamics : Introduction, Euler's equation analog a streamline, energy equation, Bernoulli's equation, Analysis of finite control volumes and its application to siphon, venture, office

   Turbine : Classification, reaction, Impulse, outward flow, inward flow and mixed flow turbines, Francis & Kaplan turbines, Pelton wheel, Physical description and principle of operation, Governing of Turbine.

   Centrifugal Pump : Principles of classification, Blade angles, Velocity triangle, efficiency, specific speed, characteristics curve.

   Reciprocating Pump : Principles of working, slip, work done, effect of acceleration and frictional resistance, separation

Tex Books

1. Fluid Mechanics, A.K. Mohanty, PHI
2. Introduction to Fluid Mechanics and Fluid Machines, S.K. Som and G. Biswas, TMH
3. Fluid Mechanics, Modi & Seth

BSCP 2201 PHYSICS - II (2-0-0)

This one semester Physics course is divided into four units. The unit - I deals with some aspects of nuclear physics, unit - II introduces certain features of condensed matter physics, unit - III deals with certain aspects of semiconductors and superconductors and unit - IV introduces Opto-electronic devices and fibre-optic communication system.

Unit - 1

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

Detailed constructional features of accelerators are not necessary.

1. Need for nuclear accelerators.
2. D.C. Accelerators : Cockcroft - Walton, Van de Graff, Tandem accelerators.
3. RF accelerators : Linear accelerator, cyclotron, electron accelerator, betatron.
4. Application of nuclear accelerators - production of radioisotopes, radiation processing of materials, medical applications.

Unit - 2

This Unit deals with diffraction in crystals and its role in determining crystal structure.

Study of crystal structure by diffraction methods, Bragg's condition for crystal diffraction, Lau condition, Miller indices, Reciprocal lattice, Geometrical structure factor, Atomic form factor.

Unit - 3

This unit deals with certain features of semiconductors and superconductors.

1. Energy bands in solids: Kronig - Penny model, allowed bands and forbidden gaps, elemental and compound semiconductors.
2. Superconductivity : Superconductors and their properties, Meisner effect, Type - I and Type - II Superconductors, Thermodynamic properties of superconductors, London equation, Application of superconductors.

Unit - 4

This unit introduces some Opto - electronic devices and fibre - optic communication system.
Laser : Principle of lasing, properties of Laser, construction and working of semiconductor laser, Application of laser.
LED : Principle construction of operation and application, Introduction to fibre optics, basic characterstics of optical fibres, optical fibre communication system.

Books Recommended

1. Nuclear Physics, P. R. Roy & B. P. Nigan
2. Particle Accelerators, M. S. Livingston & J. P. Blewett
3. Concepts of Modern Physics, A. Beiser
4. Introduction to Solid State Physics, C. Kittel
5. Introduction to Lasers, A. Avadhnulu
6. Physics - II, B. B. Swain and P. K. Jena.

BSCC 2201 CHEMISTRY - II (2-0-0)

(Total No. of Lectures = 40)

Module I (10 Lectures)

Water quality parameters and standards. Treatment of water for industrial and domestic purpose.

Hardness of Water : Types of hardness, Units of hardness, Determination of hardness(EDTA method). Disadvantages of hardwater in boiler, Water Softening Techniques (Lime soda, Ion exchange and zeolite). Boiler feed water, Water for Domestic purposes (Municipal / Drinking Water)

Module II (14 Lectures)

(To develop the basic concepts on corrosion and industrially important polymers.

1. Corrosion:

Dry and wet corrosion, Galvanic Corrosion, Stress Corrosion, Factors affecting corrosion, Corrosion Control : (Proper design and fabrication procedure, Cathodic protection, Passivation).

(6 Lectures)

2. Polymers:

Nomenclature and classification, Mechanism of polymerization (free radical and ionic) Thermoplastic and thermosetting resins, Some typical useful polymers: Polyethylene, PVC, polystyrene, PMMA, Nylon 6 : 6, Nylon 6, Bakelite, Terylene, Silicones, Natural and synthetic rubbers: Neoprene, Butyl and Polyuarethane rubber, Vulcanization.

(8 Lectures)

Module III (10 Lectures)

(To introduce the students about the basic concepts of fuels)

1. Fuels:

Classification of fuels, calorific value, Analysis of Coal, Manufacturing process of metallurgical coke, Refining of Crude oil, Fractional distillation, Cracking, Knocking and antiknocking, Octane and Cetane number.

Gaseous Fuel : Producer gas, Water gas, LPG & CNG.

Combustion Calculation.

Module IV (6 Lectures)

1. Environment pollution :

Green house effect, acid rain, depletion of ozone layer; Water pollution- bio chemical effect of lead, arsenic, mercury and fluorides, sewage-B.O.D. and C.O.D.

Books :

1. Engineering Chemistry by P. C. Jain and M. Jain.
2. Engineering Chemistry by R. Gopalan, D. Venkapaya and S. Nagarajan - Vikas Publishing House.
3. Environmental Pollution, A.K. Dey.

BSCC 2202 MATERIAL SCIENCES (2-0-0)

MODULE - I (10 Lectures)

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 (10 Lectures)

5. Dielectric Materials : Microscopic Displacement of atoms and molecules in an external dc electric field, Polarization and dielectric constant, Dielectric susceptibiity. 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 (10 Lectures)

8. Organic Materials : Polymers - Mechanism of Polymerization : Addition, condensation and co-polymerisation, applications.

   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

MODULE - IV (10 Lectures)

10. Composite Materials : Agglomerated Materials : Cermets, Reinforced Materials : Reinforced Concrete. Glass fibre reinforced plastics, Carbon fibre reinforced plastics. Whiskers, fibre reinforced plastics, Laminated plastic sheets. Tufnol, Properties of composites. Metal matrix composites, manufacturing procedure for fibre reinforced composites.
11. Performance of Materials in Service : Service performance, failure, design considerations, Corrosion - types, (Atmospheric, Pitting, Stress Corrosion), Control & prevention, protective coating, Performance of metals and Ceramics at high temperature.

Text Books :

1. Callister W.D., Materials Science and Engineering, John Wiley & Sons.
2. Vijaya M. S., Rangarajan G, Materials Science, TMH
3. Rajendra V., Marikani A., Materials Science, TMH
4. Van Vlack L. H., Elements of Material Science and Engineering, Addison Wesley
5. Material Science, Raghavan

6. Processes and Material of manufacture : Lindberg, PHI.

BCSE 3201 OBJECT ORIENTED PROGRAMMING USING C++ (3-0-0)

Module I (10 Hours)

Introduction to object oriented programming, user defined types, polymorphism, and encapsulation. Getting started with C++ -syntax, data-type, variables, strings, functions, exceptions and statements, namespaces and exceptions, operators. Flow control, functions, recursion. Arrays and pointers, structures.

Module II (10 Hours)

Abstraction mechanisms: Classes, private, public, constructors, member functions, static members, references etc. Class hierarchy, derived classes.
Inheritance: simple inheritance, polymorphism, object slicing, base initialization, virtual functions.

Module III (12 Hours)

Prototypes, linkages, operator overloading, ambiguity, friends, member operators, operator function, I/O operators etc.
Memory management: new, delete, object copying, copy constructors, assignment operator, this input/output.
Exception handing: Exceptions and derived classes, function exception declarations, Unexpected exceptions, Exceptions when handling exceptions, resource capture and release etc.

Module IV (8 Hours)

Templates and Standard Template library: template classes, declaration, template functions, namespaces, string, iterators, hashes, iostreams and other type.
Design using C++ design and development, design and programming, role of classes.

Text Books:

1. Bhave & Patekar- Object oriented Programming with C++, Pearson Education
2. Ashok N. Kamthane- Object oriented Programming with ANSI & Turbo C++, Pearson Education.
3. Robert Lafore- Object oriented programming in Microsoft C++.
4. Balguru Swamy-C++, TMH publication

HSSM 4201 ENGINEERING ECONOMICS AND COSTING(3-0-0)

Module I (10 Hours)

Present worth comparisons, Comparisons of assets with equal, unequal and infite lives, comparison of deferred investments, Future worth comparison, pay back period comparison.

Module II (10 Hours)

Benefit/ Cost analysis, quantification of project, cost and benefits, benefit/ cost applications, Cost – effectiveness analysis.

Module III (10 Hours)

Module IV (12 Hours)

1. Horn green, C.T., Cost Accounting, Prentice Hall of India

2. Riggs, J.L ., Dedworth, Bedworth, D.B, Randhawa, S.U. Engineering Economics, McGraw Hill International Edition, 1996 (Chapter 2,3,4,5,7,8,9,11,12)

HSSM 4202 ORGANIZATIONAL BEHAVIOUR (3-0-0)

Module I (8 Hours)

The Study of Organizational Behaviour : Learning objectives, Definition and Meaning, Why Study OB, An OB Model, New Challenges for OB Manager.
Learning – Nature of Learning, How Learning occurs, Learning and OB.
Case Analysis

Module II (10 Hours)

Foundations of Individual Behaviour : Personality – Meaning and Definition, Determinants of Personality, Personality Traits, Personality and OB.
Perception – Meaning and Definition, Perceptual Process, Importance of Perception in OB. Motivation – Nature and Importance, Hertzberg's Two Factor Theory, Maslow's Need Hierarchy Theory, Alderfer's ERG Theory, Evaluations.
Case Analysis

Module III (12 Hours)

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 Follwership, How to be an effective Leader. Conflict – Nature of Conflict and Conflict Resolution.
An Introduction to Transactional Analysis (TA).
Case Analysis

Module IV (10 Hours)

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 Organizational Behaviour – Trends in International Business, Cultural Differences and Similarities, Individual and Interpersonal Behaviour in Global Perspective.
Case Analysis

TEXTBOOKS:

Keith Davis, Organizational Behaviour, McGraw – Hill.
K.Aswathappa, Organizational Behaviour, Himalaya Publishing House.

