



ANNA UNIVERSITY
Chennai-25.
Syllabus for

B.E.(Full Time) Metallurgical Engineering

CM125 Chemistry I **3** **0** **0** **100**

1. CHEMICAL THERMODYNAMICS **9**

Definition of free energy and spontaneity - Maxwell relations - Gibbs-Helmholtz equation - Van't Hoff equations - Stoichiometry and energy balances in Chemical reactions.

2. DYNAMICS OF CHEMICAL PROCESSES **10**

Basic concepts - composite reactions (opposing, parallel and consecutive reactions) - Collision theory - Thermodynamic formulation of reaction rates - unimolecular reactions - Chain reactions (Stationary and non-stationary) - Enzyme Kinetics - Michaelis - Menten Equation.

3. ELECTRODICS **8**

Types of electrodes and cells - Nernst Equation - emf measurement and its applications - Principles of chemical and electrochemical corrosion - corrosion control (Sacrificial anode and impressed current methods).

4. WATER **8**

Water quality parameters - Definition and expression - Estimation of hardness (EDTA method) - Alkalinity (Titrimetry) - Water softening (zeolite) - Demineralisation (Ion-exchangers) and desalination (RO) - Domestic water treatment.

5. POLYMERS **10**

Monomer - Functionality - Degree of polymerisation - Classification based on source and applications - Addition, Condensation and copolymerisation - Mechanism of free-radical polymerisation - Thermoplastics and thermosetting plastics - Processing of plastics - Injection moulding, blow moulding and extrusion processes.

Total No of periods: 45

Text Books:

1. Alkins P.W., " *Physical Chemistry* ", ELBS, IV Edition, 1998, London.

References:

1. Balasubramanian M.R., Krishnamoorthy S. and Murugesan V., " *Engineering Chemistry* ", Allied Publisher Limited., Chennai, 1993.
2. Karunanidhi M., Ayyaswamy N., Ramachandran T and Venkatraman H., " *Applied Chemistry* ", Anuradha Agencies, Kumbakonam , 1994.
3. Sadasivam V., " *Modern Engineering Chemistry - A Simplified Approach* ", Kamakya Publications, Chennai , 1999.
4. Kuriakose, J.C. and Rajaram J., " *Chemistry in Engineering and Technology* ", Vol. I and II, Tata McGraw-Hill Publications Co.Ltd, New Delhi ,1996.
5. Jain P.C. and Monica J., " *Engineering Chemistry* ", Dhanpat Rai Publications Co.,(P) Ltd., New Delhi, 1998.

1. BASICS 5

Introduction - Units and Dimensions - Laws of Mechanics - Vectors - Vectorial representation of forces and moments - Vector operations.

2. STATICS OF PARTICLES 8

Coplanar Forces - Resolution and Composition of forces - Equilibrium of a particle - Forces in space - Equilibrium of a particle in space - Equivalent systems of forces - Principle of transmissibility - single equivalent force.

3. EQUILIBRIUM OF RIGID BODIES 7

Free body diagram - Types of supports and their reactions - requirements of stable equilibrium - Equilibrium of Rigid bodies in two dimensions - Equilibrium of rigid bodies in three dimensions.

4. PROPERTIES OF SURFACES AND SOLIDS 12

Determination of Areas and Volumes - First moment of area and the centroid - second and product moments of plane area - Parallel axis theorems and perpendicular axis theorems - Polar moment of inertia - Principal moments of inertia of plane areas - Principal axes of inertia - Mass moment of inertia - relation to area moments of inertia.

5. FRICTION 4

Frictional Force - Laws of Coloumb friction - Simple Contact friction - Rolling Resistance - Belt Friction.

6. DYNAMICS OF PARTICLES 16

Displacement, Velocity and acceleration their relationship - Relative motion - Curvilinear motion - Newton's Law - Work Energy Equation of particles - Impulse and Momentum - Impact of elastic bodies.

7. ELEMENTS OF RIGID BODY DYNAMICS 8

Translation and Rotation of Rigid Bodies - Velocity and acceleration - General Plane motion - Moment of Momentum Equations - Rotation of rigid Body - Work energy equation.

Total No of periods: 60

Text Books:

1. *Beer and Johnson, " Vector Mechanics for Engineers ", Vol. 1 " Statics " and Vol. 2 " Dynamics ", McGraw Hill International Edition, 1995.*
2. *Merriam, " Engineering Mechanics ", Vol.1 " Statics " and Vol.2 " Dynamics 2/e ", Wiley International, 1988.*

References:

1. *Rajasekaran S. and Sankara Subramanian, G., " Engineering Mechanics - Statics and Dynamics ".*
2. *Irving, H., Shames, " Engineering Mechanics - Statics and Dynamics ", Thrid Edition, Prentice-Hall of India Pvt.Ltd., 1993.*
3. *Mokoshi, V.S., " Engineering Mechanics ", Vol.1 " Statics " and Vol.2 " Dynamics ", Tata McGraw Hill Books, 1996.*
4. *Timoshenko and Young, " Engineering Mechanics ", 4/e, McGraw Hill, 1995.*
5. *McLean, " Engineering Mechancis ", 3/e, SCHAUM Series, 1995.*

(Revised Syllabus For B.E. / B.Tech. Programmes - Effective From June 2002)

1. MATRICES	9
Characteristic equation - Eigen values and eigen vectors of a real matrix. Some properties of eigen values, Cayley-Hamilton theorem, Orthogonal reduction of a symmetric matrix to diagonal form - Orthogonal matrices - Reduction of quadratic form to canonical form by orthogonal transformation.	
2. THREE DIMENSIONAL ANALYTICAL GEOMETRY	9
Direction cosines and ratios - Angle between two lines - Equation of a plane - Equation of a straight line - Coplaner lines - Shortest distance between skew lines - Sphere - Tangent plane - Plane section of a sphere - orthogonal spheres.	
3. GEOMETRICAL APPLICATIONS OF DIFFERENTIAL CALCULUS	9
Curvature - cartesian and polar coordinates - Circle of curvature - Involutives and Evolutes - Envelopes - properties of envelopes - Evolute as envelope of normals.	
4. FUNCTIONS OF SEVERAL VARIABLES	9
Functions of two variables - Partial derivatives - Total differential - Differentiation of implicit functions - Taylor's expansion - Maxima and Minima - Constrained Maxima and Minima by Lagrangean Multiplier method - Jacobians - differentiation under integral sign.	
5. ORDINARY DIFFERENTIAL EQUATIONS	9
Simultaneous first order linear equations with constant coefficients - Linear equations of second order with constant and variable coefficients - Homogeneous equation of Euler type - equations reducible to homogeneous form - Method of reduction of order - Method of variation of parameters.	
6. TUTORIAL	15
Total No of periods: 60	

Text Books:

1. Kreyszig, E., " *Advanced Engineering Mathematics* " (8th Edition), John Wiley and Sons (Asia) Pte Ltd., Singapore, 2001
2. Veerarajan, T., " *Engineering Mathematics* ", Tata McGraw Hill Publishing Co., NewDelhi, 1999.

