



SEMESTER - III

Code	Subject	Hours/week			Marks		University Examination Hours	Credits
		L	T	P/D	Internal	End Semester University Examination		
EN010 301A	Engineering Mathematics II	2	2	-	50	100	3	4
EN010 302	Economics and Communication Skills	2	2	-	50	100	3	4 (3+1)
MT 010 303 (EE)	Electrical and Electronic Engineering	3	1	-	50	100	3	4
MT 010 304	Physical Metallurgy	3	1	-	50	100	3	4
MT 010 305	Programming in C	3	1	-	50	100	3	4
MT 010 306	Mineral Dressing	3	1	-	50	100	3	4
MT 010 307	Computer Programming Laboratory	-	-	3	50	100	3	2
MT 010 308 (EE)	Electrical and Electronics Engineering Laboratory	-	-	3	50	100	3	2
Total		16	8	6				28



SEMESTER - IV

Code	Subject	Hours/week			Marks		University Examination Hours	Credits
		L	T	P/D	Internal	End Semester University Examination		
EN 010 401	Engineering Mathematics - IV	2	2	-	50	100	3	4
EN 010 402	Principles of Management	3	1	-	50	100	3	4
MT 010 403	Mechanical Behavior and Testing	3	1	-	50	100	3	4
MT 010 404	Phase Transformation and Heat Treatment	3	1	-	50	100	3	4
MT 010 405	Electrical, Electronic and Magnetic Materials	3	1	-	50	100	3	4
MT 010 406	Transport Phenomenon	3	1	-	50	100	3	4
MT 010 407	Heat Treatment of Ferrous Metals Laboratory	-	-	3	50	100	3	2
MT 010 408	Mechanical Testing Laboratory	-	-	3	50	100	3	2
	Total	17	7	6				28



SEMESTER - V

Code	Subject	Hours/week			Marks		University Examination Hours	Credits
		L	T	P/D	Internal	End Semester University Examination		
EN 010 501A	Engineering Mathematics - V	2	2	-	50	100	3	4
MT 010 502	Metal Joining Technology	3	1	-	50	100	3	4
MT 010 503	Iron and Steel Making	3	1	-	50	100	3	4
MT 010 504	Pyro, Electro and Hydro Metallurgy	3	1	-	50	100	3	4
MT 010 505	Fuels, Refractories and Furnaces	3	1	-	50	100	3	4
MT 010 506	Metallurgical Thermodynamics	3	1	-	50	100	3	4
MT 010 507	Welding Laboratory	-	-	3	50	100	3	2
MT 010 508	Heat Treatment of Non Ferrous metals Laboratory	-	-	3	50	100	3	2
Total		17	7	6				28



SEMESTER - VI

Code	Subject	Hours/week			Marks		University Examination Hours	Credits
		L	T	P/D	Internal	End Semester University Examination		
EN 010 601	Non Ferrous Physical Metallurgy	3	1	-	50	100	3	4
MT 010 602	Secondary and Advanced Steel Making	3	1	-	50	100	3	4
MT 010 603	Foundry Technology	3	1	-	50	100	3	4
MT 010 604	Metallography and X ray Diffraction	3	1	-	50	100	3	4
MT 010 605	Non-ferrous Extractive Metallurgy	3	1	-	50	100	3	4
MT 010 606	Elective - I	2	2	-	50	100	3	4
MT 010 607	Metallography Laboratory	-	-	3	50	100	3	2
MT 010 608	Foundry Laboratory	-	-	3	50	100	3	2
Total		17	7	6				28

ELECTIVES – I

MT 010 606 L01	Design and Selection of Materials
MT 010 606 L02	Nuclear Metallurgy
MT 010 606 L03	Surface Engineering
MT 010 606 L04	Vacuum Science and Deposition Techniques
MT 010 606 L05	Analytical Methods in Materials Science
MT 010 606 L06	Mathematical modeling
MT 010 606 L07	Computational physical chemistry



