BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ORISSA
Mineral Engineering

3rd SEMESTER				4th SEMESTER			
THEORY		*Contact Hours*		*THEORY*		*Contact Hours*	
Code	*Subject*	*L-T-P*	*Credits*	*Code*	*Subject*	*L-T-P*	*Credits*
BSCM 1205	Mathematics – III	3-1-0	4				
				PCME4207	Machine Dynamics	3-1-0	4
PCME4201	Fluid Mechanics & Hydraulic Machines	3-1-0	4	BEEE2215	Energy Conversion Technique	3-0-0	3
PCME4202	Mechanics of Solids	3-0-0	3	BECS2208	Database Management System	3-0-0	3
BECS2212	C++ & Object Oriented Programming	3-0-0	3	HSSM3205	Organisation Behaviour		
					OR	3-0-0	3
				HSSM3204	Engineering Economics & Costing		
HSSM3204	Engineering Economics & Costing	3-0-0	3	PCML4202	Introduction to Mineral Processing and Metallurgy.	3-0-0	3
	OR						
HSSM3205	Organizational Behaviour						
PCML4201	Geology	3-0-0	3	PCMT4202	Metallurgy Thermodynamics and Kinetics	3-1-0	4
		Credits (Theory)	20			Credits (Theory)	20
	PRACTICALS / SESSIONALS				*PRACTICALS / SESSIONALS*		
HSSM7203	Communication & Interpersonal Skills for Corporate Readiness Lab.	0-0-3	2	BECS7208	Database Management System Lab	0-0-3	2
BECS7212	C++ & Object Oriented Programming Lab	0-0-3	2	BEEE7215	Energy Conversion Technique Lab	0-0-3	2
PCML7201	Geology Lab.	0-0-3	2	PCML7202	Mineral Processing lab	0-0-3	2
		Credits (Practicals/ Sessionals)	6			Credits (Practicals/Sessionals)	6
		TOTAL SEMESTER CREDITS	26			TOTAL SEMESTER CREDITS	26

BSCM1205 **Mathematics - III**

Module-I (18 hours)
Partial differential equation of first order, Linear partial differential equation, Non-linear partial differential equation, Homogenous and non-homogeneous partial differential equation with constant co-efficient, Cauchy type, Monge's method, Second order partial differential equation The vibrating string, the wave equation and its solution, the heat equation and its solution, Two dimensional wave equation and its solution, Laplace equation in polar, cylindrical and spherical coordinates, potential.

Module-II (12 hours)
Complex Analysis:
Analytic function, Cauchy-Riemann equations, Laplace equation, Conformal mapping, Complex integration: Line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula, Derivatives of analytic functions

Module –III (10 hours)

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

Text books:

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

Reference books:

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

PCME4201 **Fluid Mechanics and Hydraulic Machines**

Module I **(13 Lectures)**

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

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

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

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

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

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

Mathematical definitions of irrotational and rotational motion. Circulation, potential function and stream function. Flow net

Module II **(12 Lectures)**

Fluid dynamics : Introduction, Euler's equation along a streamline, energy equation, Bernoulli's equation and its application to siphon, venturimeter, orificemeter, pitot tube.

Flow in pipes and ducts: Loss due to friction, Minor energy losses in pipes Hydraulic Gradient Line (HGL), Total Energy Line (TEL), Power transmission in the fluid flow in pipes, fluid flow in pipes in series and parallel. Flow through nozzles.

Module III **(15 Lectures)**

Hydraulic turbine: Classification, Impulse and Reaction turbine; Tangential, Radial and axial turbine.

Impulse turbine, Pelton wheel, bucket dimensions, number of buckets in pelton wheel, efficiency and performance curves.

Reaction Turbines: Francis turbine and Kaplan turbine, velocity triangle and efficiencies, performance curve. Function of draft tube and casing cavitation

Centrifugal Pump: constructional features, vane shape, velocity triangles, Efficiencies, Multi stage centrifugal pumps, Pump Characteristic, NPSH and Cavitation.

Positive displacement pumps: Reciprocating Pump, Working principle, Discharge, work done and power requirement, Slip, Indicator diagram

Text Books

1. Fluid Mechanics and Hydraulic Machines, Modi & Seth
2. Introduction to Fluid Mechanics and Fluid Machines by S.K. Som and G. Biswas, TMH
3. Fluid Mechanics, A.K.Jain, Khanna Publishers

Reference Books:

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

PCME4202 **Mechanics of Solids**

MODULE - I (14 Lectures)

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

MODULE - II (13 Lectures)

4. Shear Force and Bending Moment for Simple Beams :
   Shear force and bending moment. Types of load and Types of support. Support reactions, Relationship between bending moment and shear force, Point of inflection. Shear Force and Bending Moment diagrams.

5. Simple Bending of Beams :Theory of simple bending of initially straight beams, Bending stresses, Shear stresses in bending, Distribution of normal and shear stress, beams of two materials, Composite beams.
6. Deflection of Beams :Differential equation of the elastic line, Slope and deflection of beams by integration method and area - moment method.

MODULE - III (12 Lectures)

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

TEXT BOOKS

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

REFERENCE BOOKS

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

BECS2212 C++ & Object Oriented Programming

Module I **(08 hrs)**

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

Module II **(16 hrs)**

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

Module III **(08 hrs)**

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

Text Books:

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

Reference Books:

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

HSSM3204 Engineering Economics & Costing

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

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

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

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

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

Cost concepts, Elements of costs, Preparation of cost sheet, Segregation of costs into fixed and variable costs. Break-even analysis-Linear approach. (Simple numerical problems to be solved)

Banking: Meaning and functions of commercial banks; functions of Reserve Bank of India. Overview of Indian Financial system.

Text Books:

1. Riggs, Bedworth and Randhwa, “Engineering Economics”, McGraw Hill Education India.
2. M.D. Mithani, Principles of Economics.

Reference Books :

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

HSSM 3205 **Organizational Behaviour**

Module I :

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

Module II :

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

Module-III :

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

Text Books :

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

Reference Books :

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

PCML 4201 Geology (3-0-0)

Module I **14 hours**

Mineral resources: Brief idea about mineral resources of India: Geographical Distribution and reserves, Mining methods. Crystal systems- all normal classes.

Petrology- Brief description of Igneous, Sedimentary & Metamorphic rocks, Genesis of common rocks.

Crystallography – Axial relationship, symmetry elements and forms present in normal class of cubic, Tetragonal, Hexagonal, Orthorhombic, monoclinic and Triclinic systems.

Mineralogy – Classification of minerals, Physical properties of minerals, Chemical physical and optical properties of silicate mineral groups : Olivine, Garnet, pyroxene, Amphibole, Mica, Felspar and Quartz.

Module II **16 hours**

Mineral Chemistry: Geochemical differentiation, Geochemical classification of elements, isomorphism polymorphism, geochemical cycle. Mineral Economics: Sampling, assaying, elementary idea on drilling and mining.

Module III **6 hours**

Mineral Deposits: Classification of mineral deposits, Process of formation of mineral deposits- Magmatic concentration, Hydrothermal, Residual and Mechanical concentration, contact metasomatism, Oxidation and supergene sulphide enrichment, sublimation, Evaporation and Metamorphism. Uses Mineralogy, mode of occurrence, genesis and Indian distribution of ore deposits viz., Iron, Manganese, chromium, Aluminium, Copper, Lead and Zinc, Radioactive minerals.

HSSM7203 Communication & Interpersonal skills for Corporate Readiness Lab.

Lab **30 hours**

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

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

1. Gaining entry into an organization

   i. Preparing job-applications and CVs

   ii. Facing an interview

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

2 In-house communication

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

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

BECS7212 C++ & Object Oriented Programming Lab

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

PCML7201 Geology Lab (0-0-3)

1. Identification of crystals of the normal classes.
2. Megascopic identification of rock forming minerals, ore minerals and industrial minerals.
3. Megascopic identification of Rocks.