References:

1. Grewal, B.S., " *Higher Engineering Mathematics* " (35th Edition), Khanna Publishers, Delhi , 2000.
2. Kandasamy, P., Thilagavathy, K., and Gunavathy, K., " *Engineering Mathematics* ", Volume I (4th Revised Edition), S. Chand & Co., New Delhi, 2000.
3. Narayanan, S., Manicavachagom Pillay, T.K., Ramanaiah, G., " *Advanced Mathematics for Engineering Students* ", Volume I (2nd Edition), S. Viswanathan (Printers & Publishers), 1992.
4. Venkataraman, M.K. " *Engineering Mathematics - First year* " National Publishing Company, Chennai (2nd Edition), 2000.

- .
- 1. PROPERTIES OF MATTER 9**
 Elasticity - stress-strain diagram-factors affecting elasticity - Twisting couple on a wire-Shafts-Torsion pendulum-Depression of a cantilever- Young's modulus by cantilever-Uniform and Non Uniform bending-I shape girders-Production and measurement of high vacuum-Rotary pump-Diffusion pump-Pirani Gauge-Penning gauge-Viscosity-Oswald Viscometer-Comparison of viscosities.
- 2. ACOUSTICS 9**
 Acoustics of buildings-Absorption coefficient-Intensity-Loudness-Reverberation time-Sabine's formula-Noise pollution-Noise control in a machine-Ultrasonics-production-Magnetostriction and Piezoelectric methods-Applications of ultrasonics in Engineering and Medicine.
- 3. HEAT AND THERMODYNAMICS 9**
 Thermal conductivity-Forbe's and Lee's Disc methods-Radial flow of heat-Thermal conductivity of rubber and glass-Thermal insulation in buildings-Laws of thermodynamics-Carnot's cycle as heat engine and refrigerator-Carnot's theorem-Ideal Otto and Diesel engines-Concept of entropy-Entropy Temperature diagram of carnot's cycle.
- 4. OPTICS 9**
 Photometry-Lummer Brodhum photometer-Flicker Photometer-Antireflection coating-Air wedge-Testing of flat surfaces-Michelson's Interferometer and its applications-Photoelasticity and its applications-Sextant-Metallurgical microscope-Scanning electron microscope.
- 5. LASER AND FIBRE OPTICS 9**
 Principle of lasers-laser characteristics-Ruby-NdYAG, He-Ne, CO₂ and semiconductor lasers-propagation of light through optical fibers-types of optical fibre-Applications of optical fibres as optical waveguides and sensors.

Total No of periods: 45

Text Books:

1. Arumugam.M., " *Engineering Physics* ", Anuradha Publications, 1998.

References:

1. Resnik R. and Halliday D., " *Physics* ", Wiley Eastern, 1986.
2. Nelkon M. and Parker.P., " *Advanced Level Physics* ", Arnold-Heinemann, 1986.
3. Vasudeva A.S., " *Modern Engineering Physics* ", S. Chand and Co., 1998..
4. Gaur, R.K., and Gupta, S.L., " *Engineering Physics* ", Dhanpat Rai and Sons, 1988.
5. Mathur, D.S, " *Elements of properties of Matter* ", S.Chand & Co., 1989.

- 1. Preparation of standard solutions.
- 2. Estimation of hardness of water by EDTA method
- 3. Estimation of different types and amounts of alkalinity in water - Indicator method
- 4. Determination of dissolved oxygen - Winkler's method.
- 5. Estimation of iron in water - Spectrophotometric method.
- 6. Estimation of sodium in water - Flame Photometric method
- 7. Determination of molecular weight of polymers-Viscometric method.
- 8. Determination of total dissolved solids in water.
- 9. Corrosion experiments:
 - * Corrosion rate measurements
 - * Inhibition efficiency.
- 10. Electrochemistry experiments:
 - * Determination of emf.
 - * Single electrode potential
 - * Potentiometric and conductometric titration

Total No of periods: 30

1. FUNDAMENTALS OF COMPUTERS AND OPERATING SYSTEMS 4

Evolution of Computers - Organization of Modern Digital Computers-Single user Operating System-Multitasking OS-GUI

2. OFFICE AUTOMATION 11

- a) Word Processing
- b) Data Base Management System
- c) Spread Sheet Package
- d) Presentation Software

3. PRACTICALS 45**Total No of periods: 60***Text Books:*

1. Ghosh Dastidar, Chattopadhyay and Sarkar, " Computers and Computation - A Beginner's Guide ", Prentice Hall of India, 1999.

References:

1. Nelson, Microsoft Office 97, Tata McGraw Hill, 1999.
2. Taxali, " PC Software for Windows Made Simple ", Tata McGraw Hill, 1999.

GE133 Workshop Practice

0 0 4 100

1. SHEET METAL 10

Tools and Equipments - Fabrication of tray, cone, etc., with sheet metal

2. WELDING 10

Tools and Equipments - Arc Welding of butt joint, Tap Joint, Tee fillet etc., Demonstration of gas welding.

3. FITTING 10

Tools and Equipments- Practice in Chipping, Filing, Drilling - making Vee joints, square and dove tail joints.

4. CARPENTRY 10

Tools and Equipments-Planning Practice-making halving joint and dove tail joint models.

5. FOUNDRY 10

Tools and Equipments Preparation of moulds of simple objects like flange, gear V- grooved pulley etc.

6. SMITHY 10

Tools and Equipments - Demonstration for making simple parts like keys, bolts etc.

Total No of periods: 60

References:

1. Venkatachalapathy V.S., " *First Year Engineering Workshop Practice* ", Raamalinga Publications, Madurai, 1999.
2. Kanaiah P.and Narayana K.C., " *Manual on Workshop Practice Scitech Publications* ", Chennai, 1999.

1. PRACTICALS

30

1. Young's modulus by non uniform bending.
2. Rigidity modulus and moment of inertia using Torsion Pendulum
3. Viscosity of a liquid by Poiseuille's method.
4. Wavelength determination using grating by Spectrometer.
5. Particle size determination by Laser
6. Thermal conductivity by Lees' disc.
7. Thickness of wire by Air wedge.
8. Thermo emf measurement by potentiometer.

Total No of periods: 30

1. SEMICONDUCTORS AND RECTIFIERS 9

Classification of solids based on energy band theory - Intrinsic semiconductors - Extrinsic semiconductors - P type and N type - P-N junction - VI characteristic of PN junction diode - Zener effect - Zener diode - Zener diode characteristic - Half wave and full wave rectifiers - Voltage regulation.

2. TRANSISTORS AND AMPLIFIERS 9

Bipolar Junction Transistor - CB, CE, CC - Configurations and characteristics - Biasing circuits - Elementary treatment of voltage amplifier - Class A, B and C power amplifiers - principles of Tuned amplifiers.