SEMESTER - VII

Code	Subject	Hours/week			Marks		University Examination Hours	Credits
		L	T	P/D	Internal	End Semester University Examination		
EN 010 701	Corrosion Science and Engineering	3	1	-	50	100	3	4
MT 010 702	Advanced Materials Characterization	3	1	-	50	100	3	4
MT 010 703	Ceramic, Polymers and Composites Materials	3	1	-	50	100	3	4
MT 010 704 (PE 010 704)	Theory of Metal Forming	2	1	-	50	100	3	4
MT 010 705	Powder Metallurgy	3	1	-	50	100	3	4
MT 010 706	Elective - II	2	1	-	50	100	3	4
MT 010 707	Corrosion Engineering Laboratory	-	-	3	50	100	3	2
MT 010 708	Metal Forming Laboratory	-	-	3	50	100	3	2
MT 010 709	Seminar	-	-	2	50	-	-	2
MT 010 710	Project Preliminaries	-	-	-	50	-	-	1
Total		16	6	8				30

ELECTIVES – II

MT 010 706 L01	Ladle Metallurgy and continuous Casting of Steels
MT 010 706 L02	Emerging Materials
MT 010 706 L03	High Temperature Materials
MT 010 706 L04	Special Casting Techniques
MT 010 706 L05	Semiconducting Materials and Devices
MT 010 706 L06	Optimization techniques
MT 010 706 L07	Computational materials science



SEMESTER - VIII

Code	Subject	Hours/week			Marks		University Examination Hours	Credits
		L	T	P/D	Internal	End Semester University Examination		
MT 010 801	Non Destructive Testing and Failure Analysis	3	1	-	50	100	3	4
MT 010 802	Creep, Fatigue and Fracture Mechanics	3	1	-	50	100	3	4
MT 010 803	Alloy Design and Applications	4	1	-	50	100	3	4
MT 010 804	Elective - III	2	2	-	50	100	3	4
MT 010 805	Elective - IV	2	2	-	50	100	3	4
MT 010 806	Non Destructive Testing Laboratory	-	-	3	50	100	3	2
MT 010 807	Project	-	-	6	100	-	-	4
MT 010 808	Viva Voce	-	-	-	-	50	-	2
	Total	14	7	9		-	-	28

ELECTIVES – III

MT 010 804 L01	Experimental Techniques in Materials Engineering
MT 010 804 L02	Mechanical working of Metallic Materials
MT 010 804 L03	Materials for jet Engines and Gas Turbines
MT 010 804 L04	Metallurgy of Tool Materials
MT 010 804 L05	Molecular Spectroscopy
MT 010 804 L06	Statistical quality control
MT 010 804 L07	Stochastic models

ELECTIVES – IV

MT 010 805 G01	Finite Elements Methods
MT 010 805 G02	Nano Technology
MT 010 805 G03	Financial and Management Accounting
MT 010 805 G04	Analytical Methods in Material Science
MT 010 805 G05	Micro Machining and Micro Sensors



THIRD SEMESTER



EN010301A ENGINEERING MATHEMATICS - II
(Common to all branches except CS & IT)

Teaching scheme

Credits: 4

3 hours lecture and 1 hour tutorial per week

Objectives

• *To apply standard methods and basic numerical techniques for solving problems and to know the importance of learning theories in Mathematics.*

MODULE 1 Vector differential calculus (12 hours)

Scalar and vector fields – gradient-physical meaning- directional derivative-divergence and curl - physical meaning-scalar potential conservative field- identities - simple problems

MODULE 2 Vector integral calculus (12 hours)

Line integral - work done by a force along a path-surface and volume integral-application of Greens theorem, Stokes theorem and Gauss divergence theorem

MODULE 3 Finite differences (12 hours)

Finite difference operators and - interpolation using Newtons forward and backward formula – problems using Stirlings formula, Lagrange’s formula and Newton’s divided difference formula

MODULE 4 Difference Calculus (12 hours)

Numerical differentiation using Newtons forward and backward formula – Numerical integration – Newton’s – cotes formula – Trapezoidal rule – Simpsons 1/3rd and 3/8th rule – Difference equations – solution of difference equation

MODULE 5 Z transforms (12 hours)

Definition of Z transforms – transform of polynomial function and trigonometric functions – shifting property, convolution property - inverse transformation – solution of 1st and 2nd order difference equations with constant coefficients using Z transforms.