4th Semester

PCME4207 Machine Dynamics (3-1-0)

MODULE – I **(12 Hours)**

1. Mechanisms : Basic Kinematic concepts and definitions, Mechanism, Link, Kinematic Pair, Classification of kinematic pairs, Degrees of freedom, Kinematic chain, Binary Ternary and Quaternary joints and links, Degrees of freedom for plane mechanism, Grubler's Equation, Inversion of mechanism, Four bar chains and their inversions, Single slider crank chain, Double slider crank chain and their inversion.
2. Kinematic Analysis : Determination of velocity using graphical and analytical techniques, Instantaneous centre method, Relative velocity method, Kennedy theorem, Velocity in four bar mechanism, Slider crank mechanism, Rubbing velocity at a Pin-joint.
   Acceleration Diagram for a slider – crank mechanism, Corili's component of acceleration and its application.

MODULE – II **(12 Hours)**

3. Inertia forces in reciprocating Parts : Velocity and acceleration of piston by analytical method, Angular velocity and angular acceleration of connecting rod by analytical method and by graphical metho, Piston effort, force acting along the connecting rod, Crank effort, Turning moment on crank – shaft.
4. Dynamically equivalent system, compound Pendulum, correction couple.
   Turning moment diagrams for different types of engines, Fluctuation of energy and fluctuation of
   speed.
5. Friction of a screw and nut, Square threaded screw, V-threaded screw, Pivot and collar friction, friction circle, Friction axis, Friction clutches, Transmission of power by single plate, mutiplate and cone clutches.

MODULE – III **(12 Hours)**

6. Brakes & Dynamometers : Classification of brakes, Analysis of simple block, Band and internal expanding shoe brake, Braking of a vehicle.
   Absorbing and transmission dynamometers, Prony brake, Rope brake, Band brake dynamometer, Belt transmission dynamometer, Torsion dynamometer.
7. Gear Trains : Simple Train, Compound train, Reverted train, Epicyclic train and their applications.
8. Belt, rope and chain drives, Initial tension, Effect of centrifugal tension on power transmission, Maximum power transmission capacity, Belt creep and slip.

TEXT BOOKS

L.A Textbook of Theory of Machines (In S. I. units) – R. K. Bansal, Laxmi Publication

Chapter : 1, 3, 4, 7, 8, 10, 11, 12.

REFERENCE BOOKS :

L. The Theory of Machines – Thomas Bevan.

BEEE2215 **Energy Conversion Techniques**

MODULE- I (10 Hrs)

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

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

MODULE- II (10 Hrs)

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

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

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

MODULE- III (10 Hrs)

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

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

Text Book :

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

Reference Book(s):

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

BECS2208 Database Management System

Module I : (10 hours)

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

Module II : (12 hours)

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

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

Query Processing Strategy.

Module III: (10 hours)

Transaction processing: Recovery and Concurrency Control. Locking and Timestamp based Schedulers.

Database Recovery System: Types of Data Base failure & Types of Database Recovery, Recovery techniques

Text Books:

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

References Books:

(1) An introduction to Database System – Bipin Desai, Galgotia Publications
(2) Database System: concept, Design & Application by S.K.Singh (Pearson Education)
(3) Database management system by leon &leon (Vikas publishing House).
(4) Fundamentals of Database Management System – Gillenson, Wiley India
(5) Database Modeling and Design: Logical Design by Toby J. Teorey, Sam S. Lightstone, and Tom Nadeau, "", 4th Edition, 2005, Elsevier India Publications, New Delhi

PCML4202 Introduction to Mineral Processing and Metallurgy

Module-I **(8 Hours)**

Introduction to mineral processing, scope and importance, liberation and its importance-degree of liberation, Optimum degree of liberation

Module-II **(14 Hours)**

Brief introduction to different types of unit operations; Quantification of mineral Engineering unit processes: recovery, ratio of concentration, enrichment ratio and separation efficiency etc. Economics of mineral processing.

Module-III **(14 Hours)**

Basic concept of metallurgy, different types of metallurgical processes (pyro, hydro & electro metallurgy). Roasting, smelting, converting, leaching, precipitation processes. Faraday's laws, electro winning and refining.

PCMT4202 Metallurgy Thermodynamics and Kinetics

Module I **(15 Hours)**

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

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

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

Module II **(13 Hours)**

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

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

Module III **(15 Hours)**

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

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

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

References

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

BECS7208 Database Managements System Lab

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

BEEC7215 Energy Conversion Techniques Lab

Select any 8 experiments from the list of 10 experiments

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

PCML 7202 Mineral Processing Lab

1. Crushing of the ore and finding the R.R. of the Jaws.
2. Determination of R.R. of the ball mill.
3. Determination of critical speed of the ball mill.
4. Determination of grindability index of ball mill
5. Laboratory screen analysis for finding average particle size.(Sieve analysis)
6. Roll crusher
7. Jigging.
8. Electromagnetic separation.

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BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ORISSA

MINERAL ENGINEERING

5th SEMESTER				6th SEMESTER			
THEORY		*Contact Hours*		*THEORY*		*Contact Hours*	
Code	*Subject*	*L-T-P*	*Credits*	*Code*	*Subject*	*L-T-P*	*Credits*
HSSM3303	Environmental Engineering & Safety	3-0-0		HSSM3302	Optimization Engineering	3-0-0	
	OR		3		OR		3
HSSM3302	Optimization Engineering	3-0-0		HSSM3303	Environmental Engineering & Safety	3-0-0	
PCML4301	Transport Phenomena	3-0-0	3	PCML4305	Mining Methods & Unit Operation	3-0-0	3
PCML4303	Particle Technology	3-0-0	3	PCML4304	Material Handling Systems	3-0-0	3
PCML4302	Comminution & Classification	3-0-0	3		Professional Elective – II (*Any One*)	3-0-0	3
	Professional Elective – I (*Any One*)	3-0-0	3	PEML5301	Fuel technology		
PEML5303	Physical Separation			PEML5302	Material Characterisation		
PCMN4301	Mine Machinery				Professional Elective – II (*Any One*)	3-0-0	3
	Free Elective – I (*Any One*)	3-0-0	3	PEML5304	Coal Preparation		
FEML6302	Mining Geology			PEML5305	Waste Processing & Utilisation		
FESM6301	Numerical Methods				Free Elective – II (*Any One*)	3-0-0	3
				FEML6303	Process Dynamic		
				PEEI5301	Analytical Instrumentation		
				HSSM3301	Principle of Management		
	Credits (Theory)		18		Credits (Theory)		18
	PRACTICALS/SESSIONALS				*PRACTICALS/SESSIONALS*		
PCML7301	Material Lab.	0-0-3	2	PCML7305	Fuel Technology Lab/ Material Characterisation Lab.	0-0-3	2
PCML7302	Comminution & Classification Lab.	0-0-3	2	PCML7304	Material Handling Lab.	0-0-3	2
PCML7303	Particle Technology Lab.	0-0-3	2				
	Credits (Practicals / Sessionals)		6		Credits (Practicals / Sessionals)		4
	TOTAL SEMESTER CREDITS		24		TOTAL SEMESTER CREDITS		22
	TOTAL CUMULATIVE CREDITS				TOTAL CUMULATIVE CREDITS		

HSSM3303 **ENVIRONMENTAL ENGINEERING & SAFETY**

(3-0-0)

Module – I

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

Module – II

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

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

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

Module – III

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

Text Book :

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

Reference Books

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

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

Module-I **(10 Hours)**

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

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

Module-II **(10 Hours)**

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

Assignment problems: Hungarian method for solution of Assignment problems

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

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

Module-III **(10 Hours)**

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

Unconstraint optimization: Fibonacci and Golden Section Search method.

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

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

Introduction to Genetic Algorithm.

Recommended text books

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

Recommended Reference books:

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

PCML4301 **TRANSPORT PHENOMENA** (3-0-0)

Module-I: (12 hrs)
Introduction: Transport Processes, Dimensional Analysis.

Momentum Transfer: Steady & Unsteady Flows; Overall mass, energy & momentum balance; Navier Stokes equation; Newton's Law, Non-Newtonian Fluids; Laminar flow in falling film, flow through conduits etc; Inviscid fluid flow, Viscous flow, Laminar & Turbulent Boundary Layer Theory, Friction Factor; Flow past immersed objects, packed and fluidized bed.