REFERENCE BOOKS:

Stephen P. Robbins, Organizational Behaviour, Prentice Hall of India.
Pradip N. Khandwalla, Organizational Behaviour, McGraw – Hill, New Delhi.

CPMT 6201 INTRODUCTION TO PHYSICAL METALLURGY(3-1-0)

Module I (10 Hours)

1.Characteristic property of metals, bonding in solids, primary bonds like ionic, covalent and metallic bond, crystal syste

2. Solidification of pure metals, homogenous and heterogeneous nucleation processes, cooling curve, concept of supercooling, microstructures of pure metals, solidification of metal in ingot mould.

Module II (10 Hours)

1. Concept of plastic deformation of metals, critical resolve share 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; recrystalization and grain growth; hotworking.

2. 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.

Module III (13 Hours)

1. 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.
2. 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.
3. 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.

Module IV (11 Hours)

1. Effect of common alloying elements on the equilibrium and T-T-T diagrams, concept of hardenability, factors affecting hardenability.
2. Common ally steels, stainless steel, tool steel, high speed steel, high strength low alloy steel, microalloyed steel, specification of steels.
3. 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. Introduction to Physical Metallurgy by S. H. Avner, 2nd edition, Tata McGraw Hill Publishing Co. Ltd.
2. Engineering Physical Metallurgy and Heat Treatment by Y. Lakhtin, Mir Publisher, Moscow.
3. Materials Science and Engineering by W. D. Callister, Wiley and Sons Inc.
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 International edition.
6. Materials Science and Engineering by V. Raghavan, Prentice Hall of India Pvt. Ltd.
7. An Introduction to Metallurgy, Sir Alan Cottrell, University Press

PRACTICALS

BENG 9202 BASIC ELECTRONICS LAB. (0-0-3)

(At least 8 experiments including 1 - 7 and any one from 8 - 10)

1. Familiarity with electronics components and Devices

   Testing of a semiconductor Diode and a Transisitor. IC pins connection (Digital Multimeter should be used should be used in testing components and devices).
2. Study and use of Oscilloscope to view waveforms and measure its amplitude and frequency.
3. V - I Characterstic of a semiconductor diode. Determining DC and AC resistance.
4. Half wave and Full wave rectifiers without and with capacitor filter. Record of waveforms, Measurement of Average and rms values.
5. V - I Characterstics of anpn or pnp transistor. DC Biasing and measurement of dc voltages and currents.
6. Gain - frequency response of JFET common source R-C coupled amplifier/BJT CE RC coupled Amplifier.
7. Op amp in Inverting, non inverting, Integrating and Differentiating configuration, Record of wave forms.
8. Truth Tables of logic gates.
9. Study and experiment using MUX - DEMUX ICs / Shift Register IC.
10. Study on CMOS logic Inverter.

BENG 9201 BASIC ELECTRICAL ENGINEERING LAB. (0-0-3)

List of Experiment (Any 8 of the following)

1. Study and measurement the armature and field resistance of a DC machine.
2. Calibration of ammeter, voltmeter and wattmeter with the help of sub-standard instrument.
3. Verification of circuit theorems. Thevenin's and Superposition theorems (with DC source only).
4. Voltage-current characteristics of incandescent lamps and fusing time-current characteristics of fuse wire.
5. Measurement of current, voltages and power in R-L-C series circuit excited by Single Phase AC supply.
6. Connection and starting of a three phase induction motor using direct online (DOL). or star-delta starter.
7. Connection and measurement of power consumption of a fluorescent lamp.
8. Determination of open circuit characteristics (OCC) of DC machine.
9. Starting and speed control of a DC shunt motor.
10. Connection and testing of a single phase energy meter (unity power factor load only)
11. Study of fan motor

BCSE 9201 COMPUTER (OOP) WITH C++ LAB. (0-0-3)

(10 classes for 10 different programs)

1. Programs on concept of classes and objects.(1 class)
2. Programs using inheritance.(1 class)
3. Programs using polymorphism.(1 class)
4. Programs on use of operator overloading.(1 class)

5. Programs on use of memory management.(1 class)
6. Programs on exception handling and use of templates.(1 class)
7. Programs on File handling in C++.(1 class)
8. Design problem on stock and accounting of a small organization, railway reservation, payroll preparation and optimization problem.(3 classes)

BENG 9203 MECHANICAL ENGINEERING LAB. (0-0-3)

Group A (Mechanics / Material Testing Lab.

1. Determination of equilibrium of coplanar forces.
2. Determination of Moment of Intertia 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 Cd and Cd of Orifices.

Group C

7. Calibration of Bourden Type Pressure gauj and measurement 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.

CPME 9203 WORKSHOP - III (0-0-3)

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

CPMT 9201 PHYSICAL METALLURGY LAB. (0-0-3)

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

BSCM 2202 MATHEMATICS - IV (3-1-0)

Module - I

Solution of equations by iteration, Newton's method, Secant method, Interpolation

Numerical integration and differntiation

Module - II

Gauss Siedel iteration method for solving a system of linear equations, Ruage Kutta Methods, Introductory Linear Programming, Introductory Programming

Module - III

Probability, Random variables, Probability distribution, mean & variance of distribution

Binomial, Poisson, hyper-geometric and normal distributions

Module - IV

Random sampling, estimation of parameters, confidence intervals, Testing of hypothesis, acceptance sampling, correlation and regression

Course covered by : Advance Mathematics by E. Kreyszig (8th Edition)

Chapter 17 (17.1 - 17.3, 17.5), Chapter 18 (18.4), Chapter 19 (19.1), Chapter 20, Chapter 21, Chapter 22

CPME 6202 MECHANICS OF MATERIALS - I (3-1-0)

MODULE - I (10 Hours)

1. Analysis of Axially Loaded Members :
   Composite bars in tension and compression - temperature stresses in composite rods - statically inderterminate problem.
2. Members in Biaxial State of Stress :
   Stresses in thin cylinders, thin spherical shells under internal pressure - wire winding of thin cyliners.

MODULE - II (12 Hours)

3. Strain Deformation :
   Two dimensional state of strain, Principal strains and peincipal axes of strain measurements, Calculation of principal stresses from principal strains.
4. Shear Force and Bending Moment Diagrams for Simple Beams :
   Support reactions for statically determinate beams, relationship between bending moment and sheer force. Sheer force and Bending Moment diagrams.

MODULE - III (12 Hours)

5. Simple Bending of Beams :
   Theory of simple bending of intially straight beams, distribution of normal and sheer stress, beams of two materials, Composite beams.
6. Deflection of Beams :
   Slope and delection of beams by integration method and area - moment method.

MODULE - IV (6 Hours)

7. Torsion in solid and hollow circular shafts, Twisting moment, strength of solid and hollow circular shafts. Strength of shafts in combined bending and twisting.
8. Close - Coiled helical springs.

TEXT BOOKS :

1. Elements of Strength of Materials by Timoshenko & Young (Fifth Edition)
   Chapter : 1, 2, 3, 4, 5, 6, 7 ,8 (Relevant articles only)

REFERENCE BOOKS :

2. Strength of Materials by G. H. Ryder

BSCC 2201 CHEMISTRY - II (2-0-0)

(Total No. of Lectures = 40)

Module I (10 Lectures)

Water quality parameters and standards. Treatment of water for industrial and domestic purpose.

Hardness of Water : Types of hardness, Units of hardness, Determination of hardness(EDTA method). Disadvantages of hardwater in boiler, Water Softening Techniques (Lime soda, Ion exchange and zeolite). Boiler feed water, Water for Domestic purposes (Municipal / Drinking Water)

Module II (14 Lectures)

(To develop the basic concepts on corrosion and industrially important polymers.

1. Corrosion:

Dry and wet corrosion, Galvanic Corrosion, Stress Corrosion, Factors affecting corrosion, Corrosion Control : (Proper design and fabrication procedure, Cathodic protection, Passivation).

(6 Lectures)

2. Polymers:

Nomenclature and classification, Mechanism of polymerization (free radical and ionic) Thermoplastic and thermosetting resins, Some typical useful polymers: Polyethylene, PVC, polystyrene, PMMA, Nylon 6 : 6, Nylon 6, Bakelite, Terylene, Silicones, Natural and synthetic rubbers: Neoprene, Butyl and Polyuarethane rubber, Vulcanization.

(8 Lectures)

Module III (10 Lectures)

(To introduce the students about the basic concepts of fuels)

1. Fuels:

Classification of fuels, calorific value, Analysis of Coal, Manufacturing process of metallurgical coke, Refining of Crude oil, Fractional distillation, Cracking, Knocking and antiknocking, Octane and Cetane number.