Reference

1. Erwin Kreyszing – Advance Engg. Mathematics – Wiley Eastern Ltd.
2. B.S. Grewal – Higher Engg. Mathematics - Khanna Publishers
3. B.V. Ramana - Higher Engg. Mathematics – McGraw Hill
4. K Venkataraman- Numerical methods in science and Engg -National publishing co
5. S.S Sastry - Introductory methods of Numerical Analysis -PHI
6. T.Veerarajan and T.Ramachandran- Numerical Methods- McGraw Hill
7. Babu Ram – Engg. Mathematics -Pearson.
8. H.C.Taneja Advanced Engg. Mathematics Vol I – I.K.International



EN010 302 ECONOMICS AND COMMUNICATION SKILLS
(Common to all branches)

Teaching scheme

Credits: 4

2 hours lecture and 2 hours tutorial per week

Objectives

- To impart a sound knowledge of the fundamentals of Economics.

Economics

Module I (7 hours)

Reserve Bank of India-functions-credit control-quantitative and qualitative techniques
Commercial banks-functions- Role of Small Industries Development Bank of India and
National Bank for Agriculture and Rural Development-The stock market-functions-problems
faced by the stock market in India-mutual funds.

Module II (6 hours)

Multinational corporations in India-impact of MNC's in the Indian economy Globalisation-
necessity-consequences Privatisation-reasons-disinvestment of public sector undertakings -
The information technology industry in India-future prospects

Module III (6 hours)

Direct and indirect taxes- impact and incidence- merits of direct and indirect taxes
progressive and regressive taxes-canons of taxation-functions of tax system tax evasion-
reasons for tax evasion in India-consequences-steps to control tax evasion Deficit financing-
role-problems associated with deficit financing.

Module IV (5 hours)

National income-concepts-GNP, NNP, NI, PI and DPI-methods of estimating national
income-difficulties in estimating national income Inflation-demand pull and cost push-effects
of inflation-government measures to control inflation.

Module V (6 hours)

International trade-case for free trade-case for protectionism Balance of payments-causes of
disequilibrium in India's BOP-General Agreement on Tariffs and Trade-effect of TRIPS and
TRIMS in the Indian economy-impact of WTO decisions on Indian industry.

Text Books

1. Ruddar Datt, Indian Economy, S.Chand and Company Ltd.
2. K.K.Dewett, Modern Economic Theory, S.Chand and Company Ltd.



References

1. Paul Samuelson, Economics, Tata McGraw Hill
2. Terence Byres, The Indian Economy, Oxford University Press
3. S.K.Ray, The Indian economy, Prentice Hall of India
4. Campbell McConnel, Economics, Tata McGraw Hill

Communication Skills

Objectives

- To improve Language Proficiency of the Engineering students
- To enable them to express themselves fluently and appropriately in social and professional contexts
- To equip them with the components of different forms of writing

MODULE – 1 (15 hours)

INTRODUCTION TO COMMUNICATION

Communication nature and process, Types of communication - Verbal and Non verbal, Communication Flow-Upward, Downward and Horizontal, Importance of communication skills in society, Listening skills, Reading comprehension, Presentation Techniques, Group Discussion, Interview skills, Soft skills.

MODULE – II (15 hours)

TECHNICAL COMMUNICATION

Technical writing skills- Vocabulary enhancement-synonyms, Word Formation-suffix, affix, prefix, Business letters, Emails, Job Application, Curriculum Vitae, Report writing- Types of reports.

Note: No University examination for communication skills. There will be internal evaluation for 1 credit.

REFERENCES

1. The functional aspects of communication skills, P.Prasad and Rajendra K. Sharma, S.K. Kataria and sons, 2007
2. Communication skills for Engineers and Scientists, Sangeeta Sharma and Binod Mishra, PHI Learning private limited, 2010
3. Professional Communication, Kumkum Bhardwaj, I.K. International (P) House limited, 2008
4. English for technical Communication, Aysha Viswamohan, Tata Mc Graw Publishing company limited, 2008.



MT 010 303 (EE) ELECTRICAL AND ELECTRONICS TECHNOLOGY

(Same syllabus as ME 010 406(EE), PE 010 406(EE) - Electrical Technology)

Teaching scheme

3 hours lecture and 1 hour tutorial per week

Credits: 4

Objectives

Understanding the basic working principles of DC machines Ac machines and its drives

Module I (8 hours)

D.C. Generator - O.C.C. – Condition for self excitation – field critical resistance – critical speed - Load characteristics of generators- Losses- power flow diagram- efficiency- condition for maximum efficiency- Application.

Module II (16 hours)

D.C. Motors: Back emf – speed and torque equation- starting and speed control – testing of D.C. Motors – brake test – Swinburn’s test- Performance characteristics of Shunt, Series and Compound motors. – Applications -Transformer – Emf equation: No load current – equivalent circuit – regulation- efficiency.