3. POWER AND CONTROL ELECTRONIC DEVICES 9

Field Effect Transistor - Configurations and characteristics - FET amplifier - SCR, Diac, Triac, UJI - Characteristics and simple applications - switching transistors - concept of feed back - negative feed back - application in temperature and motor speed control.

4. SIGNAL GENERATORS AND LINEAR IC'S 9

Sinusoidal oscillators - positive feed back - RC phase shift, Hartley, Colpitt's, Wien bridge Oscillators - multivibrators - operational amplifier - adder, multiplier, integrator and differentiators - Integrated circuits.

5. DIGITAL ELECTRONICS 9

Binary number system - AND, OR, NOT, NAND, NOR circuits - Boolean algebra - Exclusive or gate - Half and full adders - flip flops - registers and counters - A/D, D/A conversion - Digital computer principle.

6. TUTORIAL 15

Total No of periods: 60

Text Books:

1. *Milman and Halkias, " Integrated Electronics ", McGraw Hill, 1979.*

References:

1. *Mehta,V.K., " Principles of Electronics ", S.Chand and Company Ltd., 1994.*
2. *Malvino & Leach, " Digital Principles and Applications ", McGraw Hill, 1986.*

1. ELECTRICAL CIRCUITS 9

Ohms Law - Kirchoff's Laws - steady state solution of DC circuits - Introduction to AC circuits - Waveforms and RMS value - power and power factor, single phase and 3 phase balanced circuits.

2. ELECTRICAL MACHINES 15

Principles of operation and characteristics of DC machines, Transformers (single phase and three phase) - Synchronous Machines - 3 Phase and single phase Induction motors - (op. principles).

3. ELECTRICAL MEASUREMENTS 6

Moving coil and moving iron instruments (Ammeter and Voltmeter) Dynamometer type watt meters and energy meters (op. principles).

4. PRACTICAL 30**Total No of periods: 60***Text Books:*

1. Mittle, V.N., " Basic Electrical Engineering ", TMH Edition, New Delhi, 1990.
2. Del Toro, " Electrical Engineering Fundamentals ", Prentice Hall of India Pvt.Ltd., New Delhi, Second Edition.

References:

1. Jimmie J.Cathey and Nasar, S.A., " Basic Electrical Engineering ", Schaurn outline series in Engineering, McGraw Hill Book Co.1987.
2. Deshpande, N.V., " Electrical Machines " A.A.Wheeler and Co. Ltd., New Delhi, 1994.

(Revised Syllabus For B.E. / B.Tech. Programmes - Effective From June 2002)

- 1. MULTIPLE INTEGRALS 9**
 Double integration in Cartesian and polar coordinates - Change of order of integration - Area as a double integral - Triple integration in Cartesian coordinates - Change of variables - Gamma and Beta functions.
- 2. VECTOR CALCULUS 9**
 Curvilinear coordinates - Gradient, Divergence, Curl - Line, surface & volume integrals - Statements of Green's, Gauss divergence and Stokes' theorems - Verification and applications.
- 3. ANALYTIC FUNCTIONS 9**
 Cauchy Riemann equations - Properties of analytic functions - Determination of harmonic conjugate - Milne-Thomson's method - Conformal mappings : Mappings $w = z + a$, az , $1/z$, z^2 and bilinear transformation.
- 4. COMPLEX INTEGRATION 9**
 Cauchy's theorem - Statement and application of Cauchy's integral formulae - Taylor's and Laurent's expansions - Singularities - Classification - Residues - Cauchy's residue theorem - Contour integration - Circular and semi circular contours (excluding poles on real axis).
- 5. STATISTICS 9**
 Moments - Coefficient of correlation - Lines of regression - Tests based on Normal and t distributions, for means and difference of means - Chi Square test for goodness of fit.

Total No of periods: 45

Text Books:

1. Kreyszig, E., " *Advanced Engineering Mathematics* " (8th Edition), John Wiley and Sons, (Asia) Pte Ltd., Singapore, 2000.
2. Grewal, B.S., " *Higher Engineering Mathematics* " (36th Edition), Khanna Publishers, Delhi 2001

References:

1. Kandasamy, P., Thilagavathy, K., and Gunavathy, K., " *Engineering Mathematics* ", Volumes I & II (4th Revised Edition), S. Chand & Co., New Delhi, 2001.
2. Narayanan, S., Manicavachagom Pillay, T.K., Ramanaiah, G., " *Advanced Mathematics for Engineering Students* ", Volumes I & II (2nd Edition), S. Viswanathan (Printers & Publishers, Pvt, Ltd.), 1992.
3. Venkataraman, M.K. " *Engineering Mathematics III - A* ", National Publishing Company, Chennai, (13th Edition), 1998.

1. FUELS: 10

Classification, solid, liquid and gaseous fuels. Coal - Classification - preparation of coal- pulverised coal- carbonisation and coke formation - caking power of coal - manufacture of coke - properties of metallurgical coke. Petroleum - classification. Composition of crude petroleum - Processing. Fractional distillation - Cracking. Gaseous Fuels - Natural gas, Coal gas. Producer gas. Water gas. Blast furnace gas. Air gas and Lurgi gas - manufacture. Properties and applications.

2. TESTING OF FUELS: 8

Coal : Proximate and ultimate analysis Calorific value. caking power. Liquid fuels: Calorific value specific gravity, viscosity, flash point- fire point, pour point, cloud point. carbon residue Knocking - Octane number and Cetane number Gaseous fuels: calorific value Flue gas analysis - Orsat apparatus. Combustion calculations - Air requirements for combustion. Flue Gas analysis - Excess air used. producer gas calculations problems .

3. HEAT TRANSFER: 7

Modes of heat transfer- Definition and the unit of thermal conductivity - Formulation of simple heat conduction problems for steady state heat conduction Convection heat transfer - the differential energy balance Radiation heat transfer - definition and basic laws of radiation - definition of a black body. Emissivity and absorptivity- radiation properties of surfaces - definition of gray body.

4. REFRACTORIES: 8

Introduction-Requirements of good refractory - Classification - Properties and testing - raw materials for manufacture of refractories. Common methods for manufacture of refractories. Properties. manufacture and application of silica, fireclay magnesite, dolomite,chrome-magnesite.carbon and SiC refractories.

5. FURNACES: 12

General: Introduction, classification. thermal efficiency. heat balance, methods of heat recovery, recuperation and regeneration -atmosphere control. Types of burners. Melting Furnace: Construction and operation of crucible furnaces, cupola, rotary furnace,electric arc, resistance and induction furnaces. Heat Treatment Furnaces : Introduction and classification - Batch type and continuous types. Pyrometry : Introduction - Principle. Construction application and calibration of thermoelectric, resistance, optical and total radiation pyrometers - Source of errors

Total No of periods: 45

Text Books:

1. Gupta O.P "*Elements of fuels, furnace and refractories*". 4th ed. Khanna Publishers. New Delhi. 2000

References:

1. Balusamy V. "*Fuels and Furnace Technology*". Course material. Dept. of Metallurgical Engineering. PSG College of Technology. Coimbatore. 1993
2. Samir Sarkar. "*Fuels and Combustion*". Orient Longman Ltd. Hyderabad. 1990.