Gaseous Fuel : Producer gas, Water gas, LPG & CNG.

Combustion Calculation.

Module IV (6 Lectures)

1. Environment pollution :
   Green house effect, acid rain, depletion of ozone layer; Water pollution- bio chemical effect of lead, arsenic, mercury and fluorides, sewage-B.O.D. and C.O.D.

Books :

1. Engineering Chemistry by P. C. Jain and M. Jain.

2. Engineering Chemistry by R. Gopalan, D. Venkapaya and S. Nagarajan - Vikas Publishing House.
3. Environmental Pollution, A.K. Dey.

BSCC 2202 MATERIAL SCIENCES (2-0-0)

MODULE - I (10 Lectures)

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 (10 Lectures)

5. Dielectric Materials : Microscopic Displacement of atoms and molecules in an external dc electric field, Polarization and dielectric constant, Dielectric susceptibiity. 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 (10 Lectures)

8. Organic Materials : Polymers - Mechanism of Polymerization : Addition, condensation and co-polymerisation, applications.

   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

MODULE - IV (10 Lectures)

10. Composite Materials : Agglomerated Materials : Cermets, Reinforced Materials : Reinforced Concrete. Glass fibre reinforced plastics, Carbon fibre reinforced plastics. Whiskers, fibre reinforced plastics, Laminated plastic sheets. Tufnol, Properties of composites. Metal matrix composites, manufacturing procedure for fibre reinforced composites.
11. Performance of Materials in Service : Service performance, failure, design considerations, Corrosion - types, (Atmospheric, Pitting, Stress Corrosion), Control & prevention, protective coating, Performance of metals and Ceramics at high temperature.

Text Books :

1. Callister W.D., Materials Science and Engineering, John Wiley & Sons.
2. Vijaya M. S., Rangarajan G, Materials Science, TMH
3. Rajendra V., Marikani A., Materials Science, TMH

4. Van Vlack L. H., Elements of Material Science and Engineering, Addison Wesley
5. Material Science, Raghavan
6. Processes and Material of manufacture : Lindberg, PHI.

BSCP 2201 PHYSICS - II (2-0-0)

This one semester Physics course is divided into four units. The unit - I deals with some aspects of nuclear physics, unit - II introduces certain features of condensed matter physics, unit - III deals with certain aspects of semiconductors and superconductors and unit - IV introduces Opto-electronic devices and fibre-optic communication system.

Unit - 1

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

Detailed constructional features of accelerators are not necessary.

1. Need for nuclear accelerators.
2. D.C. Accelerators : Cockcroft - Walton, Van de Graff, Tandem accelerators.
3. RF accelerators : Linear accelerator, cyclotron, electron accelerator, betatron.
4. Application of nuclear accelerators - production of radioisotopes, radiation processing of materials, medical applications.

Unit - 2

This Unit deals with diffraction in crystals and its role in determining crystal structure.

Study of crystal structure by diffraction methods, Bragg's condition for crystal diffraction, Lau condition, Miller indices, Reciprocal lattice, Geometrical structure factor, Atomic form factor.

Unit - 3

This unit deals with certain features of semiconductors and superconductors.

1. Energy bands in solids: Kronig - Penny model, allowed bands and forbidden gaps, elemental and compound semiconductors.
2. Superconductivity : Superconductors and their properties, Meisner effect, Type - I and Type - II Superconductors, Thermodynamic properties of superconductors, London equation, Application of superconductors.

Unit - 4

This unit introduces some Opto - electronic devices and fibre - optic communication system.
Laser : Principle of lasing, properties of Laser, construction and working of semiconductor laser, Application of laser.
LED : Principle construction of operation and application, Introduction to fibre optics, basic characterstics of optical fibres, optical fibre communication system.

Books Recommended

1. Nuclear Physics, P. R. Roy & B. P. Nigan
2. Particle Accelerators, M. S. Livingston & J. P. Blewett
3. Concepts of Modern Physics, A. Beiser
4. Introduction to Solid State Physics, C. Kittel

5. Introduction to Lasers, A. Avadhnulu

6. Physics - II, B. B. Swain and P. K. Jena.

BCSE 3202 RELATIONAL DATABASE MANAGEMENT SYSTEMS (3-0-0)

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 (10 Hours)

Relation Query Languages, Relational Algebra, Tuple and Domain Relational Calculus, SQL and QBE.
Relational Database Design: Domain and Data dependency, Armstrong's Axioms, Normal Forms, Dependency Preservation, Lossless design, Comparison of Oracle & DB2

Module III (8 Hours)

Query Processing and Optimization: Evaluation of Relational Algebra Expressions, Query Equivalence, Join strategies, Query Optimization Algorithms.

Module IV (12 Hours)

Storage Strategies: Indices, B-Trees, Hashing, Transaction processing: Recovery and Concurrency Control, Locking and Timestamp based Schedulers, Multiversion and Optimistic Concurrency Control Schemes.
Advanced topics: Object-Oriented and Object Relational databases. Logical Databases, Web Databases, Distributed Databases, Data Warehouse and Data Mining.

Text Books:-

1. Elmaski & Navathe -Fundamentals of Database Systems, 4th Edition, Pearson Education
2. C.J.Date - An introduction to Database Systems, Pearson Education
3. Bipin Desai -An introduction to Database System, Galgotia Publication.

HSSM 4202 ORGANIZATIONAL BEHAVIOUR (3-0-0)

Module I (8 Hours)

The Study of Organizational Behaviour : Learning objectives, Definition and Meaning, Why Study OB, An OB Model, New Challenges for OB Manager.
Learning – Nature of Learning, How Learning occurs, Learning and OB.
Case Analysis

Module II (10 Hours)

Foundations of Individual Behaviour : Personality – Meaning and Definition, Determinants of Personality, Personality Traits, Personality and OB.
Perception – Meaning and Definition, Perceptual Process, Importance of Perception in OB. Motivation – Nature and Importance, Hertzberg's Two Factor Theory, Maslow's Need Hierarchy Theory, Alderfer's ERG Theory, Evaluations.
Case Analysis

Module III (12 Hours)

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 Follwership, How to be an effective Leader. Conflict – Nature of Conflict and Conflict Resolution.
An Introduction to Transactional Analysis (TA).
Case Analysis

Module IV (10 Hours)

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 Organizational Behaviour – Trends in International Business, Cultural Differences and Similarities, Individual and Interpersonal Behaviour in Global Perspective.
Case Analysis

TEXTBOOKS :

Keith Davis, Organizational Behaviour, McGraw – Hill.
K.Aswathappa, Organizational Behaviour, Himalaya Publishing House.

REFERENCE BOOKS :

Stephen P. Robbins, Organizational Behaviour, Prentice Hall of India.
Pradip N. Khandwalla, Organizational Behaviour, McGraw – Hill, New Delhi.

HSSM 4201 ENGINEERING ECONOMICS AND COSTING(3-0-0)

Module I (10 Hours)

Present worth comparisons, Comparisons of assets with equal, unequal and infite lives, comparison of deferred investments, Future worth comparison, pay back period comparison.

Module II (10 Hours)

Benefit/ Cost analysis, quantification of project, cost and benefits, benefit/ cost applications, Cost – effectiveness analysis.

Module III (10 Hours) Depreciation, Computing depreciation charges, after tax economic comparison, Break-even analysis; linear and non-linear models. Sensitivity analysis: single and multiple parameter sensitivity.

Module IV (12 Hours)

Fixed and variable cost, Product and Process Costing, Standard Costing, Cost estimation, Relevant Cost for decision making, Cost estimation, Cost control and Cost reduction techniques.

Text Book

1. Horn green, C.T., Cost Accounting, Prentice Hall of India
2. Riggs, J.L ., Dedworth, Bedworth, D.B, Randhawa, S.U. Engineering Economics, McGraw Hill International Edition, 1996 (Chapter 2,3,4,5,7,8,9,11,12)

CPMT 6202 METALLURGICAL THERMODYNAMICS AND KINETICS (3-1-0)

Module I (10 Lectures)

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.

Module II (9 Lectures)

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

Fugacity, activity, equilibrium constant, use of S - functions, controlled atmospheres, homogeneous and heterogeneous equilibria.

Ellingham-Richardson diagrams, phase stability diagrams.

Module III (13 Lectures)

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

Module IV (12 Lectures)

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. Problems in Applied Thermodynamics by C. Bodsworth & A. S. Appleton; Longmas, Green and Co. ltd.
2. Physical Chemistry of Metals by L. S. Darken & R. W. Gurry; McGraw Hill Book Company Inc.
3. Intoduction to Metallurgical Thermodynamics by R. H. Tupkary; tu publishers, Nagpur.
4. Introduction to the Thermodymics of Materials by D. R. Gaskell; 3rd edition, Taylor and Francis.
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.

PRACTICALS

BENG 9201 BASIC ELECTRICAL ENGINEERING LAB. (0-0-3)

List of Experiment (Any 8 of the following)

1. Study and measurement the armature and field resistance of a DC machine.
2. Calibration of ammeter, voltmeter and wattmeter with the help of sub-standard instrument.
3. Verification of circuit theorems. Thevenin's and Superposition theorems (with DC source only).
4. Voltage-current characteristics of incandescent lamps and fusing time-current characteristics of fuse wire.
5. Measurement of current, voltages and power in R-L-C series circuit excited by Single Phase AC supply.
6. Connection and starting of a three phase induction motor using direct online (DOL). or star-delta starter.