Determination of regulation and efficiency from O.C. and S.C. tests – cooling of transformer. Basic principle of 3 phase transformer – Applications

Module III (13 hours)

Alternators - Construction details: Type – emf equation (winding factor need not be derived) – synchronous impedance – regulation by emf and mmf method.

Synchronous Motors: Principle of operation – method of starting.

Three phase induction motor: Production of rotating magnetic field - equivalent circuit – torque equation – torque slip characteristics – no load and blocked rotor tests – starting and speed control – Application

Single Phase motor: Different types - Application.

Module IV (13 hours)

Industrial drives – electric drives – advantages – individual drive and group drive – factors affecting choice of motor – mechanical characteristics of A.C. and D.C. motors – motors for particular application like textile mill, steel mill, paper mill, mine, hoists, crane etc. – size and rating of motor . Electric traction – Different systems of traction – comparison – track electrification – different systems – traction motor characteristics – electric braking – plugging – Dynamic and regenerative braking.

Module V (10 hours)

Power semiconductor devices: power diodes – SCR’s - principle of operation of SCR’s – two transistor analogy of SCR – characteristics – SCR rating (basic principle only). High frequency heating – induction and dielectric heating – resistance heating resistance welding block schematic of resistance welding scheme.

Text Books

1. Dr. P S Bimbra, *Electrical Machinery*, Khanna Publishers



2. J B Gupta, *Electrical Machines*, S K Kataria and Sons
3. Dr. P S Bimbira, *Power Electronics*, Khanna Publishers

Reference Books

1. Alexander Langsdorf A S: Theory of AC Machinery, Mc-Graw Hill
2. Say M G: Performance and design of AC Machines, ELBS
3. Electrical machines, Drives and Power Systems: Theodore Wildi, Pearson Ed.
4. P.C. Sen, *Thyristor DC Drives*, Wiley-Interscience Publication 1984
5. Joseph Vithayathil, *Power Electronics-Principles and applications*, TMH, 2010
6. B. K. Bose, *Modern Power Electronics and A.C. Drives*, PHI, 2002.
7. G.K. Dubey, *Fundamentals of Electrical Drives*, Narosa Publishing House, New Delhi, 2005

University Examination Pattern

PART A: *Short answer questions (one/two sentences)*

All questions are compulsory. There should be at least one question from each module. $5 \times 3 \text{ marks} = 15 \text{ marks}$

PART B: *Analytical/Problem solving questions*

Candidates have to answer five questions out of seven. There should be at least one question from each module and not more than two questions from any module. $5 \times 5 \text{ marks} = 25 \text{ marks}$

PART C: *Descriptive/Analytical/Problem solving questions*

Two questions from each module with choice to answer one question. $5 \times 12 \text{ marks} = 60 \text{ marks}$

Maximum Total Marks: 100



MT 010 304 – PHYSICAL METALLURGY

Teaching scheme

3 hours lecture and 1 hour tutorial per week

4

Credits:

Objective:-

To impart a sound knowledge in the basic concepts of structure of metals. Defects in crystals, diffusion mechanism and physical properties of materials

MODULE I

Atomic structure and structure of metals: - Review of atomic bonding, Stability of the structure, Hydrogen molecule, Electronic structure of atoms, Ionic, Covalent, Metallic bonds, Vander waal's forces - **The structure of metals:** - Definition of metal, Short and long range orders, Unit cells, Crystal systems, Bravis lattices, Coordination number, SC, BCC,FCC, HCP structures, Atomic Packing Factor - Fundamental laws of crystallography:- law of interfacial angle, law of rationality of indices, law of symmetry, Miller indices – directions and planes, Interplaner spacing, Braggs law (basic only), allotropism, Basics of structures- of liquids and vapors, ionic crystals, molecular crystals, ceramics, concepts of inorganic glasses, polymeric structure, nano crystalline materials, and quasi crystals (basic only). Problems related to crystal structure.