1. CRYSTAL PHYSICS 9

Crystalline and non-crystalline materials, Bravais lattices, Crystal systems, Symmetry elements, Simple crystal structures, Packing factor for sc, bcc, fcc, hcp structures, Miller Indices, Imperfections in Crystals, Bragg's law and x-ray diffraction methods to study crystal structures.

2. CONDUCTING MATERIALS 9

Classical free electron theory of metals, Electrical conductivity of Al, Draw backs of classical theory, Quantum free electron theory of metals and its importance, Density of states, Fermi, Dirac statistics, Calculation of Fermi energy and its importance, Concept of hole, Origin of bandgap in solids (qualitative treatment only), Effective mass of Electron, High resistivity alloys Super conductors, Properties and applications.

3. SEMICONDUCTING MATERIALS 9

Elemental and compound semiconductors and their properties, Carrier concentration in intrinsic semiconductors, Carrier concentration in n-type and p-type semiconductors, Variation of fermi level and carrier concentration with temperature, Hall effect, Experimental arrangement, Applications.

4. MAGNETIC AND DIELECTRIC MATERIALS 9

Different types of magnetic materials and their properties, Domain theory of ferromagnetism, Heisenberg criteria, Hysteresis, Energy product of a magnetic material, Ferrites and their applications, Magnetic recording materials, Metallic glasses, Active and passive dielectrics and their applications, Various polarization mechanisms in dielectrics and their frequency and temperature dependence, Internal field and deduction of Clausius Mosotti equation, Dielectric loss, Dielectric breakdown.

5. OPTICAL MATERIALS 9

Optical properties of metals, insulators and semiconductors, Phosphorescence and fluorescence, Excitons, traps and colour centers and their importance. Different phosphors used in CRO screens, Liquid crystal as display, LED materials, Working of LED, Thermography and its applications, Photoconductivity and photo conducting materials.

Total No of periods: 45

Text Books:

1. Arumugam M., " *Materials Science* ", Anuradha Technical Book Publishers, 1997.

References:

1. Pillai S.O., " *Solid State Physics* ", New Age Inc., 1998.
2. Van Vlack L.H., " *Materials Science of Engineers* ", Addison Wesley, 1985.
3. Sze S.M., " *Physics of Semiconductor Devices* ", Wiley Eastern, 1986.
4. Raghavan V., " *Materials Science and Engineering* ", Prentice Hall of India, New Delhi, 1993.
5. Allison J., " *Electronic Engineering Materials and Devices* ", Tata McGraw Hill, 1985.

1. PRINCIPLES OF GRAPHICS 16

Two dimensional geometrical construction - Conic sections, involutes and cycloids - Representation of three dimensional objects - Principles of projections - standard codes of principles.

2. ORTHOGRAPHIC PROJECTIONS 28

Projections of points, straight line and planes - ' Auxiliary projections ' - Projection and sectioning of solids - Intersection of surfaces - Development of surfaces.

3. PICTORIAL PROJECTIONS 8

Isometric projections - ' Perspectives ' - Free hand sketching.

4. COMPUTER GRAPHICS 8

Hardware - Display technology - Software - Introduction to drafting software.

Total No of periods: 60*Text Books:*

1. Narayanan, K.L., and Kannaiah, P., " Engineering Graphics ", Tata McGraw-Hill Publishers Co., Ltd., 1992.

References:

1. William M. Neumann and Robert F.Sproul, " Principles of Computer Graphics ", McGraw Hill, 1989.
2. Warren J. Luzzadder and John M. Duff, " Fundamentals of Engineering Drawing ", Prentice-Hall of India Private Ltd., Eastern Economy Edition, 1995.
3. Natarajan K.V., " A Text Book of Engineering Drawing ", Private Publication, Madras, 1990.
4. Mathur, M.L. and Vaishwanar, R.S., " Engineering Drawing and Graphics ", Jain Brothers, New Delhi, 1993.

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| 1. MULTIUSER OPERATING SYSTEM | 4 |
| Unix: Introduction - Basic Commands - Vi editor - filters - Input/output redirection - piping - transfer of data between devices - shell scripts. | |
| 2. FUNDAMENTALS OF NETWORKING | 3 |
| Working on a networked environment - Accessing different machines from one node - concept of E-mail - Uses of Internet. | |
| 3. HIGH LEVEL LANGUAGE PROGRAMMING | 8 |
| C Language: Introduction - Operator - Expressions - Variables - Input/output statements - control statements - function arrays - pointer - structures - unions - file handling - case studies. | |
| 4. TUTORIAL | 45 |

Total No of periods: 60

Text Books and References:

1. *Stephan J. Kochen & Patrick H. Wood, "Exploring the UNIX System", Techmedia, 1999.*
2. *Maurice J. Bach, "The design of UNIX Operating Systems", Prentice Hall of India, 1999.*
3. *Ramos, "Computer Networking Concepts", Prentice Hall International, 1999.*
4. *Balagurusamy, "Programming in ANSI C", Tata McGraw Hill, 1999.*
5. *Kernighan and Ritchie, "The C Programming Language", Prentice Hall of India, 1999.*
6. *Gottfried, "Programming with C", Tata McGraw Hill, 1999.*
7. *Kutti, "C and UNIX Programming: A Conceptual Perspective", Tata McGraw Hill, 1999.*
8. *Eric Nagler, "Learning C++", M/s. Jaico Publishing Co., 1998-99.*

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- 1. PARTIAL DIFFERENTIAL EQUATIONS 9**
Formation - Solutions of standard types of first order equations - Lagrange's Linear equation - Linear partial differential equations of second and higher order with constant coefficients.
- 2. FOURIER SERIES 8**
Dirichlet's conditions - General Fourier series - Half-range Sine and Cosine series - Parseval's identity - Harmonic Analysis.
- 3. BOUNDARY VALUE PROBLEMS 9**
Classification of second order linear partial differential equations - Solutions of one - dimensional wave equation, one-dimensional heat equation - Steady state solution of two-dimensional heat equation - Fourier series solutions in Cartesian coordinates.
- 4. LAPLACE TRANSFORMS 9**
Transforms of simple functions - Basic operational properties - Transforms of derivatives and integrals - Initial and final value theorems - Inverse transforms - Convolution theorem - Periodic functions - Applications of Laplace transforms for solving linear ordinary differential equations upto second order with constant coefficients and simultaneous equations of first order with constant coefficients.
- 5. FOURIER TRANSFORMS 10**
Statement of Fourier integral theorem - Fourier transform pairs - Fourier Sine and Cosine transforms - Properties - Transforms of simple functions - Convolution theorem - Parseval's identity.

Total No of periods: 45

Text Books:

1. Kreyszig, E., " *Advanced Engineering Mathematics* " (8th Edition), John Wiley and Sons, (Asia) Pte Ltd., Singapore, 2000.
2. Grewal, B.S., " *Higher Engineering Mathematics* " (35th Edition), Khanna Publishers, Delhi 2000.