7. Connection and measurement of power consumption of a fluorescent lamp.
8. Determination of open circuit characteristics (OCC) of DC machine.
9. Starting and speed control of a DC shunt motor.
10. Connection and testing of a single phase energy meter (unity power factor load only)
11. Study of fan motor

BENG 9202 BASIC ELECTRONICS LAB. (0-0-3)

(At least 8 experiments including 1 - 7 and any one from 8 - 10)

1. Familiarity with electronics components and Devices

   Testing of a semiconductor Diode and a Transisitor. IC pins connection (Digital Multimeter should be used should be used in testing components and devices).
2. Study and use of Oscilloscope to view waveforms and measure its amplitude and frequency.
3. V - I Characterstic of a semiconductor diode. Determining DC and AC resistance.
4. Half wave and Full wave rectifiers without and with capacitor filter. Record of waveforms, Measurement of Average and rms values.
5. V - I Characterstics of anpn or pnp transistor. DC Biasing and measurement of dc voltages and currents.
6. Gain - frequency response of JFET common source R-C coupled amplifier/BJT CE RC coupled Amplifier.
7. Op amp in Inverting, non inverting, Integrating and Differentiating configuration, Record of wave forms.
8. Truth Tables of logic gates.
9. Study and experiment using MUX - DEMUX ICs / Shift Register IC.
10. Study on CMOS logic Inverter.

BCSE 9202 COMPUTER (RDBMS) LAB. (0-0-3)

(10 Classes for 10 Different Programs)

1. Use of SQL syntax : Insertion, Deletion, Join), Updation using SQL. (1 class)
2. Program segments in embedded SQL using C as host language to find average grade point of a student, etc. (1 class)
3. Program for Log based data recovery technique. (1 class)
4. Program on data recovery using check point technique. (1 class)
5. Concurrency control problem using lock operations. (1 class)
6. Use of package (ORACLE) for programming approaches(2 classes)
7. Use of package (DB2) for programming approaches(2 classes)
8. Programs on JDBC/ODBC to print employee's / student's information of a particular department. (1 class)

CPME 9203 WORKSHOP - III (0-0-3)

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

BENG 9203 MECHANICAL ENGINEERING LAB. (0-0-3)

Group A (Mechanics / Material Testing Lab.

1. Determination of equilibrium of coplanar forces.
2. Determination of Moment of Intertia 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 Cd and Cd of Orifices.

Group C

7. Calibration of Bourden Type Pressure gauj and measurement 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.

CPMT 9202 MATERIAL PROCESSING LAB. (0-0-3)

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/CO2 mould as a function of gasing time and pressure.
8. Determination of the tensile strength of oil/resin bonded core sand.

COURSE STRUCTURE
THIRD YEAR B.TECH PROGRAMME
METALLURGICAL & MATERIALS ENGINEERING

5th Semester				6th Semester			
Theory		*Contact Hrs.*	*Credit*	*Theory*		*Contact Hrs.*	*Credit*
		L-T-P				**L-T-P**	
HSSM4301	Optimisation in Engineering	3-0-0	3	HSSM4302	Production & Operation Mgmt.	3-0-0	3
CPMT6301	Mineral Engineering and Fuel Technology	3-1-0	4	CPMT6306	Phase Transformation and Heat Treatment	3-1-0	4
CPMT6302	Principles of Extractive Metallurgy	3-1-0	4	CPMT6307	Deformation Behaviour of Materials	3-1-0	4
CPMT6303.	Polymeric, Ceramic and Semiconducting Materials	3-0-0	3	CPMT6308	Mechanical Working and Testing of Materials	3-1-0	4
CPMT6304	Refractories and Furnaces	3-1-0	4	CPMT6309	Iron Making and Ferro-Alloys	3-1-0	4
CPMT6305	Transport Phenomena	3-0-0	3	CPMT6310	X-Ray and Metal Physics	3-0-0	3
	Total		**21**		**Total**		**22**
Practicals/Sessionals		*ContactHrs*	*.Credit*	*Practicals/Sessionals*		*Contact Hrs.*	*Credit*
CPMT9301	Mineral Engineering Lab	0-0-3	2	CPMT9304	Phase Transformation & Heat Treatment Lab.	0-0-3	2
CPMT9302	Fuel Testng Lab.	0-0-3	2	CPMT9305	Testing of Metals Lab.	0-0-3	2
CPMT9303	Materials Characterization Lab.	0-0-3	2	CPMT9306	Design Project	0-0-3	2
	Total		**6**		**Total**		**6**
			27				**28**

L-Lecture **T-Tutorial** **P-Practical**

5th Semester

METALLURGICAL AND MATERIALS ENGINEERING

HSSM 4301 OPTIMIZATION IN ENGINEERING (3-0-0)

Course Objective : The course aims at acquainting the students to mathematical modeling of engineering design, operation and maintenance problems and their optimization algorithms.

Module – I (10 hours)

Formulation of engineering optimization problems : Decision variables, objective function and constraints. Example of typical design, operation and maintenance problems in engineering : Design of a water tank, design of a truss, design of a network (electrical, communication sewerage and water supply networks), product mix problem, transportation and assignment problems, shift scheduling of employees, design of reliable devices, design of reactors, shortest route problem, set covering problem, traveling salesman problems. Only physical problems and their mathematical models to be discussed.

Linear Programming Problem : Formulation, Graphical solution, Simplex method, Duality theory, Dual simplex method, Formulation and solution of engineering problems of planning and scheduling.

Module – II (10 hours)

Sensitivity Analysis, Transportation Problem, Assignment Problem, Network Models : Minimal Spanning Tree Problem, Maximal Flow Problem, Shortest Route Problem, Minimum Cost Flow Problem. Algorithms and applications to be covered.

Module – III (10 hours)

Integer Linear Programming Problem. Branch and Bound and Cutting Plane Methods. Zero-one Programming Problem, Knapsack Problem, Set covering Problem, Set Partitioning Problem, Traveling Salesman Problem. Deterministic Dynamic Programming Problems. Applications and algorithms to be discussed.

Module – IV (12 hours)

Queueing theory, Game theory, Simulation, Decission theory & Sequencing Problem

REFERENCES :

1. H. A. Taha – Operations Research, Prentice Hall of India, 2004.
2. D. T. Phillips, A Ravindran and J.J. Solaberg, Principles of Operation Research, John Wiley and Sons
3. S. Kalavathi, Operations research, Vikash Publication.
4. B.E Gillett, Introduction to operations research, TMH

CPMT 6301 MINERAL ENGINEERING AND FUEL TECHNOLOGY (3-1-0)

Module- I (10 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 settling 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 flotation processes, machines and practice.

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

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

Module-III (10 hours)

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

Module- IV (10 hours)

Fuels: Definition and classification of fuels, comparative study of solid, liquid and gaseous fuels. Coal preparation. Fundamentals of coal carbonization. Selection of coal and coke for metallurgical uses, Gaseous fuels; Water gas, Producer gas, Blast furnace gas:- their production details and process parameters. Fuel calorimetry. Testing of fuels. Definition and principle of combustion of fuels. Energy resources 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.
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.
8. Fuels-solid,liquid and gaseous by J.S.S. Brame and J.C. King Edward.
9. Elements of Fuel Technology by G.W. Himus.

CPMT 6302 PRINCIPLES OF EXTRACTIVE METALLURGY (3-1-0)

Module I (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- II (12 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.

Module-III (10 hours)

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…

Module- IV (10 hours)

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

Books for Reference:-

1. Principles of Extractive Metallurgy by Ahindra Ghosh and H. S. Ray
2. Fundamentals of Metallurgical Processes by L. Coudurier, D. W. Hopkins and I. Wilkomirsky
3. Metallurgical Problems by A. Butts
4. Electrochemical Engineering by C. L. Mantell

CPMT 6303 POLYMERIC, CERAMIC AND SEMICONDUCTING MATERIALS (3-0-0)

Module-I (12 hours)

Polymeric Materials: Concept of polymeric materials, Types of polymer, Molecular structure, topology and architecture, Isomerism and tacticity, polymer morphology, Elastomers, Plastics, Films, Fibers, Adhesive.

Polymerization reactions and manufacturing technology: Brief concepts.

Physical states of polymers: Amorphous, semi-crystalline, crystalline polymers and liquid crystalline polymers.

Rheological behavior of polymer melts, Polymer additives and compounding;

Processing and Fabrication of Plastics: Extrusion, Injection, Calendaring and Thermoforming. Manufacturing methods of composites.

Physical and Mechanical properties of polymers.

Module-II (10 hours)

Ceramic Materials: Classification of ceramics & glasses. Nanoceramics & cermets. Ceramic raw materials-mining, beneficiation, crystal structure and ionic bonding. Structure of glasses; point defects, line defects and grain boundaries; non-stoichiometric oxides. Phase diagrams and phase transformations. Grain growth and sintering. Toughening of ceramics. Processing of glass ceramics. Thermal, mechanical, chemical, biological, optical, magnetic, ferroelectrics and electrical properties of ceramics and glasses. Ceramics for electronic applications. Coatings of glasses and ceramics.

Module-III (10 hours)

Semiconducting Materials: Bonds and bands, concept of electron, hole and electron fields, energy band and wave behavior.