MODULE II

Crystal Imperfections: - Point, line, surface and volume imperfections; Point imperfections:-vacancies, interstitials and substitutional atoms, Frenkel and Schottky imperfections, vacancy motion, divacancy - **Line imperfections:-** Discrepancy between theoretical and observed yield stresses of crystals; dislocations; Burgers vector; Edge and screw dislocations; Nucleation of dislocations; energy of dislocation; forces on dislocation; dislocation in fcc,hcp, bcc; dislocation movements-dislocation glide; rotational slip; dislocation climb; dislocation multiplication - **Modes of plastic deformation:-** slip, slip planes and directions, Critical resolved shear stress, Schmid's law, dislocation density, cross slip, crystal structure rotation during tensile and compressive testing, dislocations in fcc lattice, partial dislocation, extended dislocations, stacking faults, sessile-glissile dislocations, dislocation interactions, jogs, dislocation pile up, evidence for existence of dislocations, Strain hardening, Twinning, Deformation twinning, nucleation of twins, Twin boundary, Twin growth, Accommodation of twinning shear - **Surface imperfections:-**Grain boundaries, small and high angle grain boundary, Twin boundaries degrees of freedom of a grain boundary, Grain boundary energy, grain boundaries between crystals of different phases, effect of grain boundaries on mechanical properties, grain boundary - **Volume defects:-**Void formation, irradiation behavior, fracture. Problems.

MODULE III

Diffusion in substitutional solid solutions:-Ideal and non ideal solutions, diffusion in ideal solutions, Fick's first law, Diffusion coefficient, diffusion mechanisms, formation of voids, Darken's equation, Fick's second law, Determination of diffusivities (Matano method), self diffusion, temperature dependence of diffusion coefficient, factors influencing diffusion, Chemical diffusion, Types of diffusion, Applications of diffusion- grain growth, diffusion



bonding, sintering of powders, heat treatment, (case hardening, recrystallisation, grain growth) –problems

Interstitial diffusion: - Interstitial diffusion, Measurement of interstitial diffusivities, The Snoek effect, relaxation time, and its experimental determination - Diffusion in ionic crystals.

Kirkendall effect - Related numerical problems.

MODULE IV

Solid solutions: - Interstitial and substitutional solid solutions, solubility of carbon in BCC iron, Vegard's law, Hume Rothery rules - Phases:-Basic definitions, Physical nature of phase mixtures, Number of phases in an alloy system-single, and two components systems, Gibb's phase rule - Binary phase Diagrams:-Isomorphous alloy systems, The Lever rule, Equilibrium heating and cooling of an isomorphous alloy, super lattices, miscibility gaps, eutectic, peritectic, Monotectic, peritectoid, eutectoid, syntectic systems with examples, important phase diagrams- Fe-C System, Mg-Si system showing intermediate phases, Cu-Zn, Cu-Pb systems, Alumina-silica system, Coring and segregation as applied to various binary systems, zone refining, Ternary phase diagrams. Drawing important phase diagrams from data provided.

MODULE V

Structure insensitive and Physical properties of materials:- Density, Change of volume on melting, Thermal properties- Thermal expansion, Abnormal thermal expansion, Specific heat capacity, Specific heat curve and transformations, Free energy of transformation- Anelasticity and internal friction, Ordering in alloys- long and short range ordering- detection of ordering- influence of ordering on properties.

Annealing:-Stored energy of cold work, Relationship of free energy to strain energy, Release of stored energy, Recovery, Polygonisation, Dislocation movement in polygonisation, Recovery at low and high temperatures, Dynamic recovery, Recrystallisation, Recrystallisation temperature, Effect of strain on recrystallisation, Recrystallised grain size, ASTM grain size, Grain growth, rate of nucleation and growth abnormal grain growth, Hall Petch relation and grain growth law, Interaction between impurities (second phase inclusions) and grain boundaries, Free surface effect, Limiting grain size, Secondary recrystallisation, strain induced grain boundary movement- problems.

Text Books

- 1 Bruce Chalmers. Physical Metallurgy, John Wiley, 1959
- 2 Bishop R.J and R.E Smallman Modern Physical Metallurgy and Materials Engineering, Butterworth-Heinemann 1999
- 3 Reza Abbaschian, Lara Abbaschian, Robert E. Reed-Hill Physical Metallurgy Principles, Cengage Learning 2008
- 4 W.G.Moffatt, G.W.Pearsall, John Wulff Structure and Properties of Materials Vol. 1, John Wiley, 1964



Reference Books

- 1 Abhijit Mallick Principles of Physical Metallurgy, Viva Books Private Limited, 2010
- 2 William D. Callister, David G. Rethwisch Fundamentals of Materials Science and Engineering, John Wiley, 2011

University Examination Pattern

PART A: Short answer questions (one/two sentences)