Module-II: (15 hrs)
Mass Transfer: Steady state mass transfer and diffusion; molecular diffusion in gasses, liquid, biological gels and solids; Unsteady state mass transfer under different conditions, mass transfer coefficient, diffusion through porous medium and capillaries; Boundary layer flow and turbulence in mass transfer, Simulation heat, mass and momentum transfer.

Module-II: (18 hrs)
Heat Transfer:

Conduction: Steady State: One Dimensional- Composite wall and cylinder; Multidimensional- Differential heat balance, shape factor, graphical and numerical methods.

Unsteady State: Analytical solutions of one dimensional lumped heat capacitysystem, heat flowin semi-infinite solid, convection boundary conditions, Heisler chart solutions.

Convection: Natural & forced convection, overall heat transfer coefficient, fouling factor, types of heat exchanges.

Radiation: Physical mechanism, radiation properties, shape factor, heat exchange between non-black bodies, infinite parallel planes, radiation shields, gas radiation.

PCML4303 **PARTICLE TECHNOLOGY** (3-0-0)

Module-I:
Sampling of solids and slurries- principle, methods, sampling theories, sampling for different application, Indian standards. Production of fine particles and their characterization, Concept of equivalent diameter for small particles. **(12 hrs)**

Module-II:
Particle size distribution and quantification: Gaudin- Schumann, Gaudin-Meloy equation, Rosin-Rammler, Broadbent and Calcott equation . Methods of particle size measurement: Sieving, sedimentation and elutriation, Optical methods, On-line particle size measurement, Computer analysis of size distribution data. **(15 hrs)**

Module-III:
Particle shape characterization – different methods, image analyzers, Surface area measurement – direct and indirect methods, permeability, gas adsorption., Volume and porosity measurements, Bulk solids packing density and ratio, Bulk solids properties – bulk density, true density abrasivity, voidage, friability and flowability. Fundamentals of blending. **(18 hrs)**

Books:
Introduction to Particle Technology by Martin Rhodes

PCML4302 **COMMINUTION AND CLASSIFICATION** (3-0-0)

Module-I: (10 hrs)
Mining and its effect on rock size distribution, Fundamentals of size reduction, Comminution laws; Liberation studies-effect of size on liberation; drop shatter tests and shatter index, single particle breakage and packed bed breakage.

Module-II: (25 hrs)
Crushing: Jaw, Gyratory, Cone, Roll crusher, Hammer mills and Rotary breakers, High compression rolls: their construction, operation maintenance and performance aspects. In-pit and portable crushers.

Grinding: Grinding mills principles, construction and their operation, Mill liners, Feed entry, and product discharge mechanisms. Open and closed circuit grinding: Ball, Rod, Pebble, Autogenous and Fluid energy mills. Application of these mills for specific processing requirements: Effect of process parameters on mill performance.

Industrial screening: Fundamentals of screening, Dry and wet screening, Classification of screens, operation and maintenance of different types of industrial screens. Pre-scrubbing and other processes to improve screening efficiency.

Module-III: (10 hrs)
Classification: Introducing to different types of classifiers used in mineral industry; Hydrocyclones; construction, operation, maintenance. Efficiency of classifiers, solid and water balance calculations.

Books:
Mineral Processing Technology by B.A. Wills and Tim Napier-Munn

Free Electives

PCML5303 **PHYSICAL SEPARATION PROCESSES** (3-0-0)

Module-I:

Separation of particles using Wilfley Table. Performance analysis of a laboratory size mineral Jig, laboratory concentration table treating synthetic mixture samples. **(12 hrs)**

Module-II:
Effect of irrigation water, inclination, angle on the performance of a Mozely Mineral Separator treating various minerals. Demonstration on Multi-gravity separator. **(13 hrs)**

Module-III:
Determination of magnetic content of a given sample using Davis tube magnetic separator, Effect of feed rate, current intensity on separation of magnetic and non-magnetic particles with Low and high intensity magnetic separators. Recovery of minerals by using Electrostatic separator. **(20 hrs)**

Books:
Mineral Processing Technology by B.A. Wills and Tim Napier-Munn

PCMN4301 **MINE MACHINERY** (3-0-0)

Module-1:
Prime mover for mining machinery, I.C. Engine, Hydraulic power Pneumatic power, Element of mechanical power transmission gears, coupling, clutch and brake. **(12 hrs)**

Module-II
Wire rope and winding system, Mine hoist: Different types of winders, their constructional features, kinematics, torque and power calculation, speed control, safety devices, cage, skip head gear structure, cage guide, shaft fittings, Man riding system in mines. **(18 hrs)**

Module-III
Belt conveyors, rope haulage, chain conveyor and locomotive their constructional features, power calculation and safety appliances.Mine pump and drainage. **(15 hrs)**

BOOKS :

1. Mine Transport by L. T. Kerelin
2. EMT Volume III by D. J. Desmukh

FEML4301**MINING GEOLOGY** (3-0-0)

Module-I (12 hrs)
Process of formation of mineral deposits. Controls of mineral deposition. Principles and methods of geological, Geophysical and geochemical prospecting.
Module-II (15 hrs)
Mineralogy, mode of occurrence, distribution and commercial uses of important Mineral deposits of India i.e Iron, Chromite, Buxite, Manganise, Copper, Lead- Zinc, Industrial mineral- Mica, Gypsum, Kyanite, Limestone.

Module-III (18 hrs)
Mine Sampling, Estimation of ore reserves and grades, tenor, impurities and quality control.
Engineering Geology: Geological considerations in connection with -

1. Dam and associated reservoirs
2. Tunnels.
3. Bridges.
4. Ground water.

BOOKS:

FESM6301 **NUERICAL METHODS** (3-0-0)

Unit –I (10 hors)
Approximation of numbers, Significant figures, Accuracy and precision, Error definition, Round off errors, Error propagation, Total numerical error
Roots of equation: Bisection ethos, False-position method, Fixed point iteration, Newton-Raphson method, Secant method, Convergence and error analysis, System of non-linear equations
Linear algebraic equation: LU decomposition, The matrix inversion, Error analysis and system conditions, Gauss-Siedel method

Unit-II (10 hours)
Interpolation: Newton's divided difference interpolating polynomial, Lagrange interpolating polynomial, Spline interpolation.
Numerical integration: The Trapezoidal rule, Simpson's rule, Newton-Cotes algorithm for equations, Romberg integration, Gauss quadrature

Unit-III (10 Hours)
Ordinary differential equation: Euler method, Improvement of Euler's method, Runge-Kutta methods, System of equations, Multi step methods,
General methods for boundary value problems, Eigen value problems
(Algorithm and error analysis of all methods are included)

Text Book:

1. S.C. Chapra, R.P.Canale," *Numerical methods for Engineers*", Fifth edition, THM Publication.

Reference Books

1. S. Kalavathy, " *Numerica methods*", Thomson/ Cengage India K.E. Atkinson," *Numerical analysis,*" Second edition, John Wiley & Sons.

MATERIALS LAB. (0-0-2)

1. To determine the Hardness of the given Samples by Brinell, Vickers and Rockwell hardness Testing.
2. To determine the impact strength of the given samples by Charpy Impact Tests.
3. To determine the tensile properties of the given materials using Universal Testing Machine (UTM) – yield strength, tensile strength, % elongation, % reduction of area.
4. To determine the compression strength of the given sample.
5. To determine the fatigue strength of the given sample.
6. To study the ultrasonic flaw detector and determine the cracks within a sample.

PCML7302 COMMINUTION AND CLASSIFICATION Lab (0-0-3)

Estimation of reduction ratios, capacities and efficiencies for various size reduction unit such as Jaw crushers, Roll Crushers, Ball mills etc. Determination of Bond and HGI work index values for the given samples. Performance analysis of laboratory model continuous screen. Calculation of setting velocity of particle.