References:

1. Kandasamy, P., Thilagavathy, K., and Gunavathy, K., " *Engineering Mathematics* ", Volumes II & III (4th Revised Edition), S. Chand & Co., New Delhi, 2001.
2. Narayanan, S., Manicavachagom Pillay, T.K., Ramanaiah, G., " *Advanced Mathematics for Engineering Students* ", Volumes II & III (2nd Edition), S. Viswanathan (Printers & Publishers, Pvt, Ltd.) 1992.
3. Venkataraman, M.K. " *Engineering Mathematics* " Volumes III - A & B, 13th Edition National Publishing Company, Chennai, 1998.
4. Shanmugam, T.N. : <http://www.annauniv.edu/shan/trans.htm>

1. ATOMIC STRUCTURE AND ARRANGEMENT: 10

Review of atomic bonding - atomic arrangement - short range and long range orders -Unit cells - Crystal systems and Bravis lattice Detailed discussion of BCC. FCC and HCP structures, voids in BCC and FCC lattices. directions and planes in unit cells. Miller indices. Miller Bravis indices Close packed planes and directions, interplanar spacing and Bragg's Law. Allotropy - Examples- Concept of Quasicrystals and nanocrystals.

2. CRYSTAL IMPERFECTION'S: 9

Types of crystal imperfections - point, line. surface and volume defects. Point defects - variation of vacancy concentration with temperature - Arrhenius law - Concept of activation energy. Substitutional and interstitial solutions. Grain boundaries. ASTM Grain Size number determination. Small angle grain boundaries, twin and twist boundaries, stacking faults. Dislocation. types. significance - slip system - slip directions and planes. Schmid's law - factors affecting Critical Resolved Shear Stress - climb & cross slip of dislocations

3. DIFFUSION: 8

: Self diffusion, diffusion in alloys, diffusion mechanism (vacancy, interstitial, interstitial and ring mechanisms) - activation energy calculations Law's of diffusion - Fick's I law - diffusion coefficient versus temperature - Fick's II law. Interdiffusion and kirkendall effect. Factors influencing diffusion - Types of diffusion - Volume, surface, grain boundary diffusion. Practical applications of diffusion (grain growth, diffusion bonding and powder metallurgy, and heat treatment).

4. PHASE DIAGRAMS: 11

Solidification of metals and alloys - casting or ingot structure - cooling curves - Phase diagram determination - Phases, solid solution types, compounds - Hume - Rothery Rules. Gibbs Phase Rule. modified phase rule. Composition and amount of phases. Lever rule. Solidification behaviour of alloys. Non equilibrium solidification. segregation and its effects. Detailed discussion of eutectic. eutectoid and peritectic systems Concept of peritectoid. monotectic. syntectic systems - examples. Detailed discussion of Iron-Carbon diagram. Ternary phase diagram Concept of isothermal isopleth and liquidus plots.

5. STRAIN HARDENING: 7

Cold working, relationship to stress strain diagrams, concept of strain hardening coefficient. Effect of cold working on structure and properties (strength, ductility, corrosion resistance, electrical conductivity etc.). microstructure of cold worked metals -advantages and limitations of cold working. Annealing - Recovery. Recrystallisation and grain growth - effect on mechanical and physical properties. Factors controlling recrystallisation - Annealing textures - concept of hotworking - comparison with cold working - examples.

Total No of periods: 45

Text Books:

1. Avner.S.H.. "An Introducton to Physical Metallurgy". McGraw Hill Book Co. New York. USA. 1997.
2. William D.Callister. "Materials Science and Engineering - An Introduction". 4th edition. John Wiley & Sons. New York. USA. 1997

References:

1. Donald R Askeland. "The Science and Engineering of Materials".Brooks Cole Engineering Division. Monterey. U.S. 1989
2. James A Jacob and Thomas. F Kilduff. " Engineering Materials Technology Structure. Processes. Properties and Application " Prentice Hall Inc . New Jersey. USA. 1997
3. William F Smith. "Principlcs of Materials Science and Engineering". 3rd edition. McGraw Hill Publishing Co..New York, USA. 1996
4. Milton Ohring, "Engineering Materials Science". Academic Press. New York. USA. 1996.
5. Raghavan V.. "Physical Metallurgy : Principles and Practice". Prentice Hall of India. New Delhi. 1996.
6. Vernon B John. "Introduction to Engineering Materials". 3rd edition. Academic Press. New York. USA. 1995
7. Van Vlack.L.H.. "Elements of Materials Science and Engineering". 6th edition. Addison Wesley Publications. London. 1990
8. James F Shackelford. "Introduction to Materials Science for Engineers". McMillan Press New York. USA. 1985.

1. SYSTEM AND FIRST LAW OF THERMODYNAMICS: 10

Path and state properties -Thermodynamic processes. Thermodynamic equilibrium - Reversible and irreversible processes. First law - Internal energy, heat capacity of materials - enthalpy - Hess's law - Kirchoff's law.

2. SECOND LAW OF THERMODYNAMICS: 10

Entropy. Free energy function - Maxwell's relations.

Thermodynamic potentials: Fugacity. activity coefficient and equilibrium constant - Clausius - Clayperon equation - Vant Hoff's Isochore.

3. THIRD AND ZEROth LAWS OF THERMODYNAMICS: 8

Third and Zeroth law of Thermodynamics, applications. Phase rule- Derivation of phase rule and application of free energy - composition diagrams to the study of alloy systems.

4. THERMODYNAMICS OF SOLUTIONS: 10

Raoult's law. Henry's law. ideal solutions, real and regular solutions. Partial and integral molar functions of mixing - Gibbs - Duhem equation. Excess Thermodynamics quantities - change of standard states-

5. LIQUID MELTS AND SLAGS: 7

Quasi chemical theory - Kinetics - First- Second and Third order reactions- Arrhenius equation - activation energy - determination of order of the reaction.

Total No of periods: 45

Text Books:

1. David V Ragone. "Thermodynamics of Materials - Volume-1". John Wiley & Sons. Inc. 1995.
2. Upadhyaya. G.S and Dube.R.K. "Problems in Metallurgical Thermodynamics & Kinetics". Pergamon. 1977.

References:

1. Darken L S and Gurry.R W . "Physical Chemistry of Metals". McGraw Hill. 1987
2. Gaskell D R . "Introduction to Metallurgical Thermodynamics". McGraw Hill. 1973
3. Swalin.R A . "Thermodynamics of solids". John Wiley Sons Inc. 3rd edition. 1966
4. Parker.R.H . "An introduction to chemical metallurgy". Pergamon press. New York. 2nd edition. 1978.
5. Ward R.G . "An Introduction to Physical Chemistry of Iron and Steel Making". Edward Arnold. London. 1962.