Defects-their classification and effect on electronic properties.

Crystal growth techniques, doping, thermal diffusion and ion implantation.

Module-IV (10 hours)

Transport properties and effect of temperature on optical and opto-electronic properties.

Contacts, barriers and junctions. Metallisation and phase diagram.

Piezo, pyro and ferroelectric materials, ferrites and garnets-properties and applications.

Conducting polymers, semiconductors, electroceramics and superconducting materials for case studies.

p-n junction and schottky barrier diodes, transistors.

Books for Reference

1. Elements of Materials Science & Engineering by L.H. Van Vlack
2. Materials Science and Engineering by V. Raghavan
3. Polymer Science and Technology – Plastics, Rubber, Blends and Composites by Premamoy Ghosh,2nd edition
4. Principles of Materials Science and Engineering by W.F. Smith
5. Strengthening of Ceramics: Treatments, Tests and Design Application by H.P. Kirchner
6. Engineering Applications of Ceramic Materials –Source Book: ASM 1985
7. Clays and Ceramic Raw Materials by W.E. Worrell

8. Introduction to Ceramics by W.D. Kingery
9. Electronic Properties of Materials by R.E. Hummel

CPMT 6304 REFRACTORIES AND FURNACES (3-1-0)

Module- I (12 hours)

Refractories:

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

Binary phase diagrams of Al 2O 3-SiO 2 ,CaO-MgO,Cr2O 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 (12 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.

Module-III (10 hours)

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.

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

Module-IV (10 hours)

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. Steel Plant Refractories by Chester
4. Refractories by Norton
5. Industrial Furnace, Vol –I & II, by Trinks & Mawhinney
6. Modern Furnace Technology by Erthrington
7. Science of Flames and Furnaces by Thring
8. Fuels & Combustion by Smith & Stinson
9. Industrial Electric Furnaces and Applications by Pasckis & Pearson

10. Vacuum Equipment and Techniques by Gutheris & Wakerins
11. Experimental Techniques by Seybolt & Burke

CPMT 6305 TRANSPORT PHENOMENA (3-0-0)

Module-I (10 hours)

Momentum transfer (fluid flow): 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 (10 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.

Module – IV (10 hours)

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

PRACTICALS

CPMT 9301 MINERAL ENGINEERING LAB. (0-0-3) 2

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. Crushing of ore/ coal in a roll crusher and to study the size analysis of the product.
4. Crushing of ore/ coal in a gyratory crusher / pulveriser and to study the size analysis of the product.
5. Crushing of ore/ coal in a cone crusher and to study the size analysis of the product.
6. To study the effect of grinding with grinding time in cylindrical ball mill and rod mill.
7. To separate coal from a mixture of coal and stones or quarts by zigging and determine the weight fractions of the products.
8. 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.
9. Beneficiation of ore pulp mix using flotation cell.
10. To separate a mixture of iron and sand using magnetic separator and determine its efficiency.
11. Screening of ore/ coal using vibrating screen and determine its effectiveness.

CPMT 9302 FUEL TESTING LAB. (0-0-3) 2

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.

CPMT 9303 MATERIALS CHARACTERIZATION LAB. (0-0-3) 2

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 hardnesses of ferrite, pearlite and carbides in a steel using microhardness 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 conuctivity 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.

6th SEMESTER

HSSM 4302 PRODUCTION AND OPERATIONS MANAGEMENT (3-0-0) 3

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

Module I

1. Operation Function in an Organization, Manufacturing Vrs Service Operation, System view of Operations, Strategic Role of Operations, Operations Strategies for Competitive Advantages, Operations Quality and Productivity Focus, Meeting Global Challenges of Production and Operations Imperatives.

(3 hours)

2. Designing Products, Services and Processes New Product Design : Product Life Cycle, Product Development Process, Product Quality and Reliability Design, Process Technology : Project , Jobshop, Batch, Assembly Line, Continuous Manufacturing, Process Technology Life Cycle, Process Technology Trends; FMS, CIM, CAD, CAM, GT, Design for Services, Services Process Technology, Services Automation. Value Engineering, Standardization, Make or buy Decision.

(4 hours)

3. Job Design and Work Measurement, Method Study : Techniques of Analysis, recording, improvement and standardization. Work Measurement : Work Measurement Principles using Stopwatch Time Study, Predetermined Motion Time Standards and Work Sampling, Standard Time Estimation.

(4 hours)

Module II

4. Location and Layout Planning : Factor Influencing Plant and Warehouse Locations, Impact of Location on cost and revenues. Facility Location Procedure and Models : Qualitative Models, Breakeven Analysis, Single Facility, Location Model, Multi-facility Location Model, Mini max Location, Total and Partial Covering Model.

   Layout Planning : Layout Types : Process Layout, Product Layout, Fixed Position Layout Planning, Systematic

   Group Technology and Cell Formation, Rank Order Clustering Method for Machine – Component Assignment,. Line Balancing : Basic concepts, General Procedure, Rank Positional Weight Method.

(7 hours)

5. Forecasting : Principles and Method, Moving Average, Double Moving Average, Exponential Smoothing, Double Exponential Smoothing, Winter's Method for Searonal Demand, Forecasting Error Analysis.

Module III

6. Manufacturing Planning and Control : The Framework and Components : Aggregate Planning, Master Production Scheduling, Rough-cut-Capacity Planning, Material Requirements Planning, Capacity Requirements Planning, Shop Order System and Purchase Order System. Transportation Method for Aggregate Production Planning, Material Requirement Planning, Scheduling and Dispatching Functions, Progress Monitoring and Control.

(4 hours)

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

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

(4 hours)

Module - IV

9. Project Management : Project Management through PERT / CPM. Network Construction, CPM, Network Calculation, Crashing of Project Network, Project Scheduling with Limited Resources. Line of Balance.

(5 hours)

10. Modern Trends in Manufacturing : Just in Time (JIT) System; Shop Floor Control By Kanbans, Total Quality Management, Total Productive Maintenance, ISO 9000, Quality Circle, Kaizen, Poke Yoke, Supply Chain Management

(6 hours)

Reference :

1. J. L. Riggs : Production Systems : planning Analysis and Control, John Wiley.
2. E. E Adam and R. J. Ebert " Production and Operation Management", Prentice Hall of India, 2004.
3. S.N. Chary, " Production and Operations Management", Tata McGraw Hill.
4. R. Paneerselvam, "Production and Operation Management, Prentice Hall of India, 2005.

CPMT 6306 PHASE TRANSFORMATION AND HEAT TREATMENT (3-1-0) 4

Module-I (12 hours)

Introduction: Component, phase, phase rule and 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; Kirkindall 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; Ternary phase diagram.

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

Module- II (10 hours)

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; Matensite and martensitic changes in ferrous materials.

Module-III (10 hours)

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.

Module-IV (10 hours)

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; Heat treatment of some Cu, Al and Ti based alloys.

Books for reference

1. Phase Transformation in Materials by R. C. Sharma
2. Phase Transformation in Metals and Alloys by D. A.Porter and K. Easterling, Van Nostrand, 1981
3. Physical Metallurgy Principles by R. E. Reed-Hill
4. Structure and Properties of Alloys by R. M. Brick, R. B. Gordon and A. Phillips
5. Introduction to Materials Science and Engineering by J. F. Shackelford
6. Phase Transformations in Materials by Jena, A.K. and Chaturvedi, Prentice-Hall, 1993
7. Theory of Structural Transformations in Solids by Khachaturyan, A.G., John Wiley, 1983

CPMT 6307 DEFORMATION BEHAVIOUR OF MATERIALS(3-1-0) 4

Module – I (10 hours)

Introduction: Scope of the subject, 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.

Module – II (10 hours)

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.

Module – III (10 hours)

Microscopic basis of plastic deformation: 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.

Plastic deformation of single crystals: Critical resolved shear stress, deformation by twinning, deformation band and kink band, strain hardening of single crystal; stress-strain curves of fcc, bcc and hcp materials.

Module – IV (12 hours)

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.

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 and D. Bacon:, 3rd Edition, Mcgraw-Hill Company, New-Delhi, 1988
2. Deformation and Fracture Mechanics of Engineering Materials by R.W. Hertzberg:, 3rd edition, John Wiley & Sons, Inc., New York, 1989
3. Mechanical behaviour of materials by M. A. Meyers and k. K. Chawla
4. Mechanical behaviour of materials by T.H. Courtney

CPMT 6308 MECHANICAL WORKING AND TESTING OF MATERIALS (3-1-0) 4

Module- I (10 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, defects .

Module – II (10 hours)

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

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

Drawing of Rods, Wires and Tubes- Processes, drawing stress.

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

Module – III (12 hours)

National and International Standards for Mechanical tests

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

Tension test- Engineering & true stress-strain curves, evaluation of tensile properties, Tensile instability, Effect of strain-rate & temperature on flow properties.

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- IV (12 hours)

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

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.

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

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 and D. Bacon:, 3rd Edition, Mcgraw-Hill Company, New-Delhi, 1988
2. Testing of Metallic materials by C. Suryanarayana:
3. An Introduction to principles of Metal working by G. W. Rowe
4. Deformation and Fracture Mechanics of Engineering Materials by R.W. Hertzberg, 3rd edition, John Wiley & Sons, Inc., New York, 1989.
5. Practical Non Destructive Testing by Baldev Raj.