PCML7303 PARTICLE TECHNOLOGY Lab (0-0-3)

Methods of sampling, accuracy and precision of sampling. Determination particle size distribution of powder by Dry sieving, Comparison of wet and dry sieving efficiencies for fine powders, Sieving by alpine air jet sieve sizer, Sub sieve sizing by: Warman cyclosizer, beaker decantation techniques, Andersen Pipette method. Surface area determination. Bulk density, true density and apparent, porosity, fariability determination

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6th Semester

PCML4305 MINING METHODS & UNIT OPERATIONS (3-0-0)

Surface Mining: Deposits amenable to surface mining; Box Cut: Objectives, types parameter and methods, Production benches- objectives, formation and bench parameters, Unit operations and associated equipments, Classification of surface mining systems.

Underground Coal Mining: Deposits amenable to underground coal mining classification of underground coal mining methods, Board and Pillar methods – general description and applications and merits and demerits, selection of panel size, operation involved and associated equipment. Longwall methods-type and their general description, applicability, merits and demerits, selection of face length and panel length, operations involved and associated equipments, Methods for mining steeply inclined seams and thick seams, hydraulic mining.

Underground metal mining: Deposits amenable to underground metal mining, shape size & position of drifts and cross cuts, Raises and Winzes, classification of underground metal mining methods, Stoping methods – general description, applicability, operations involved and associated equipments for room and pillar mining, stope and piellar mining, shrinkage, stoping, sub-level stoping, cut and fill stoping, VCR methods, Sub-level caving and caving.

References:

a) Mining by Boky
b) Coal Mining Practice by Statham
c) Longwall Mining by Sykd S Peng and H. S. Chiang

PCML4304 **MATERIAL HANDLING SYSTEMS** (3-0-0)

Module - I:

Property of bulk material vis-a-vis different bulk handling operation. classification of bulk material transportation systems.

Module - II :

Design, operation & maintenance aspect of belt conveyor & chain conveyor special conveyor : Their selection & application. Hydraulic & Pneumatic conveying.

Module - III :

Stacking, blending & reclaiming of bulk materials. Automation & on-line monitoring of bulk material handling system. Design of storage system : Silos, bins & Bunkers, Rapid loading system., Merry-go-round systems.

PEML5301 **FUEL TECHNOLOGY** (3-0-0)

Introduction: Types of solid fuel, origin of coal petrography, mineral matter in coal, classification and grading of coal, chemical and physical properties of coal, plastic/coking properties of coal, thermal decomposition of coal, selection, testing utilization of coking and Non-coking coal.

Coal carbonization: Fundamentals of coal carbonization, types of carbonization process, by product recovery and coke properties; non-recovery coke ovens.

Liquid Fuels: Classification of petroleum, characterization of petroleum and their products. Coal liquefaction.

Gaseous Fuels: Classification of gas, production of gaseous fuel such as producer gas, water gas, natural gas coal bed methane.

PEML5302 **MATERIALS CHARACTERIZATION** (3-0-0)

Module I (12 Hours)
Introduction: Scope of subject, classification of techniques for characterization, macro and micro-characterization structure of solids. Bulk averaging techniques:
Thermal analysis: DTA, DSC, TGA, dilatometry, resistivity/ conductivity.
Optical & X-ray spectroscopy: Atomic absorption spectroscopy, X-ray spectrometry, infrared spectroscopy and Raman spectroscopy.
Mass spectroscopy: Principles and brief account.
Metallographic techniques: Optical metallography, image analysis, quantitative phase estimation.

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

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

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

PEML5304 COAL PREPARATIONS (3-0-0)

Coal characteristics, Necessity, scope and application of coal preparation, washability characteristics of coal, effect of mining methods on size, quality and washability.

Crushing of coal : Various types of coal size reduction process and their significance.

Screening of coal: Classification of coal using various screens and their efficiency.

Coarse coal cleaning: Jigs, heavy media baths and heavy media cyclones. Use of Spirals and tables for coal processing. Performance analysis of different coal cleaning unit operations(Partition curves, misplacement , Meyers curve) and their merits and demerits.

Fine coal cleaning : Challenges in fine coal cleaning, Froth-Flotation, water-only cyclone, Vorsyl separators, oil – agglomeration.

Product disposal and Miscellaneous methods, coal preparation economics, coal preparation flowsheets, modern developments.

PEML5305 WASTE PROCESSING & UTILISATION

Introduction: Types of waste generated from processing plant, related environmental hazards, different methods of solid waste utilization with special emphasis on red mud, steel plant waste and Fly ash wastes.

Characterisation of different solid wastes, problems encountered in handling and storing, environmental Impacts, methodologies for disposal of the above solid waste. Uitlisation of above solids in different industries such as building material, fertilizer, PVC products, paints, pigments, cement industries, use of solid wastes in brick making, coating, chemical industries for adsorption, filteration, purification etc.

Properties: Composition of slags from BF, LD, EAF, Cupola, Slag produced in Non-ferrous plants. Properties. Use of slags. Cement – Type of slag, granulation treatment, transportation, grinding, mixing & properties, Slag Wool – Type of slag, granulation, handling, compaction, Slag Balast – properties & uses in Fertilizer industries, Composition, treatment & application, Slag grinding.

Properties: Composition, size, shape, surface properties, refractoriness, density.

Applications: Building Brick – Binder selection, mixing, compaction, strengthening, Testing, Equipments, economics. Insulation brick – Additives, compaction firing and testing. Soil treatment – characteristic properties, uses, Pozolana – Properties & testing Road Making – Properties & Testing, Horticultural Use, Effluent Treatment, Mine filling, Smelting, Other uses.

FEML6303 **PROCESS DYNAMICS** (3-0-0)

Module - I

Response of first order systems, Physical examples of first order systems Response of first order systems in series, Response of Second order systems, Transportation lag. Control System, controllers and final control elements, Block diagram of a Chemical Reactor Control system, Closed loop transfer functions, Transient response of simple control systems.

Module - II

Stability, Root locus, Frequency response, Control system design by frequency response. Cascade control, feed forward control, Ratio control, Dead time compensation, Internal model control, controller tuning and process identification, control valves.

Module – III

Introduction to sampled data controllers, sampled data control of a first order process with transportation lag, Design of sampled data controllers, Digital computer simulation of control systems.

Textbooks and References :

1. Corghnowr, D. R., Process Systems Analysis and Control, Mc Graw Hill Book.
2. Chemical Process Control, George Stephenopoulos, Prentice Hall.
3. J. M. Douglas, Process Dynamics & Control, Prentice Hall.

PEEI5301 **ANALYTICAL INSTRUMENTATION** (3-0-0)

Module I: 12 Hours

Fundamentals of Analytical Instruments: Elements of an Analytical Instrument, Intelligent Analytical Instrumentation Systems, PC-based Analytical Instruments.

Spectrophotometers: Ultraviolet and Visible Absorption Spectroscopy, Calorimeters, Photometers, Different types of Spectrophotometers, Sources of Errors and Calibration, Infrared Spectrophotometers – Basic Components and Types, Sample Handling Techniques, Flame Photometers – Principle, Constructional Details, Types and accessories, Atomic Absorption Spectrophotometers and their instrumentation.

(1.1, 1.5, 1.6, 2.4, 2.5, 2.6, 2.7, 3.1, 3.2, 3.3, 3.4, 4.1, 4.2, 4.3, 4.5, 5.1 and 5.2)

Module II: 14 hours

Chromatography: Gas Chromatograph – Basic Parts of a Gas Chromatograph, Methods of Measurement of Peak Areas, Liquid Chromatograph – Types, High Pressure Liquid Chromatograph.

pH meters and Ion Analyzers: Principle of pH Measurement, Electrodes for pH Measurement, pH Meters, Ion Analyzers, Blood pH Measurement.

Gas Analyzers: Measurement of Blood pCO_2 and pO_2, Industrial Gas Analyzers – Types, Paramagnetic Gas Analyzer, Infrared Gas Analyzers, Industrial gas Analyzers Based on Other Methods.

(16.1, 16.3, 16.4, 16.5, 17.1, 17.2, 17.3, 21.2, 21.3, 21.4, 21.6, 22.2, 22.3, 22.4, 23.1, 23.2, 23.3, 23.5)

Module III: 12 Hours

Principles of Nuclear Magnetic Resonance: Nuclear Magnetic Resonance (NMR) Spectroscopy – Principle, Types and Construction details of NMR Spectrometers.