1. FLUID MECHANICS: 10

Properties of fluid such as density viscosity and specific weight. Fluid statics - Pressure at a point - pressure variations in horizontal and vertical directions - Concept of gauge and absolute pressure Use of manometer for pressure measurements. Force on plates - Horizontal and inclined. Energy balance in fluid flow: Types of flow - continuity equation - Application to one dimensional problems. Derivations of Bernoulli's energy equation and Euler's equation - Examples illustrating the use of energy equation

2. FLOW THROUGH PLATES AND PIPES: 10

Classification of flow- Reynolds number. Laminar flow between parallel plates and circular pipes - Simple problems. Pressure in fluid flow: Heat loss due to friction - Darcy - Weisbach equation - flow through pipes - use of Moody's diagram - Minor losses- Simple problems

3. TRANSIENT HEAT CONDUCTION: 10

Introduction - Systems with Negligible Internal resistance - Lumped heat analysis - Response time of a temperature measuring instrument - System with negligible surface resistance- heat flow in an infinitely thin plate (Semi infinite body)-Systems with finite surface and internal resistance - Chart solutions of transient heat conduction problems. Numerical methods in transient conduction- Simple problems

4. CONVECTIVE HEAT TRANSFER: 8

Convective heat transfer coefficient- Boundary layer concept -velocity and thermal boundary layers- (no derivation)- Simple problems. Boundary layer development in circular ducts (no derivation) - Simple problems - Flow over a flat plate-laminar and turbulent boundary layers(no derivation) -Simple problems - Flow over cylinders and spheres-Simple problem.

5. RADIATION HEAT TRANSFER: 7

Emissive power - Grey body - Radiation heat transfer between surfaces - Shape factor - Gas radiation. Simple problems - Concepts mass transfer - Fick's Law of diffusion - Principles of Physical Modelling.

Total No of periods: 45

Text Books:

1. Kothandaraman C P and Rudramoorthy. R., "*Basic Fluid Mechanics*", New Age International Publishers. Chennai 1998.
2. Mohanty A.K. , "*Rate processes in metallurgy*" , Prentice Hall of India, New Delhi, 2000
3. Byron bind R. W.E. Shawart. "*Transport Phenomena*". John-Wiley & Sons Inc. 1994.

References:

1. Irving H Shames. "*Mechanics of Fluids*". 3rd ed - McGraw Hill Publishing Co.. New York. 1992.
2. Robert W. Fox. "*Introduction to Fluid Mechanics*". John Wiley & Sons. New York. USA. 1994.
3. Sachdeva. R.C. "*Fundamentals of Engineering Heat and Mass Transfer*". New Age International Publishers. New Delhi. 1996.

1. STRUCTURE, PROPERTIES AND USES OF ORES 10

Elementary knowledge of crystal systems- Three laws of crystallography - systems of crystallisation - Symmetry elements. Physical, chemical characteristics and uses: Hematite. Magnetite. Bauxite. Pyrolusite. Chalcopyriie. Galena, and Sphalerite.

2. ELEMENTARY KNOWLEDGE OF ORE FORMATION AND PROCESSING 10

Rock cycle - Crystal inter lock - Economic grinding mesh. Mineral paragenesis. Physical properties of minerals made use of in mineral dressing studies. Study of petrological microscope. Mineral resources of india - General resources- Sea as a source of mineral. Scope, objectives and advantages of mineral processing - Choice of mineral processing method. Principal steps in ore processing.

3. COMMINATION 10

Jaw and Gyrotory crushers, roll crusher and their performance. Ball & rod mills - capacities and reduction ratios Hammer mills, gravity stamps and Disc crushers. Grinding - Dry and wet grinding. Open and closed circuit grinding. Laws of crushing and work index. Screening, sizing and sampling.

4. GRAVITY CONCENTRATION TECHNIQUES 8

Theory of settling - Practice of Hydraulic and mechanical classification, working of thickeners. hydrocyclones and Rotary filters. Heavy media separation. Principles of jigging and Tabling. Processes with equipments used. important controlling factors in operation.

5. FLOTATION TECHNIQUES 7

Application Froth flotation. Frothers. collectors. Depressants. aciivators. pH modifiers etc.,multistage flotation Electrostatic and magnetic (dry and wet) separation - Principle, equipments, and application.

Total No of periods: 45

Text Books:

1. Parbin Singh. "Engineering and General Geology". S.K.Kataria & Sons. Delhi, 1997.
2. Jain.S K "Ore Processing". Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, 1986.
3. Gaudin A.M. , "Principles of mineral dressing", TMH ,New Delhi,1978.

References:

1. Newton. "Extractive Metallurgy". Wiley Eastern. New Delhi, 1967
2. Gilchrist. "Extraction Metallurgy". 2nd edition. Pergamon Press. London, 1981.

1. STRESSES IN MACHINE MEMBERS 10

Types of loads - axial bending & torsional loads - static and dynamic loads - fatigue and creep loads - eccentric loads - applications Types of stresses- Simple tensile, bending and shear stresses - concept of stress raiser and stress concentrations - factor of safety - combined stresses - Principal stresses - Theories of failure - design of shaft members subjected to simple and combined stresses.

2. MECHANICAL POWER TRANSMISSION 10

Need - types of mechanical drives - belt, rope, chain and gear drives - comparison - places of use - speed reduction - need - types - calculation of reduction ratio for different drives - gear trains - types - applications - simple compound and epicyclic trains - calculations of forces on shafts due to belts, spur, helical and bevel gears - meaning and applications of balancing in rotating machines - simple problems.

3. BEARINGS AND APPLICATIONS 8

Need for bearing - types - sliding & rolling contact bearings - Hydro-dynamic and hydrostatic bearings - Ball and roller bearings - types and applications - static and dynamic load capacities - life of bearings - selection of deep groove ball bearings for constant load cases - problems.

4. MATERIAL HANDLING EQUIPMENT 7

Need - types of Materials Handling Equipment used in Foundries - cranes, hoists, fork lift trucks applications - limitations - conveyors - belt and chain conveyors - elevators - applications - shakers and vibrators.

5. METAL MACHINING 10

Basic Machining process - single point tool - nomenclatures - chip formation- heat generation and wear in cutting tools - tool life - Principal of operation of lathe. shaping, planing, milling, drilling, boring and grinding machines - CNC machines - Basic differences - Comparison with conventional machine tools - advantages and limitations.

Total No of periods: 45

Text Books:

1. Robert.L.Mott., "*Machine Elements in Mechanical Design*", Macmillan Publishing Co., London. UK. 1992
2. Hindustan Machine Tools, "*Production Technology*". Tata McGraw Hill Co., New Delhi. India 1996

References :

1. Shighley and Mische, "*Mechanical Engineering Design*". McGraw Hill. 1992
2. Faculty of Mechanical Engineering PSG College of Technology "*Design Data Book*". DPV Printers. Coimbatore 1994
3. Sharma.P.C. , "*Production Engineering*" S Chand & Co. New Delhi. 1993.

1. PROBABILITY AND RANDOM VARIABLES 9

Probability concepts, Random variables, Moment, Moment Generating function, Binomial, Poisson, Geometric, Negative binomial, Exponential, Gamma, Weibull distributions, Functions of Random variable, Chebychev inequality.