CPMT 6309 IRON MAKING AND FERRO-ALLOYS (3-1-0)

Module – I (12 hours)

General overview of iron and steel making in India and abroad. General layout of an integrated steel plant.
Raw materials and their properties: Iron ores agglomerates and coke:
Preparation of ore: Sintering and palletizing process and bonding mechanisms. Blast furnace burdening and distribution; testing of raw materials for the blast furnace.
Design: Blast furnace profile, stove and gas cleaning units; instrumentation; refractories used in blast furnace and stove.

Module – II (12 hours)

Operation: Blowing in, blowing out and blast furnace; concept of cohesive zone reactions, thermodynamic equilibrium in stack , bosh and hearth.
Slags: Formation of primary and Bosh slag; hearth slag, slag composition; effect of Al2O3, MgO and SiO2; slag control, metal slag reaction.

Module – III (10 hours)

Modern developments: Bell-less charging system, use of super fluxed sinter, high top pressure, humidified and oxygen enriched blast and auxiliary fuel injection through tuyers and their effect on productivity and coke rate; on line computer control. Charge calculations and materials balance.

Module- IV (12 hours)

Ferro-alloys: Production of Fe-Mn, Fe-Si, Fe-Cr and their uses in metallurgical industries.

Alternative route of iron making: Direct reduction process, coal based processes such as SLRN, ACCAR etc, Gas based process such as Midrex, Hyl etc.Use of DRI in iron and steel industries.

Smelting Reduction process Viz: Corex and Romelt, DIOS,HISmelt. Pollution control in iron and steel industries.

Books for reference:

1. Principles of Blast Furnace Iron Making by A.K.Biswas, SWA Publication Calcutta, 1981.
2. Physical Chemistry of Iron and Steel Manufacture by Bodsworth, ELBS, 1963.
3. Physical Chemistry of Iron and Steel Making by R.G.Ward, Edward Amold, 1962.
4. Introduction of Modern Iron Making by R.H.Tupkary, Khanna Publishers, New Delhi 1982.
5. The Making Shaping and Treating of Steel, U.S.Steel Corporation,1971.
6. Transport Phenomena by R.B.Bird, W.E.Steward and E.N.Light Foot, John Wiley & Sons N.Y.1960.
7. Transport Phenomena in Metallurgy by G.H.Geoger & D.R.Poirer, Addison Wesley, 1973.
8. Rate Phenomena in Process Metallurgy by J.Szekely & N.J.Themelis, John Wiley N.Y.1971.
9. Principles of Extractive Metallurgy by A.Ghosh & H.S.Ray, Wiley Eastern 1991.

CPMT 6310 X-RAY AND METAL PHYSICS(3-0-0)

Module –I (10 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 (10 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.

Module – III (10 hours)

Application: Phase diagram, order-disorder transformation, chemical analysis, residual stress, texture.

Module – IV (12 hours)

Metal Physics: Electron Theory of metals: Uncertainty principle, dual nature of matter, free electron theory, density of states, zone theory, dependence of energy on wave number, conductors and insulators, semiconductors – intrinsic and impurity, important semiconductors and their band structures.

Books for reference :

1. Elements of X-Ray Diffraction by B. D. Cullity, 2nd Ed., Adison-Wesley, 1978
2. Structure of Metals by C. Barret and T. B. Massalski, 3rd Ed., Pergamon, 1980
3. X-ray Diffraction – its Theory and Applications by S. K. Chatterjee, Prentice – Hall of India, New Delhi, 1999
4. Physical Metallurgy Principles by R. E. Reed-Hill.
5. An Introduction to Solid State Physics by C. Kittel.

PRACTICALS

CPMT 9304 PHASE TRANSFORMATION 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 –
   (i) low temperature tempering.
   (ii) medium temperature tempering.
   (iii) 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.

CPMT 9305 TESTING OF METALS 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.

COURSE STRUCTURE
FOURTH YEAR B.TECH PROGRAMME
METALLURGICAL & MATERIALS ENGINEERING

7th Semester				8th Semester			
Theory		*Contact Hrs.*	*Credit*	*Theory*		*Contact Hrs.*	*Credit*
		L-T-P				**L-T-P**	
HSSM4403	Environmental Engg.	3-0-0	3	HSSM4404	Marketing Management	3-0-0	3
CPMT6301	Steel Making	3-1-0	4	CPMT6404	Characterization of Materials	3-1-0	4
CPMT6402	Non-Ferrous Extractive Metallurgy	3-1-0	4	CPMT6405	Corrosion & Degradation of Materials	3-1-0	4
CPMT6403	Fabrication of Materials	3-1-0	4	PEMT6405	Alternative Routes of Iron Making/	3-0-0	3
PEMT6401	Powder Metallurgy /	3-0-0	3	PEMT6406	Ferro-Alloy Technology	3-0-0	3
PEMT6402	Composite Materials			PEMT6407	Metals and Alloys/	3-0-0	3
PEMT6403	Metallurgy of Metal Joining/	3-0-0	3	PEMT6408	Fracture Mechanics & Failure Analysis		
PEMT6404	Casting Processes and Solidification						
	Total		**21**		**Total**		**17**
Practicals/Sessionals		*Contact Hrs.*	*Credit*	*Practicals/Sessionals*		*Contact Hrs.*	*Credit*
CPMT9401	Project		3	CPMT9404	Project		5
CPMT9402	Seminar		1	CPMT9405	Seminar		1
CPMT9403	Process Metallurgy Lab	0-0-3	2	CPMT9406	Entrepreneurship Project	0-0-3	2
				CPMT9407	Comp. Viva Voce	0-0-3	2
			6				**10**
	Total		**27**		**Total**		**27**

L-Lecture **T-Tutorial** **P-Practical**

7th SEMESTER

HSSM 4403 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, Air cycle etc., Environmental gradients, Tolerance levels of environment factor, EU, US and Indian Environmental Law, Global Perspective.

Chemistry and Microbiology in Environmental Engineering : Physical and chemical properties of water, Atmospheric chemistry, Soil chemistry, Microbiology, Chemical and biochemical reactions, Material balances and Reactor configurations.

Concept in Hydrology : Hydrological cycle, Water balance, Energy budget, Precipitation, Infiltration, evaporation and evapotranspiration, Rainfall-runoff relationships, Urban hydrology, Ground water, Ground water chemistry, Water contamination and pollution prevention.

Module – II (9 hours)

Water Pollution : water quality standards and parameters, Assessment of water quality, Aquatic pollution, Freshwater pollution, Estuarine water quality, Marine pollution, Organic content parameters, DO and BOD demand in streams, Transformation process in water bodies, Oxygen transfer by water bodies, Turbulent mixing, Water quality in lakes and preservers , Ground water quality.

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.

Noise Pollution : Physical Properties of sound, Noise criteria, Noise Standards, Noise measurement, Noise control.

Module – III (15 hours)

Water Treatment : Water quality standards, Water sources and their quality, Water treatment processes, Pre-treatment of water, Conventional process, Advanced water treatment process.

Waste Water Treatment : Water flow rate and characteristics, Design of waste water network, 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. Bio-solids regulations, Characteristics and processing of bio-solids, first and second stage processing of sludge. Sludge disposal,. Integrated sewage and sludge management.

Solid Waste Management

Source classification and composition of MSW : properties and separation, storage and transportation, MSW Management, Waste minimization of MSW, Reuse and recycling, Biological treatment, Thermal treatment, Landfill, Integrated waste management.

Hazardous Waste Management, Hazardous waste and their generation, Medical hazardous waste, Household waste, Transportation and treatment of hazardous waste : Incinerators, Inorganic waste treatment, Treatment systems for hazardous waste, handling of treatment plant residue.

Industrial Air Emission Control :

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

Module – IV (8 hours)

Waste Minimization : Concept, Life Cycle Assessment, Elements of waste minimization strategy, Benefits of waste minimization, Elements of waste minimization programme, Waste reduction techniques.

Environment impact Assessment, Origin and procedure of EIA, Project Screening for EIA, Scope studies, Preparation and review of EIS.

Reference :

1. Environmental Engineering Irwin/ McGraw Hill International Edition, 1997, G. Kiely,
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. Principles of Environmental Science, Curringhum
5. Introduction to Environmental Science, Y. Anjaneyalu, B. S. Publication.

CPMT 6301 STEEL MAKING (3-1-0)

Module-I (10 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.

Module – II (12 hours)

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, sloping, maneuvering lance height for dephosphorisation and decarburization. Catch Carbon technique. Recovery of waste heat.

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.

Module – III (10 hours)

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. UIIP electric arc furnace with D.C supply, single graphite electrodes, 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 – IV (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 application.

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.