Radiochemical Instruments: Fundamentals of Radiochemical Methods, Radiation Detectors, Liquid Scintillation Counters, Gamma Spectroscopy.

X-Ray Spectrometers: Instrumentation for X-Ray Spectrometry, X-Ray Diffractometers, X-Ray Absorption Meters, Electron Probe Microanalyzer.

(10.1, 10.2, 10.3, 10.4, 13.1, 13.2, 13.3, 13.5, 14.2, 14.3, 14.4, 14.6)

TEXT BOOK:

1. Handbook of Analytical Instruments – by R.S. Khandpur, TMH Education Pvt. Ltd.

REFERENCE BOOKS:

1. Instrumental Methods of Analysis – by Willard H.H., Merrit L.L., Dean J.A.. and Seattle F.L., CBS Publishing and Distributors, 6/e, 1995.
2. Instrument Technology – by Jones B.E., Butterworth Scientific Publ., London, 1987.
3. Mechanical and Industrial Measurements by Jain R.K., Khanna Publishing,N Delhi, 2/e, 1992.
4. Principles of Instrumental Analysis – by Skoog D.A. and West D.M., Holt Sounder Publication, Philadelphia, 1985.
5. Instrumental Analysis – by Mann C.K., Vickerks T.J. & Gullick W.H., Harper and Row Publishers, New York, 1974.
6. Jone's instrument Technology (vol. 2 and 3) - B.E. Noltingk, Butterworth-Heinmann, N Delhi.
7. Instrumental Methods of Chemical Analysis - E.W. Ewing, McGraw-Hill.
8. Instrumentation, Measurement and Analysis - B.C. Nakra and K.K. Chowdhurry, TMH.
9. Measurement and Instrumentation: Trends and Applications - M.K. Ghosh, S.Sen and S. Mukhopadhyay (ed.), Ane Books, New Delhi, 2008.

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

Module I: Functions of Management

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

Module II: Marketing Function of Management.

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

Module III: Financial Function & HRM Functions.

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

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

Reference Books:

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

PCML7305 **FUEL TECHNOLOGY LAB**

1. Proximate analysis of coal
2. Ultimate analysis of coal
3. Calorific value of coal
4. Free swelling index, coking index, GKLT, sulpher determination,
5. Petrography, aniline point, flame & fire point of coal,
6. Ash fusion temperature of coal,
7. Shatter and abrasion indices of coal,
8. Penetration index of bitumen & wax
9. Viscosity of coal slurry
10. Viscosity of oil by Redwood viscometer
11. Crossing point of a coal sample.

MATERIAL CHARACTERIZATION LAB

1. Thermo gravimetric Analysis of Ores and Minerals
2. Metallographic Analysis of Ores and Minerals
3. Chromatographic Method of Analysis of Minerals
4. X-ray Diffraction Analysis of minerals
5. Scanning Electron Microscopy of Minerals
6. Differential Thermal Analysis
7. EDAX / WDX

PCML7304 **MATERIAL HANDLING LAB**

Laboratory classes related to various material handling systems and industrial visits.

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BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ORISSA

MINERAL ENGINEERING

7th SEMESTER				8th SEMESTER			
THEORY		*Contact Hours*		*THEORY*		*Contact Hours*	
Code	*Subject*	*L-T-P*	*Credits*	*Code*	*Subject*	*L-T-P*	*Credits*
PCML4401	Surface Phenomenon & Froth Flotation	3-0-0	3	HSSM3403	Marketing Management	3-0-0	3
PCML4402	Dewatering & Drying	3-0-0	3	PCML4404	Process Flow Design & Plant Layout	3-0-0	3
PCML4403	Modeling & Simulation	3-0-0	3	PCML4405	Process Equipment Selection & Design	3-0-0	3
	Professional Elective – I (*Any One*)				Free Elective – II (*Any One*)		
PEML5401	Gravity, Magnetic & Electrical Separation	3-0-0	3	FEML6403	Elements of Material Engineering	3-0-0	3
PEML5402	Mineral Process Technology			FEML6404	Iron & Steel Making		
	Free Elective – I (*Any One*)				Free Elective – II (*Any One*)		
FEML6401	Extractive Metallurgy	3-0-0	3	FEML6405	Sintering and Pelletization	3-0-0	3
FEML6402	Combustion & Energy Engineering			PEEI5403	Industrial Instrumentation		
				FEML6406	Petroleum Production & Refining		
	Credits (Theory)		15		Credits (Theory)		15
	PRACTICALS/SESSIONALS				*PRACTICALS/SESSIONALS*		
PCML7401	Dewatering & Drying Lab.	0-0-3	2	PCML7404	Project	0-0-3	7
PCML7402	Project	0-0-3	3	PCML7405	Seminar	0-0-3	3
PCML7403	Seminar	0-0-3	2				
	Credits (Practicals / Sessionals)		7		Credits (Practicals / Sessionals)		10
	TOTAL SEMESTER CREDITS		22		TOTAL SEMESTER CREDITS		25
	TOTAL CUMULATIVE CREDITS				TOTAL CUMULATIVE CREDITS		204

SURFACE PHENOMENA AND FROTH FLOTATION

Objectives: The course aims at familiarizing the students with the underlying principles of Froth Flotation, which is finding progressively wider application in the mineral as well as the other fine particles separation industries. It would not only enable them to design and operate the froth flotation plants but also motivate them to take up new innovations in the field.

Module I

Overview of the properties of solid-liquid, solid-gas and gas-liquid interfaces. Electro kinetic (zeta) potential. Contact angle – its role in froth flotation. Different types of Frothers, Cationic, anionic and other collectors. Activators and depressants, pH regulators and modifiers. Interaction of the different reagents in froth flotation. Need and effects of conditioning. (12 hours)

Module II

Froth flotation machines – Bubble column, agitation froth and other types of flotation cells, Design of aeration devices, impellers, casings and air flow rates. Flotation Kinetics. The effects of the reagents, cell design and mode of operation on the flotation rates. Estimation of residence time and total cell volumes required

(12 hours)

Module III

Design and operation of froth flotation circuits. Rougher, scavenger, cleaner and recleaner operations. Pulp densities and hence water requirements for different stages of froth flotation. Maintenance of pulp heights and froth depths in the cells for different stages. Estimation of the effects of the circulating load in the froth flotation circuits.

(12 hours)

Text Books:

1. Froth Flotation by A.M.Gaudin - McCraw-Hill, 1957
2. Mineral Processing Technology by Barty A. Wills and Tim Napier Munn - Elsevier 2006

References

1. Handbook of Mineral Dressing by A.F.Taggart - John Wiley and Sons, New York. 1956
2. Mineral Processing Design and Operation by A.Gupta and D.S.Yan - Elsevier 2006
3. Ore Dressing by R.H.Richards (4 volumes) – Engineering & Mining Journal 1909
4. Ore Dressing Principles and Practice by T.Simon – McGraw Hill Co., 1924
5. A Text Book of Ore Dressing by S.J.Truscott – London Macmillan. 1923
6. Handbook of Ore Dressing by A.F.Taggart - John Wiley and Sons, New York. 1956
7. Handbook of Ore Dressing by A.W.Allen – McGraw Hill Co., 1920
8. Complete Technology Book on Mineral Processing by NPSC Board – Asia Pacific Business Press 2008

DEWATERING & DRYING

Objective: This course is to familiarize the under graduate students with the techniques of dewatering and drying in the mineral processing plants for the production of moisture free concentrates as well as regeneration of water for reuse.

Module I

Introduction to dewatering and drying. Need, role and scope of drying in Mineral beneficiation. Roles of flocculation and dispersion. Fundamental factors underlying flocculation and dispersion phenomena and Mechanism of reagent adsorption. Factors affecting flocculation and dispersion, selective flocculation.

(12 hours)

Module II

Dewatering by gravity sedimentation (thickening) principles and practices. Sizing and selection of thickeners, Different types of thickeners and their use in mineral industries. Filtration: Principles of filtration, Flow through packed beds, factors affecting the filtration. Different types of filters and their design features.