2. TWO-DIMENSIONAL RANDOM VARIABLES 9

Marginal and Conditional distributions, Covariance, Correlation and regression, Transformation of random variables, Central Limit theorem.

3. RANDOM PROCESS 9

Classification, Stationary and Markov Processes, Poisson Process, Pure birth Process, Birth and death Process, Markov Chains, Markovian queueing models.

4. RELIABILITY ENGINEERING 9

Concepts of reliability, Hazard function, Series and parallel systems, Reliability and Availability of Markovian systems, Maintainability, Preventive Maintenance.

5. DESIGN OF EXPERIMENTS AND QUALITY CONTROL 9

Completely randomised design, Randomised block design, Latin square design, Process control, Control charts of measurements and attributes, Tolerance limits.

6. TUTORIAL 15**Total No of periods: 60**

References:

1. Mille I.R. and Freund J.E., " *Probability and Statistics for Engineers* ", Prentice-Hall, 1995.
2. Kapur J.N. and Saxena H.C., " *Mathematical Statistics* ", S Chand and Company Ltd., New Delhi, 1997.
3. Balagurusamy E., " *Reliability Engineering* ", Tata McGraw Hill Publishers, New Delhi, 1984.
4. Bhat U.N., " *Elements of Applied Stochastic processes* ", Wiley Series in Probability and Mathematical Statistics, New York, 1983.

1. DIFFUSION CONTROLLED PHASE TRANSFORMATION 10

Nucleation and growth - Types of nucleation - Concept of free energy during solidification - Thermodynamics of Homogeneous nucleation - critical nucleus size and critical free energy change - Constitutional supercooling - Extension to heterogeneous nucleation - Nucleation rate and Growth rate - Overall Transformation rate. Concept of Activation energy - Arrhenius equation - Examples- Growth of pearlite - Johnson Mehl - Avrami equation. Spinodal decomposition - Concept of uphill decomposition -Examples from metallic systems.

2. DIFFUSIONLESS TRANSFORMATIONS 10

Martensite transformation - Definition - characteristic features of Martensitic transformation in steels - Morphology of martensite - lath and acicular martensites - Crystallography of Martensitic transformation - Martensite in Non-Ferrous systems - Thermo Elastic Martensite - Shape Memory effect - Examples and applications of shape memory alloys.

3. STRENGTHENING MECHANISMS 10

Introduction - elementary discussion of cold working and grain size strengthening. Solid solution strengthening - Factors affecting solid solution strengthening. Martensitic strengthening - Precipitation hardening : Condition for precipitation hardening - Procedure (Al-Cu alloy) - Ageing (Natural & artificial) - Formation of precipitates. Coarsening of precipitates (overageing) -Mechanism of strengthening - Problems. Dispersion strengthening: Introduction - factors for effective dispersion hardening - strengthening mechanism - examples of above strengthening mechanisms from ferrous and non-ferrous systems.

4. FRACTURE 7

Fracture Mechanics - introduction modes of fracture - stress intensity factor. Strain energy release rate - fracture toughness and determination of K_{Ic} - factors influencing K_{Ic} - Effect of metallurgical variables such as grain size, phase mixture, second phase additions on fracture.

5. FATIGUE AND CREEP 8

Review of S-N curve - Factors affecting fatigue life (surface finish, surface strength reducers- residual stresses, stress concentration, temperature and frequency). Low cycle fatigue - Coffin - Manson law - High cycle fatigue - Basquin's law. Fatigue crack growth - Fracture Mechanics approach - Paris Erdogan law - Cumulative damage and life prediction - Stages in Fatigue crack growth -Methods to improve fatigue life of Steels. Creep curve - stages - Dom-Weertman Equation - Dislocation creep, diffusion creep - grain boundary sliding - creep failure - Introduction to Deformation Mechanisms maps - Creep resistant materials, design and development - Examples and applications.

Total No of periods: 45

Text Books :

1. *Reed Hill. R.E.. "Physical Metallurgy Principles". Affiliated East West Press. New Delhi. 1992.*
2. *Raghavan.V "Phase Transformations". Prentice - Hall of India. New Delhi. 1990.*
3. *Thomas H Courtney. "Mechanical Behaviour of Materials".McGraw Hill Co., NY. 1990.*

References:

1. *Smallman. R.E.and Bishop R.J.. "Metals and Materials". Butterworth-Heinemann Ltd.. New Delhi. 1995*
2. *Porter. D.A and Easterling.K.E."Phase Transformations in Metals and Alloys". 2nd ed, Chapman and Hall. London 1992.*
3. *Dieter .,G.E., " Mechanical metallurgy",Mc-Graw Hill ,New York,1995.*
4. *Michael.F.Ashby and David.R.H.Jones."Engineering Materials : An introduction to their Properties and Applications - Vol 1"., Pergamon Press. U.K. 1980.*
5. *Haasen.P ."Advanced Physical Metallurgy". Cambridge University Press. London. 1978.*

1. ELASTIC AND PLASTIC BEHAVIOUR 10

Elastic behaviour of Materials - Hook's law - Dislocation, definition . types -Burger's vector. Plastic deformation - dislocation motion - cross slip and climb - Slip and twinning - Dislocation multiplication - Frank Read source - Dislocation pile up. Strain curves for single crystals - strain hardening and recovery - Dynamic strain aging - strengthening due to dislocations (work hardening)

2. TENSION AND TORSION TESTING 10

Need for testing -Types of testing - Introduction to material properties (structure sensitive and insensitive) - ASTM testing standards. Engineering stress & strain - True stress strain curves - Relationship between the tensile properties - Hollomon -Ludwig equation - Plastic instability (Necking) - Hot tensile tests - Testing machines - types - Testing procedures - Specimen dimensions -Problems. Testing Machines and procedures

3. HARDNESS AND IMPACT TESTING 10

Definition - Types of hardness tests - Brinell. Rockwell and Rockwell superficial hardness tests. - Precautions - Relative merits and demerits - Hardness conversion - Rebound hardness test - testing machines. Microhardness tests - Vickers and Knoop hardness tests - Application of hardness testing to various materials - Problems. Concept of nanoindentation - Ultrasonic hardness testing - Izod and Charpy Impacts tests - Ductile to Brittle Transition Temperature (DBTT) - Factors affecting DBTT - determination of DBTT.

4. FRACTURE 7

Definition - Types . Ductile and brittle fractures - Theoretical cohesive strength of solids - Griffith's theory of brittle fracture-Orowan's modification - stages in ductile fracture (cup and cone). Fracture toughness -KIC - Testing - Factors affecting KIC . special testing on polymers and ceramics.

5. FATIGUE AND CREEP TESTING 8

Introduction - stress cycles - S-N curves, fatigue test terminology - Fatigue testing machines - Creep testing - creep curve - stages in creep curve and explanation. Concept of stress Relaxation - creep failure - Examples. Stress rupture testing - comparison with creep testing - Larson - Miller Parameter.