Books for reference:

1. Physical Chemistry of Iron and Steel Manufracture by C.Bodsworth, Longman Green & Co. London 1963.
2. Physical Chemistry of Iron and Steel Making by R.G.Ward, ELBS and Edward Amold 1962
3. The Making Shaping and Treating of Steel, U.S.Steel.
4. Basic Open Hearth Steel Making by G.Derge, AIMME, N.Y.1964
5. Casting Pit Practice by J.D.Sharp, Cliff Book Ltd, London 1968
6. Oxygen Steel Making for Steel Makers by A.Jackson, Butterworth, 1969
7. Electric Furnace Steel Making: Design, Operation & Practice, Vol.I &II, by C.E.Sims (ed), Interscience, N.Y., 1963.
8. Theoretical Principles of Electric Steel Making by V.Atanseyev, Mir Publishers, Moscow (English Translation).
9. Introduction to Modern Steel Making by R.H.Tupkary, Khanna Publishers, New Delhi1977.
10. Secondary Steel Making, SP RportMetal Soc., 1978.
11. Principles of Steel Making by A.K.Biswas, Asia Publication, 1966.
12. Principles of Secondary Processing and Casting of Liquid Steel by A.Ghosh, Oxford &IBP 1990
13. Secondary Steel Making, Seminar, Jamshedpur, 1989

CPMT 6402 NON-FERROUS EXTRACTIVE METALLURGY (3-1-0)

Module- I (12 hours)

Thermodynamic considerations and process selection in pyrometallurgical extraction of metals like Cu, Ni, Pb, and Zn from sulfide ores, extraction of Sn and Mg from oxide ores, extraction of Ti and Zr through halide route.

Module – II (10 hours)

Refining by oxidation, chemical transport reactions, zone refining, distillation etc. Newer processes like. Noranda, Mitsubishi Q-s and WORCRA in Cu extraction, ISP in Zn extraction. Kinetics, mechanism and processes for leaching of pure metals, oxide and sulfide ores; bioleaching.

Module – III (10 hours)

Thermodynamics of reduction by gases for obtaining metals from solution. Ion exchange and solvent extraction processes-their application in extraction processes of Zr, V, Th, Nb, Ta etc.

Module – IV (12 hours)

Electrowinning and electro refining of metals-aqueous (Cu, Ni, Au, Ag) and fused salt (Al and Mg). Recovery of by-product metals and treatment of metallurgical wastes. Numerical problems related to extraction and refining of metals.

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. Metallurgy of Non Ferrous Metals by W.H.Dennis, Pitman.
3. Non Ferrous Production Metallurgy by J.I.Bray, John Wiley, N.Y.
4. General Metallurgy by N.Severykov et al, Mir Publishers, Moscow.
5. Rare Metal Extraction by Chemical Engg. Tech. by W.D.Jamrack, Pergamon Press, Oxford.

CPMT 6403 FABRICATION OF MATERIALS (3-1-0)

Module-I (12 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.

Module – II (12 hours)

Melting practices for ferrous and non-ferrous alloys-Cupola, rotary furnace, induction furnace, crucible furnace melting. Introduction to cast alloys-classification microstructures and properties of cast irons, plain carbon and Hadfield Manganese steels, Al-Si-alloys. Heat treatment of cast alloys. Casting defects and remedy. Special casting processes.

Module – III (10 hours)

Introduction to metal joining processes. Metallurgical principles involved in welding of carbon and alloy steels and important nonferrous alloys.

Module – IV (10 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. Introduction to Powder Metallurgy by F.V.Lenel
5. Powder Metallurgy Science by R.M.German
6. Welding by Little, TMH.
7. Welding by A.C. Davies, Cambridge University Press.
8. Metallurgy of Welding, Brazing and Soldering by J.F.Lancaster.

PEMT 6401 POWDER METALLURGY (3-0-0)

Module – I (10 hours)

Introduction: Development of powder metallurgy-scope of powder metallurgy, characterization of metal powders, physical properties-particle size and shape determination, technological properties-apparent density, flow rate, compressibility etc. and chemical properties.

Module – II (10 hours)

Powder manufacture: Mechanical fabrication techniques – machining, milling, other impaction techniques, mechanical alloying, Electrolytic fabrication techniques, chemical fabrication techniques –

decomposition of a solid by a gas, thermal decomposition, precipitation from a liquid, precipitation from a gas, Atomization fabrication techniques – gas atomization, water atomization, centrifugal atomization, other atomization approaches.

Mixing and blending approaches, friction in a powder mass – mixing efficiency, powder lubrication.

Module – III (12 hours)

Compaction and sintering: Behaviour of powder during compaction, Die compaction: Types of presses: Tooling and design: Modern methods of powder consolidation, Isostatic pressing, Roll compaction, Powder extrusion and forging, Slip casting, and other consolidation techniques. Sintering of metal powders: characteristic stages, Mechanisms, Process variables and their significance. Liquid phase sintering. Hot pressing.

Module – IV (10 hours)

Powder metallurgy products: Bearing, filters, friction parts, hard metals, refractory metals, contact materials, magnetic materials, structural parts, dispersion strengthened materials.

Books for reference:

1. Introduction to Powder Metallurgy by F.V.Lenel
2. Powder Metallurgy Science by R.M.German
3. Treaties on Powder Metallurgy by Goetzel, Vol-I&II
4. Powder Metallurgy by R.Lsande & C.R.S.Shakespere
5. Powder Metallurgy by A.K.Sinha, Dhanpat Rai

PEMT 6402 COMPOSITE MATERIALS (3-0-0)

Module – I (10 hours)

Introduction, classification, strengthening mechanism in composites, types of reinforcement-metallic and nonmetallic fibers, whiskers and particulates;

Module – II (12 hours)

Metal matrix and ceramic matrix composites:

Technology for production of composites - liquid metal route, powder metallurgy and mechanical working for metal matrix and ceramic matrix composites - processing routes including reaction sintering combustion synthesis, infiltration and in-situ processes;
Processing of intermetallic composites, Comparison of MMCs and CMCs.

Module – III (10 hours)

Polymer composites:
Matrices, thermoplastic and thermosetting; Reinforcements - continuous and discontinuous fibres - glass, aramid, polyester, and carbon fibres; surface characteristics; hybridisation techniques, Fillers and their uses, autoclave, hand lay-up techniques etc.,

Fabrication methods of polymer matrix composites:
Filament winding; Resin injection moulding; extrusion, calendering, pultrusion, degradation of fibers.

Module – IV (10 hours)

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

Application of composites: Aerospace, marine, automobile, dental products.

Design aspects, carbon-carbon and carbon - epoxy based composites, mechanical properties.

Books for reference :

1. Metal Matrix Composites, Thermomechanical Behaviour by Taya, M. and Arsenault, R.J., Pergamon Press, Oxford, 1989.
2. An Introduction to Metal Matrix Composites by Clyne, T.W., and Withers, P.J., Cambridge Univ. Press, 1993.
3. Fundamentals of Metal Matrix Composites by Suresh, S., Martensen, A. and Needleman, A., Butterworth, Heinemann, 1993.
4. Engineering Composite Materials by Hall, D., Cambridge University Press, 1991.
5. Handbook of Plastic test methods by Roger P Brown (Ed.), Longmans in association with Plastics and Rubber Institute, 1991.

PEMT 6403 METALLURGY OF METAL JOINING (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.

Module – II (12 hours)

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

Metallurgy of fusion welding of ferritic and austenitic steels, cast iron etc. welding pool solidification, structure of welds, heat treatment and transformation.

Module – III (10 hours)

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

Residual welding stresses and stress relieving treatments.

Module – IV (10 hours)

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. Welding by Little, TMH.
2. Welding by A.C. Davies, Cambridge University Press.
3. Metallurgy of Welding, Brazing and Soldering by J.F.Lancaster.
4. Metallurgy of Welding by Sefarin, John Wiley.
5. Welding Hand Book, Vol-I &II.

PEMT 6404 CASTING PROCESSES AND SOLIDIFICATION (3-0-0)

Module – I (12 hours)

Introduction: Importance of solidification in metal casting processes, heat flow and heat evolution, shrinkage during cooling and solidification.
Plane front solidification: Solidification of single phase alloys, directional solidification, crystal growth etc.

Module – II (10 hours)

Nucleation and interface kinetics: Homogeneous nucleation, heterogeneous nucleation, grain refining, lateral growth, continuous growth, instability at the solid/liquid interface.

Module – III (10 hours)

Solidification microstructure: Cells, dendrites, solidification of polyphase alloys, eutectic and peritectic solidification, growth of graphite in cast iron, segregation in castings, inclusions in castings etc.

Module – IV (10 hours)

Special casting techniques: Ceramic shell, investment casting, Rheo & thixocasting, squeeze casting, high and low pressure die casting, continuous casting, cast metal matrix components.

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 Hein R.W., Loper C. R. & Rosenthal P.C, T.M.H., New Delhi, 1981.
4. Foundry Engineering by Taylor H.F., Flemming M.C. & Wulff, Wiley Eastern.
5. Foundry Technology by Beeley P.R., Butterworth, London.

PRACTICALS
CPMT 9403 PROCESS METALLURGY LAB. (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. compression 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**.**

8th SEMESTER

HSSM 4404 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 (9 hours)

Marketing Management : Concept, Process, Functions and relevance in the current context.

Marketing Environment : Socio-economic forces. Competition : national and global, Technology, Government Policy, Suppliers, Buyers, Consumer Resistance considerations. Environment scanning tools and techniques

Competition Analysis : Factors contributing to competition, Competition analysis tools, Competitive arena mapping, Segmentation matrix.

Market Planning : Exploring Opportunity, Product –market selection, Approaches to Market Planning, Market Planning Process.

Module II (10 hours)

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, Competitive Intelligence.