(12 hours)

Module III

Hydro cyclones in drying circuits. Centrifuging & Drying: Centrifugal sedimentation, different types of centrifuges. Thermal drying of mineral concentrates for dry processing. Different types of thermal dryers and their applications. Application and practice of dewatering processes in mineral industries.

(12 hours)

Text Books

1. Handbook of Industrial Drying by Arun S Majumdar – CRC Press, Dekker 1995

2. Principles of Mineral Processing by Maurice C. Fuerstenau – SME of AIME. 2010

References:

1. Drying Technology: Volume 28, Issue 7, 2010, Special issue: Dewatering – Taylor and Francis

2. The Complete Technology Book on Mineral Processing by NPSC Board – Asia Pacific Business Press 2008

MODELING AND SIMULATION

Objective: The course aims at familiarizing the undergraduate students with the methods of system simulation which is being increasingly used to predict the behaviour and performance of the plant when it is still on the drawing board. It would also enable them to understand the working of the computer software used for simulation

Module I

Overview of simulation of stochastic and deterministic phenomena. Generation of random numbers of different types of probability distributions for the simulation of the stochastic phenomena. Monte Carlo method. Examples of simulation of the stochastic processes in mineral handling systems. (12 hours)

Module II

Representation of the size reduction and size separation processes as matrix multiplication operations. Breakage, selection and classification functions in size reduction and size separation processes. Use of the size distribution and partition value equations for the elements of the matrices. Partition values for the simulation of density separation and other mineral separation processes. (12 hours)

Module III

Circulating loads in the beneficiation circuits and their effects on the design and operation of the plants. Use of process simulation for the estimation of the circulating loads. Direct substitution and other techniques for the estimation of the circulating loads. Elements of computer simulation of beneficiation circuits. (12 hours)

Text Books

1. Mineral Crushing and Grinding circuits, Simulation … by A.J.Lynch – Elsevier 2006
2. Modeling and Simulation of Mineral Processing Systems by Peter R. King – Amazon 2001

References

1. Fishman, G. S. (1995). *Monte Carlo: Concepts, Algorithms, and Applications*. New York: Springer
2. Ripley, B. D. (1987). *Stochastic Simulation*. Wiley & Sons.
3. Computer Simulations in Science and Technology Studies by Ahrweiler, Petra, Gilbert Nigel, and F. Ahrweiler editors.**,** Springer Verlag, 1998. ISBN# 3540648712
4. Advances in Stochastic Simulation Methods by Balakrishnan, N. et. al. editors., Birkhauser, 2000. ISBN# 0817641076
5. Simulation Fundamentals Bennett, Brian., Prentice Hall, 1995. ISBN#0138132623 [general]

GRAVITY, MAGNETIC AND ELECTRICAL SEPARATION

Objective: The objective of this paper is to give the undergraduate students an insight into the principles involved in the design and operation separation processes to segregate the different mineral species.

Module I

Overview of the densities, electrical conductivities and magnetic susceptibilities of the common ore and industrial minerals. Effect of particle size on the separation processes. Testing of the minerals for their amenability to separation. Concentration criterion for dry and wet separation processes based on densities (12 hours)

Module II

Density separation equipment and processes for coarse minerals (larger than Stoke's settling range) based on free settling, hindered settling, consolidation trickling and film sizing. Principles of design and operation of Dens media Separators, Jig Separators, Vibrating Tables, Spiral Concentrators, Tray Concentrators, Cone Concentrators and Corduories. Dry processes of density separation like Air Tables and Winnowing.

(12 hours)

Module III

Different types of high intensity and low intensity dry magnetic separators – Cross belt magnetic separators, Disc magnetic separators, Drum magnetic separators, Pulley type magnetic separators. Wet magnetic separators. Variance and control of magnetic field strength, poll gaps and other parameters in magnetic separation. Design and operation of High Intensity Roll electrical separators. Roll diameters, speeds and numbers of rolls in series and parallel. Rougher, Conductor cleaner and Non conductor cleaner operations. Need and modes of drying of the feed to HTS. Overview of the Plate Electrostatic separators and Screen plate Electrical Separators.

(12 hours)

Text Books

1. Elements of Mineral Dressing by A.F.Taggart - John Wiley and Sons, 1956
2. Mineral Processing Technology by Barty A. Wills and Tim Napier Munn - Elsevier 2006

References

1. Handbook of Mineral Dressing by A.F.Taggart - John Wiley and Sons, New York. 1956
2. Mineral Processing Design and Operation by A.Gupta and D.S.Yan - Elsevier 2006
3. Ore Dressing by R.H.Richards (4 volumes) – Engineering & Mining Journal 1909
4. Ore Dressing Principles and Practice by T.Simon – McGraw Hill Co., 1924
5. A Text Book of Ore Dressing by S.J.Truscott – London Macmillan. 1923

MINERAL PROCESS TECHNOLOGY

Objectives: The objective of this paper is to familiarize the senior under graduate students with the beneficiation circuits of most of the common ore and industrial minerals produced mainly with reference to India.

Module I

Names, compositions and properties of the important minerals of common metals like iron, copper, lead, zinc, tin, chromium, aluminum, manganese, gold, silver, uranium, thorium, titanium, zirconium etc. Cut off, average and concentrate grades of each ore. Similar information about industrial minerals like calcite, silimanite, phosphate, granite, dolomite, magnesite, Ilmenite, rutile, zircon, garnet, monazite, pyrite, quartz, feldspar etc. (12 hours)

Module II

Beneficiation circuits for hematite and magnetite iron ores. Dry and wet processes – their scopes and limitations. Pulp densities at different stages of wet operations. Estimation of water requirements and pumping loads. Beneficiation circuits for lead, zinc and copper ores. Optimization of the grinding process for liberation of the minerals and minimization of slime loss. Scope and limitations of regrinding circuits.
(12 hours)

Module III

Concentration, concentrate up gradation and separation processes for beach sand minerals. Effects of repeated cleaner operations on grades and recoveries. Overview of the beneficiation circuits of ores of gold, tin, manganese and other metals Overview of the beneficiation of lime stone, graphite and other industrial minerals (12 hours)

Text Books

1. Elements of Mineral Dressing by A.F.Taggart - John Wiley and Sons, 1956
2. Mineral Processing Technology by Barty A. Wills and Tim Napier Munn - Elsevier 2006
3. Mineral Dressing by A.M.Gaudin - McCraw-Hill, 1957

References

1. Handbook of Mineral Dressing by A.F.Taggart - John Wiley and Sons, New York. 1956
2. Mineral Processing Design and Operation by A.Gupta and D.S.Yan - Elsevier 2006
3. Ore Dressing by R.H.Richards (4 volumes) – Engineering & Mining Journal 1909
4. Ore Dressing Principles and Practice by T.Simon – McGraw Hill Co., 1924
5. A Text Book of Ore Dressing by S.J.Truscott – London Macmillan. 1923
6. Handbook of Ore Dressing by A.W.Allen – McGraw Hill Co., 1920
7. Complete Technology Book on Mineral Processing by NPSC Board – Asia Pacific Business Press 2008

EXTRACTIVE METALLURGY

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 (14 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…

Numerical problems relevant to different pyro- , hydro- and electrometallurgical 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

COMBUSTION AND ENERGY ENGINEERING

Objective: To give the undergraduate students an understanding of the principles and practices involved in coal combustion processes so as to appreciate the need and scope of mineral beneficiation and transportation for power generation. The paper also aims at familiarizing the students with the alternative energy sources.

Module I

Principles, Stoichiometry and thermodynamics of combustion. Mechanism and Kinetics of coal combustion. Over view of coal combustion on fixed bed and grate firing. Pulverized fuel firing. Fluidization and fluidized bed combustion.

(12 hours)

Module II

Effects of coal properties on the equipment and efficiency of combustion, such as the effects of volatile matter, ash content, ash composition and ash fusion temperatures on the combustion and power generation systems. Economics of transportation coal to distant thermal power stations and high voltage D C transmission of electric power.