Total No of periods: 45

Text Books:

1. George.E. Dieter. "*Mechanical Metallurgy*" - Mc Graw Hill - SI edition. 1995.
2. Davis.H.E., Troxell G.E. Hanck.G.E.W "*The Testing of Engineering Materials*" - Mc Graw Hill. 1982.
3. Gupta.S.C., and Kapoor.V.K.. "*Fundamentals of mathematical Statistics*". Sultan Chand and sons, Delhi. 1982.

References:

1. Wulf et al Vol: III "*Mechanical Behaviour of Materials*". John Wiley and Sons. New York, USA, 1983.

1. RAW MATERIALS AND AGGLOMERATION METHODS: 10

Composition and domestic location of deposits - Beneficiation of ores. Pelletizing, sintering and briquetting - Coke manufacture - Fluxes.

2. BLAST FURNACE AND ACCESSORIES 10

Parts, construction and design aspects of blast furnace Charging equipment. Preheating the blast. Gas cleaning.

3. BLAST FURNACE OPERATIONS AND MODERN TRENDS 10

Reactions, Calculations. Blast furnace irregularities. Oxygen enriched blast, fuel injection, high top pressures preconditioned ores - Tysland Hole furnace.

4. ALTERNATE ROUTES OF IRON MAKING 8

Low Shaft. Furnace. Charcoal furnace. Electrical furnace. Direct reduction- Sponge iron route - Sponge Iron production in India. Electric smelting.

5. FERRO ALLOYS 7

Production of Fe-Si. Fe-Mn. Fe-Cr. Fe-Mo. Fe-V. Fe-Ni and Fe-W.

Total No of periods: 45

Text Books:

1. *Tupkary.R.H." Modern Iron Making". 3rd edn. Khanna Publishers. New Delhi. 2000.*

References:

1. *"Making Shaping and Treating of Steel". U.S. Steel Corporation. 1994.*
2. *"Manufacture of Iron & Steel". Vol I. Bashforth.G.R.. Chapman & Hall. London. 1964*

1. PYROMETALLURGY 10

Sources of metals, unit processes of metal extraction- Pyrometallurgical Processes - Principles of drying, calcination, agglomeration, roasting - roasting techniques, predominance area diagrams. Principles of smelting and converting. Ellingham diagrams. Carbothermic, Hydrothermic and Metallothermic reductions.

2. HYDRO METALLURGY 10

Principles of hydrometallurgy. advantages- properties of good solvent. Preparation of ore for leaching, leaching methods recovery of metal from liquor, solvent extraction, ion exchange, pressure leaching, gaseous reduction of metals in aqueous solutions. material leaching. recycling of leach liquor.

3. ELECTROMETALLURGY AND REFINING 8

Aqueous and fused salt electrolysis. Principles of electro refining and electrowinning of metals, Purification of crude metals produced in bulk Distillation, liquation, solvent extraction, fire refining. electrolytic refining, and zone refining -examples.

4. EXTRACTION AND REFINING OF METAL ORES 10

Extraction and refining of metals from sulphide ores copper and nickel, Extraction and refining of metals from oxide ores Al. Mg. Zn, Extraction and refining of metals through halide route - Ti. Zr. U.

5. EXTRACTION OF PRECIOUS METALS AND RECOVERY OF BY PRODUCT METALS 7

Extraction of precious metals - gold and silver, Recovery of by product metals and treatment of metallurgical wastes, material and energy balance.

Total No of periods: 45

Text Books:

1. Ray. H.S . Sridhar.R.. and Abraham. K P . "Extraction of Non Ferrous Metals". Affiliated East - West Press Pvt Ltd. New Delhi. 1990.
2. Ray. H S and Ghosh.A-. "Principles of Non-ferrous Extractive Metallurgy". Prentice Hall of India. New Delhi. 1994.
3. Venkatachalam.S.. "Hydrometalluray". Narosa Publishing House. New Delhi. 1998.

References:

1. Ray .H S.. "Extraction of Non-ferrous Metals". Eastern Law House. India. 1994.
2. Pehlke.R D.. "Unit Processes in Extractive Metallurgy". American Elsevier Publishing Co.. New York. USA. 1993.
3. Terkel Rosenqvist. "Principles of Extractive Metallurgy". 2nd ed. McGraw-Hill International Book Co. London. 1983.
4. Dennis W.H. "Metallurgy of the Non-Ferrous Metals. 2nd ed. 1966. Ditman. London.
5. Sevryukov.N. "Non Ferrous Metallurgy. 1975. Mir. Moscow.

1. CORROSION 12

Definition, classification, forms of corrosion, expressions for corrosion rate. emf and galvanic series - merits and demerits -Pourbaix diagram for iron, magnesium and aluminium. Forms of corrosion - Uniform, pitting, intergranular, stress corrosion. corrosion fatigue. dezincification. erosion corrosion, crevice corrosion - Cause and remedial measures - Pilling Bedworth ratio - High temperature oxidation.

2. CORROSION IN INDUSTRIES 8

Boiler water - corrosion by carbon di oxide and unstable salts - corrosion prevention methods by treatment. cooling water - specification, types of scales and causes - use of antiscalant - water treatments. Maintenance of boilers - protection of boilers during off loading, high temperature corrosion, turbine corrosion, corrosion inhibitors - principles and practice - inhibitors for acidic neutral and other media - Corrosion failure - Inspection and analysis of corrosion damage.

3. CORROSION TESTING 8

Purpose of corrosion testing - Classification - Susceptibility tests for intergranular corrosion- Stress corrosion test.salt spray test humidity and porosity tests, accelerated weathering tests. ASTM standards for corrosion testing.

4. KINETICS OF CORROSION 7

Polarisation - exchange current density - Activation polarisation - Tafel Equation - Passivating metals and non-passivating metals - Effect of oxidising agents.

5. CORROSION PROTECTION METHODS 10

Electroless plating and Anodising - Cathodic protection, metallic, organic and inorganic coatings, corrosion inhibitors. Special surfacing processes - CVD and PVD processes, sputter coating. Laser and ion implantation. Arc spray. plasma spray. Flame spray. HVOF.

Total No of periods: 45

Text Books :

1. *Fontana and Greene. "Corrosion Engineering". McGraw Hill Book Co. New York. USA 1983.*
2. *Raj Narayan. "An Introduction to Metallic Corrosion and its prevention". Oxford & IBH. New Delhi. 1983.*
3. *Kenneth G Budinski. "Surface Engineering for Wear Resistance". Prentice Hall Inc.. Engelwood Cliff. New Jersey. USA 1988*

References:

1. *Uhlig, H.H. "Corrosion and Corrosion Control". John Wilcy & Sons. New York. USA. 1985.*
2. *ASM Metals Handbook. Vol.5. "Surface Engineering". ASM Metals Park. Ohio. USA. 1994.*
3. *ASM Metals Handbook. Vol.13, "Corrosion".ASM Metals Park. Ohio. USA. 1994*