Consumer Behaviour : Importance of buyer and his/ her role in purchasing. Influence of buyer behaviour, Buyer behaviour study tools. Organizational buying behaviour.

Market Segmentation, Targeting and Positioning : Definition, Bases and Methods of segmenting consumer and Industrial markets. Target Market strategies: Domestic and global perspective. 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.

Module – III (11 hours)

Product Planning : Product Life Cycle, Locating products in PLC, New Product Development Process, Branding Strategy, Positioning a Brand, Brand Equity, Packaging and Labeling, Product-mix and Product Line, Product-Mix strategies, Planned Obsolescence.

Pricing Decision : Objectives and Factors influencing pricing, Cost-Plus Pricing, Breakeven Analysis, Price Based on Marginal Analysis, Price Elasticity of Demand, Operating statement, Markups Analysis Ratios, Pricing Strategies : Market-Entry, Discounts and allowances, Geographic Pricing, Special Pricing.

Promotion Decisions : Marketing Communication and Promotion Process, Promotion Mix, Advertising : Media and Media selection process. Organising for advertising, sales promotion.

Module -IV (10 hours)

Channels of Distributions : Designing Distribution Channels, Wholesaling and Physical Distribution, Retailing. Supply Chain Management (Basic only). Personal selling, Direct Marketing, Managing Sales Force.

Trends in Marketing : Global Marketing, Customer Services, Customer Relationship Management, Rural Marketing and Service Marketing.

REFERENCES :

1. M. J. Etazel , B. J. Walker and W. J. Stanton, Marketing, Tata McGraw Hill, 13th Edition, 2004.
2. R. Saxena, "Marketing Management" Tata McGraw Hill, second Edition, 2003.

CPMT 6404 CHARACTERIZATION OF MATERIALS (3-1-0)

Module – I (11 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.

Module – II (11 hours)

Mass spectroscopy: Principles and brief account.

Metallographic techniques: Optical metallography, image analysis, quantitative phase estimation.

Diffraction methods: X-ray diffraction, X-ray topography, residual stress measurement techniques, small angle X-ray and neutron scattering.

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; application of SEM and EPMA to solid samples and biological materials; type of data base required to process the results.

(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.

Module – IV (10 hours)

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. Structure of Metals by Barett, C.S. and Massalski, T.B., Pergamon Press, Oxford, 1980
2. Elements of X-ray diffraction by Cullity B.D., Addison-Wesley, 1978
3. Transmission Electron Microscopy by Williams, D.B. and Barry Carter C., Plenum Press, New York, 1996.
4. Differential Thermal Analysis by R.C.Machenzie
5. Modern Metallographic Techniques and their application by Victor A.Phillips

CPMT 6405 CORROSION AND DEGRADATION OF MATERIALS (3-1-0)

Module – I (10 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 (10 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.

Module – IV (10 hours)

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., 3rd Edition, McGraw-Hill, N.Y.,1978.
2. Introduction to Metallic Corrosion by Evans.
3. Introduction of Electrochemistry by S.Glasstone
4. Corrosion Handbook by Uhlig.
5. Microbiologically influenced corrosion handbook by Borenstein.

PEMT 6405 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 (11 hours)

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

Module – III (10 hours)

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

Module – IV (10 hours)

Smelting Reduction Processes:
COREX, ROMELT, DIOS, HI Smelt etc. Present status of alternative methods of iron making in India.

Books for reference:

1. Direct Reduction of Iron . Editiors :Jerome Feinman & Donald R.Mac Rae, Allied Publishers Ltd.
2. Beyond the Blast Furnace, by Amit Chatterjee.

PEMT 6406 FERRO-ALLOY TECHNOLOGY (3-0-0)

Module – I (10 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.

Module – II (10 hours)

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 – III (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 – IV (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. On All India Seminar on Recent Trends in Ferro-Alloys Technology, Nagpur, December, 1977.

PEMT 6407 METALS AND ALLOYS (3-0-0)

Module – I (11 hours)

Carbon and alloy steels: mechanical behaviour of steels, structure and property relationship in 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.

Stainless steels: classification, heat treatment and uses of stainless steels.

Special steels: heat resisting steels, Hadfield manganese steels, ultra high strength steels- maraging steels, TRIP steels.

Module – II (10 hours)

Cast irons: classification; microstructure, properties, heat treatment and uses of different types of cast irons; alloy cast irons such as Ni-hard, Ni-resist and high silicon cast irons.

Aluminium and its alloys: heat treatment and uses of Al-Si, Al-Cu, Al-Mg, Al-Zn alloys. Magnesium alloys; and Zinc alloys.

Copper and its alloys: brasses, bronzes, cupronickels, nickel silvers, beryllium copper. Bearing alloys.

Properties and engineering applications of beryllium, gold and silver.

Module –III (11 hours)

Special and high temperature alloys: Ti alloys, alloying behaviour of titanium, alpha grades of titanium, alpha-beta alloys and beta alloys, physical and mechanical properties, thermo-mechanical treatment of Ti-alloys.

High temperature alloys: Fe based super alloys, Ni based alloys, effects of alloying elements; Haste alloys, Inconel, Nimonic alloys and their engineering application; Co based alloys, effects of alloying elements, engineering application at elevated temperatures.

Module – IV (10 hours)

Refractory metals and alloys: structure, properties and applications of Zirconium, Molybdenum, Tungsten, Tantalum, Niobium and their alloys.

Intermetallic compounds: crystal structures, basic mechanical properties, and lattice defects of intermetallic compounds; magnetic, electrical and optical properties and applications of Intermetallic compounds – Ni3Al, NiAl, gamma TiAl, Ti3Al, Al3Ti, FeAl and Fe3Al, and their alloys, and Zr3Al - nuclear reactor structural material. Silicides and their applications. Intermetallics as precipitates and dispersoids in high-strength alloys.

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.

PEMT 6408 FRACTURE MECHANICS AND FAILURE ANALYSIS (3-0-0)

Module – I (12 hours)

Fracture Mechanics:

Stress intensity factor, stress analysis of cracks, Derivation of the relationship between strain energy release rate and stress intensity factor. Crack- tip plastic zone, Dugdales's plastic strip model.

Fracture mode transition: Plane stress versus plane strain, Crack opening displacement, Plain strain fracture toughness KIC testing, fracture toughness determination with elastic plastic analysis (JIC).

Module – II (10 hours)

Fatigue, strain life equation, Fatigue crack initiation mechanics, Fatigue crack propagation, Paris law. Fatigue life calculation, Microscopic fracture mechanics, Short crack growth behaviour, Influence of load interactions.

Stress corrosion cracking, Kiscc determination, Corrosion fatigue, Temper embrittlement, Hydrogen embrittlement, SEM fractography of ductile (Dimple), brittle (cleavage), Fatigue fractured surface.

Module – III (10 hours)

Failure Analysis:

Classification of different types of failures; Description and origin of processing defects: Metal working defects, casting defects, heat treatment defects and weld defects; Failure due to environmental degradation.

Module – IV (10 hours)

Procedures of failure analysis: stages of analysis, preliminary examination of the failed part; Fracture surface and fracture path analysis to characterize failure mechanism and to locate origin of fracture; Overview of mechanical test parameters and non-destructive testing; Selection, Presentation and clearing of fractured surfaces, Macro examination, Micro examination (Metallography and Fractography), Chemical analysis, Simulated service testing, Analysing the evidence; Generalized procedure for analysis of common failures; Fault tree technique for failure analysis; Case studies.

Books for reference:

1. Mechanical Metallurgy by G. E. Dieter, Mcgraw-Hill Company, New-Delhi, 1988
2. Deformation and Fracture Mechanics of Engineering Materials by R.W. Hertzberg:, 3rd edition, John Wiley & Sons, Inc., New York, 1989
4. Mechanical behaviour of materials by T.H. Courtney
5. Fatigue of Materials by S. Suresh, Second Edition, Cambridge University Press, 1998.
6. Fracture Mechanics by Broek.
7. Analysis of Metallurgical Failures, 2nd Edition by V. J. Colangelo, F. A. Heiser (Wiley)

CPMT 9406 ENTREPRENEURSHIP PROJECT (0-0-3)

1. The project will be for 2 credits and 3 periods per week is to be devoted for the project.
2. The teacher has to give elementary idea about entrepreneurship through classroom teaching before a project report is prepared by the student.
3. The teacher will first cover the following topics through lecturer and exercises on motivation and games.

- Entrepreneurship concept, EDP in India, Indian middle class value.
- Entrepreneurial qualities, motivation perception, risk taking etc.
- Market survey, Business opportunity guidance
- Role of DIC, SFC, Bank etc.
- Working capital assessment, Balance Sheet, Costing, Book keeping.
- Decision making, Leadership, Communication skill
- Preliminary Project Report, preparation for a specific product and submission of the report.

4. Evaluation

(a) The teacher has to conduct tests/ motivational exercises to assess entrepreneurial capability of the student (20%)

(b) The teacher has to test the knowledge of the student on the above topic through a written test. (20%)

(c) The teacher has to evaluate the report submitted by the student (i.e. Project report within 50 pages) (60%).

REFERENCE BOOKS :

1. Entrepreneurship of Small Industries, M. V. Deshpande, Deep and Deep Publication

2. Management of Small Scale Industry, Vasant Desai, Himalaya Pub. House

----