(12 hours)

Module III

Comparison of Thermal and Hydroelectric power. Alternative energy resources and energy uses, such as Solar power, Wind energy, Tidal energy, Geothermal enrgy. Current status of energy conversion and conservation technologies.

(12 hours)

Text Books

1. Clean Coal Engineering Technology by Miller – Elsevier 2010
2. Solid Fuel Blending, Principles, Practices & Problems by Tillman – Elsevier 2012

References:

1. Combustion and Energy Utilization: Proceedings of the 5th Asia-Pacific International Symposium on Combustion and Energy Utilization by Huang Zhaoxiang, Liu Xin – Amazon 2010

DEWATERING & DRYING LAB

Suggested Experiments

1. Comparison of pressure and vacuum filter using coal of same size
2. Effect of coal particle size in vacuum filtration,
3. Effect of coal particle size in pressure filtration,
4. Comparison of pressure and vacuum filter using a mineral of same size,
5. Dewatering of coal fines using hydro cyclone,
6. Estimation of filtration rate constant for coal and minerals using vacuum filter,
7. Estimation of filtration rate constant (coal and mineral) using pressure filter,
8. Estimation of rate of sedimentation of solid from a suspension with or without flocculants,
9. Estimation of rate of sedimentation of solid from a suspension with or without dispersants,
10. Estimation of rate of drying using a dryer.

8th SEMESTER

MARKETING MANAGEMENT (3-0-0)

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

Module – I **(10 hours)**

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

Marketing Environment: Elements of micro and macro environment

Competition Analysis: Factors contributing to competition, porter's five forces model, Identifying and analyzing competitors.

Marketing Planning : Exploring Opportunity, Product –market selection, Marketing Planning Process.

Market Research and Information Systems: Research Process, The Internet and World Wide Web based Information collection and processing, Database, Data Warehouses and Data Mining, Global Market Research.

Consumer Behavior: Factors influencing consumer behavior, consumer decision process. Organizational buying behavior.

Module II **(10 hours)**

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

Market Demand Forecasting: Key Terms, Forecasting Tools: Short term tools: Moving average and Exponential smoothing methods, Long-term forecasting Tools: Time series analysis, Econometrics methods, Qualitative tools : Buying Intention Survey, Sales Force Opinion and Delphi Techniques.

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

Module – III **(10 hours)**

Pricing Decision: Objectives and Factors influencing pricing, Pricing method and strategies.

Integrated Marketing Communication(IMC)- Concept of IMC, the marketing communication process, Promotion Mix, elements of promotion mix, Direct marketing.

Channels of Distributions: Types of intermediaries, functions of distribution channels, channel levels, Designing Distribution Channels, Physical Distribution, Supply Chain Management (Basic only).

Trends in Marketing: Green Marketing, Customer Relationship Management, E-marketing, Rural Marketing and Service Marketing (concepts only)

Books:

Text Book:

1. Etzel , Walker ,Stanton and Pandit, Marketing, 14/e, Tata McGraw Hill.

2. Saxena, "Marketing Management" Tata McGraw Hill, 4/e.

Reference

1. Grewal, Levy, 'Marketing' Tata McGraw Hill, special Indian edition.

2. Karunakaran "Marketing Management", Himalaya Publishing House, 2010/e.

3. Kotler, Keller,Koshy and Jha, "Marketing Management", 13/e, Pearson Education.

PROCESS FLOW DESIGN AND PLANT LAYOUT

Objective: The aim of this course is to develop in the senior under graduate students, the ability to appreciate the different aspects of design and lay out of the mineral beneficiation plants and their long term effects on the economy of the plant. It would also help them to understand the interaction of the different processes in the plant

Module I

Different types of feeders for size reduction and separation units. Dimensions of different crushing and grinding units. Head rooms and space required for feed devices, transfer points, conveying and elevating units. Effects of the storage and reclamation requirements. (12 hours)

Module II

Computation of the numbers of units of size reduction, size separation and other separation units. Effects of equipment and processes installed in series and in parallel. Estimation of the pumping requirements associated with the separation processes. Locations and design of sumps and slurry handling systems.

(12 hours)

Module III

Plant configuration and lay outs for different minerals, with reference to the locations of the mineral deposits, ground contours, sources of water, transport facilities. Special requirements for waste disposal facilities. Tailing dams, slime drains and slime ponds. Requirements of the feeder industries and the mineral based ancillary industries.

(12 hours)

Text Books

1. Mineral Processing Design and Operation by A.Gupta and D.S.Yan - Elsevier 2006
2. Mineral Processing Technology by Barty A. Wills and Tim Napier Munn - Elsevier 2006
3. Mineral Comminution Circuits by T.J.Napier Munn. – JKMRC 1996

References

1. Ore Dressing by R.H.Richards (4 volumes) – Engineering & Mining Journal 1909
2. Ore Dressing Principles and Practice by T.Simon – McGraw Hill Co., 1924
3. A Text Book of Ore Dressing by S.J.Truscott – London Macmillan. 1923
4. Handbook of Ore Dressing by A.F.Taggart - John Wiley and Sons, New York. 1956
5. Handbook of Ore Dressing by A.W.Allen – McGraw Hill Co., 1920
6. Complete Technology Book on Mineral Processing by NPSC Board – Asia Pacific Business Press 2008

PROCESS EQUIPMENT SELECTION AND DESIGN

Objective: The purpose of this course is to appraise the senior under graduate students with the different ranges of size reduction, size separation and other separation equipment available and to make a judicious choice in selction from among them for effective and economic industrial use.

Module I

Brief review of mineral engineering unit operations and the ranges of equipment ordinarily used for them. Introduction to various methodologies involved in the selection and sizing of various mineral processing units. Selection and sizing of reciprocating and non-reciprocating crushers. Selection and sizing of rod mills, different types ball mills, autogenous mills and semi autogenous mills (12 hours)

Module II

Selection and sizing of various size separators such as screens and hydraulic classifiers including limitations involved. Selection and sizing of High Tension Roll Separators and choices of configurations. Study of the effect of earlier operations. (12 hours)

Module III

Selection of size reduction equipment especially for coal beneficiation and coal handling plants. Partial deshaling in the size reduction circuit based on differences in breakage properties. Various mineral beneficiation equipments for treating coal and minerals such as jigs, flotation machines, and shakings tables.

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Text Books

1. Mineral Processing Design & Operation by A.Gupta & D.S.Yan - Elsevier 2006
2. Recent Advances in Mineral Processing Plant Design by Malhotra et al - © 2009 Society for Mining, Metallurgy, and Exploration (SME)

References:

1. The Open Mineral Processing Journal, ISSN 1874-8414, http://www.benthamscience.com/open/tompj/
2. Handbook of Mineral Dressing by A.F.Taggart - John Wiley and Sons, New York. 1956
3. Mineral Dressing by A.M.Gaudin - McCraw-Hill, 1957
4. Ore Dressing by R.H.Richards (4 volumes) – Engineering & Mining Journal 1909
5. Ore Dressing Principles and Practice by T.Simon – McGraw Hill Co., 1924
6. A Text Book of Ore Dressing by S.J.Truscott – London Macmillan. 1923
7. Handbook of Ore Dressing by A.F.Taggart - John Wiley and Sons, New York. 1956
8. Handbook of Ore Dressing by A.W.Allen – McGraw Hill Co., 1920
9. Complete Technology Book on Mineral Processing by NPSC Board – Asia Pacific Business Press 2008

ELEMENTS OF MATERIAL ENGINEERING

Objective:

The aim of this course is to give the undergraduate students an overview of the different material being used in the mineral processing industry and their properties, so as to enable them to make judicious selection of material for the construction of mineral processing and handling equipment.

Module I (12 hours)

Classification of Engineering Materials. Characteristic property of metals. Bonding in solids. Crystal systems, common crystal structure of metals, representations of planes and directions in crystals, atomic packing in crystals. Packing density, voids in common crystal structures and imperfections in crystals. Plastic deformation of metals, critical resolve shear stress, dislocation theory, deformation by slip and twin, plastic deformation in polycrystalline metals, yield point phenomenon and related effects, cold working preferred orientation. Annealing; recovery; recrystalization and grain growth; hot working.

Module II (12 Lectures)

Types of alloys, solid solutions, factors governing solids solubility. Binary phase diagrams. Allotropic transformation. Lever rule and its application. Effect of non-equilibrium cooling, coring and homogenization. Iron-cementite and iron-graphite phase diagrams, microstructure and properties of different alloys (alloy steels; stainless steel, tool steel, HSS, high strength low alloy steel) types of cast iron, their microstructures and typical uses. T.T.T. diagram: heat treatment of steels microstructural effects brought about by these processes and their influences on mechanical properties; factor affecting hardenability.

Module III (12 Lectures)

Optical properties of Materials: Scattering, Refraction, Theory of Refraction and absorption, Atomic

Theory of optical properties. Lasers, Optical fibres- Principle, structure, application of optical fibres. Plastic-: Thermosetting and thermoplastics. Ceramics: Types, structure, Mechanical properties, application Composite Materials: Agglomerated Materials: Cermets .Reinforced Materials: Reinforced Concrete. Glass fiber reinforced plastics, Carbon fibre reinforced plastics, fibre reinforced plastics, laminated plastic sheets. Teflon, Properties of composites, Metal matrix composites, manufacturing procedure for fiber reinforced composite. Introduction to Nano-materials

Text Books:

1. Engineering and Physical Metallurgy & Heat Treatment by Y.Lakhtin, Mir Publisher, Moscow
2. Introduction to Physical Metallurgy by Avner, Tata McGraw Hill
3. Material Science and Engineering by W.D.Callister, Wiley and Sons Inc

References:

1. Elements of Material Science and Engineering, L.H.Van Vlack, Addison Wesley
2. Physical Metallurgy: Principles and Practice by Ragahvan, PHI
3. Material Science and Engineering by V.Raghavan, Prentice Hall of India Pvt.Ltd
4. Mechanical Metallurgy by Dieter, Tata MacGraw Hill
5. Material Science and Metallurgy by R.B.Choudhary, Khanna Publishers

IRON & STEEL MAKING

Module – I **14Hrs**

Introduction to the subject: Blast Furnace Route for Iron Making, The Blast Furnace and its accessories, The burden and its preparation, Physical – Thermal and Chemical process in a Blast Furnace, Blast Furnace slag and its control, Control of hot metal composition, Blast Furnace plant and Accessories, Modern trends in Blast Furnace practice, Control of irregularities in the blast furnace, Performance of Blast Furnace over the years. ;

Module – II **10Hrs**

Alternative Methods: Need for alternative Methods, Sponge Iron production by using solid and gaseous reductants, Smelting Reduction Processes. ;

Module – III **14Hrs**

Modern Steel Making: Different routes of steelmaking. Oxygen Steelmaking: Top and Bottom blown converter processes, Hybrid processes. Electric Steel making: Electric Arc furnaces, Induction furnaces. Secondary Steelmaking. ; Casting of liquid steel: Ingot Casting of Steel, Continuous Casting of Steel ; Iron and Steel Scenario in India in the last decade.

Caretaker: Prof. S. Sarkar

Essential Reading:

1. A.Ghosh and A.Chatterjee: *Ironmaking and Steelmaking Theory and Practice*, Prentice-Hall of India Private Limited, 2008.
2. G. R. Bashforth, The Manufacture of Iron and Steel, vol.I, Chapman, London, 1962.
3. C. Bodsworth:Physical Chemistry of Iron & Steel Manufacture,Longman Green & Co.

Supplementary Reading:

1. A.K. Biswas: *Principles of Blast Furnace Iron making*, SBA Publication,1999

2. D.H. Wakelin (ed.): *The Making, Shaping and Treating of Steel (Iron making Volume)*, The AISE Steel Foundation, 2004.

3. R.J. Fruehan (ed.): *The Making, Shaping and Treating of Steel (Steel making Volume)*, The AISE Steel Foundation, 2004.

SINTERING AND PELLETISATION

Objective:
With the depletion of lump size iron ores, Sintering and Pelletisation are assuming progressively greater importance in iron making. This course aims at giving the under graduate students an over view of the processes of Sintering and Pelletisation of iron ores

Module I
Size requirements of irons ores and fluxes for blast furnace feed. Over view of the sources of iron ore fines: blue dust, fines generated while crushing for lump ores, ores finely ground for liberation. Size specifications of iron ores for Sintering and Pelletisation. Preferred locations of Sintering and Pelletisation plants. Sintering theory, processes, equipment and quality control; problems of sintering under Indian conditions. (12 Hours)

Module II
Preparation of feed for the Pelletisation plant. Role of Specific surface area (Blaine number). Pelletisation in disc pelletisers, cone pelletisers and drum pelletisers. Control of green pellet size and quality: drop number, green compression strength and air dried strength. Induration of the pellets in shaft furnaces, traveling grates and rotary kilns. Stages in induration: drying, preheating, exothermic heating (for magnetite), final hardening and cooling. Heat conservation (12 hours)

Module III
Control and operation of Pelletisation plants. Reduction kinetics of iron ore pellets and the effects of binders. Effects of prefluxing and super-fluxing of the feed on plant operation. Production of prereduced, metalized pellets. Overview of sintering and Pelletisation in India (12 hours)

Text Books:

1. Iron Making and Steel making by Ahindra Ghosh and Amit Chatterjee - PHI Learning Pvt. Ltd.
2. Mineral Processing Technology by G. V. Rao, Vibhuti N. Misra – I.M.M.T., Bhubaneshwar
3. Pelletisation of Fines by Jaroslav Srb, Zdeňka Růžičková – Elsevier 1988

References:

1. Agglomeration 77: proceedings of the 2nd International Symposium on Agglomeration, Atlanta, Ga., March 6-10, 1977, Volume 1
2. Mineral Processing Technology Mpt-2005 by R.Venugopal - Tata McGraw-Hill Education, 2005
3. Mineral Processing: 13th International Mineral Processing Congress, Warsaw, 1979
4. Proceedings of 3rd International Symposium on Beneficiation and Agglomeration (ISBA), January 1991, RRL (now IMMT), Bhubaneshwar
5. International Symposium on Agglomeration 2009, Sheffield, U.K.

INDUSTRIAL INSTRUMENTATION

Module 1 **18 Hours**

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

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

Module II: **10 Hours**

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

Module III: **10 Hours**

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

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

Text Book:

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

Reference Books:

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

PETROLIUM PRODUCTION AND REFINING

Objective:
To give the undergraduate students of Mineral Engineering an overview of Petroleum production, including drilling and pumping out the crude oil and its processing for producing the commercially used petroleum fractions

Module I
Introduction to the geological formations of oil and gas reserves. Habitats and traps for oil and gas. Structural geology: folds and faults, Overview of Geophysical prospecting for oil and gas reserves. Reservoir considerations. Sedimentary petrology, Sand stone Reservoirs. Carbonate reservoirs, Migration

Module II
Drilling technology: Methods of Drilling, Rotary Drilling rigs, Rotary rig circulation system,
Basic operations in drilling: The drill stem, Introduction of offshore drilling, types of offshore rigs, casing, tubing & line pipes, Cementing ,Introduction. Packers. Problems of well analysis. Formation damage. Well production testing. Fundamentals of stimulation and activation techniques

Module II
Refining: Refinery flow. Refinery Products. Characterization of petroleum. Petroleum products. Chemical composition of crude petroleum. Refinery configuration development. Blending refinery distillates. Lube refining. Wax refining, Gas processing, Alkylation, Coking, Visbreaking, Resid upgradation technologies, Sulphur removal technologies. Economics of petroleum refining. Global and Indian refining scenario.

Text Books:

1. Production operation Vol. I & II by Thomas O.Allen & P. Roberts.
2. Petroleum Refining Technology and Economics by Garry & Handework – Dekker 1984
3. Elements of Petroleum Processing by D.S.Jones – John Wiley and Sons 1995

References:

1. Petroleum Refinery Distillation by R.N.Watkins – Gulf Publishing Company
2. Petroleum Processing Handbook by S. Mcketta - Marcell Dekker Inc., 1992

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