All questions are compulsory. There should be at least one question from each module. $5 \times 3 \text{ marks} = 15 \text{ marks}$

PART B: Analytical/Problem solving questions

Candidates have to answer five questions out of seven. There should be at least one question from each module and not more than two questions from any module. $5 \times 5 \text{ marks} = 25 \text{ marks}$

PART C: Descriptive/Analytical/Problem solving questions

Two questions from each module with choice to answer one question. $5 \times 12 \text{ marks} = 60 \text{ marks}$

Maximum Total Marks: 100



MODEL QUESTION PAPER
MT 010 304 PHYSICAL METALLURGY

PART A (5x3=15 Marks)

1. What are space lattice, Coordination number and Packing fraction?
2. What are the various possible crystal defects
3. What is Kirkendall effect?
4. Differentiate between (i) eutectic and eutectoid and (ii) peritectic and peritectoid
5. What is polygonization

PART B (5x5=25 Marks)

6. Explain briefly the Bravais lattices with appropriate sketches
7. Differentiate between slip and twinning, edge and screw dislocation
8. What are the various factors affecting diffusion? explain
9. What is phase rule and lever rule?
10. What is ASTM grain size number? How it is correlated to the actual grain size?

PART C (5x12=60 Marks)

11. Explain Bragg's law of diffraction. Given that the interplanar spacing of the {110} planes in iron is 2.024 Å. Compute the lattice parameter for this crystal structure

OR

12. (a) Give the formulae to find out atomic radius of a cubic cell if the cell dimension 'a' is given. (b) Metallic iron changes from BCC to FCC at 1000 °C and correspondingly the atomic radii vary from 1.3 Å to 1.332 Å. Calculate the percentage of volume change during the structural change.

13. Explain Frank Reed sources, dislocation climb and cross slip with neat sketches

OR

14. Describe the dislocation interactions forming jogs and kinks with neat sketches
15. What are the application of diffusion in metallurgical processes (Give 3 examples)

OR

16. Derive the second law of diffusion
17. Draw a neat sketch of iron-carbon phase diagram. Explain the phases present in the diagram. Indicate the invariant points

OR

18. Draw a binary phase diagram of two metals which are (a) completely miscible in liquid state and completely immiscible in solid state (b) Completely miscible in liquid state and partially miscible in solid state
19. Write short notes on recovery, recrystallization and grain growth

OR

20. Briefly explain the structure sensitive and structure insensitive properties of Metals



MT 010 305 PROGRAMMING IN C

(Common with ME 010 305, PE 010 305 and AU 010 305)

Teaching scheme

3 hours lecture and 1 hour tutorial per week

Credits: 4

Objectives

- To impart advanced knowledge in programming in C language

Module I (15 hours)

Introduction to computer programming; Various I/O functions; Data types; Constants and Variables; Escape Sequences; Type Casting; Pre-processor Directive; Storage Classes; Scope of Variables; Mathematical Operators; Relational Operators; Branching Instructions; Logical Operators; Conditional Operator; Precedence of Operators; Loops – for, while and do-while, break and continue instructions, Nested Loops; Switch statement; Evaluation of ex, sin(x), cos(x) Numerical Integration using Trapezoidal and Simpson's rules.

Module II (10 hours)

Arrays; One Dimensional Arrays; Selection Sorting; Binary Searching; Various String Handling Functions; Multidimensional Arrays; Matrix Operations (Addition, Transpose and Multiplication); Sorting of Strings; Structure and Union; Array of Structures;

Module III (10 hours)

Functions; Call by Value Method; Stack; Passing One Dimensional and Multidimensional Arrays to a Function; Recursion; Writing Different String Handling Functions Using Simple Functions and Functions with Recursive Calls; Quick Sorting; Macros; Writing Macros for Simple Operations;

Module IV (15 hours)

Declaration of Pointers; Call by Reference Method; Pointer to a Structure; Pointer to an Array; Array of Pointers; Pointer to a Pointer; Self Referential Structure; Dynamic Memory Allocation; Reallocation of Memory; Linear Linked List; Circular Linked List; Double Linked List; Addition, Insertion and Deletion of Nodes from a Linked List; Command Line Arguments

Module V (10 hours)

Different types of Files; Reading, Writing, Appending and Rewriting of Text and Binary Files; Transfer of Data in Blocks; Moving of File Pointer in a File; Usage of bitwise AND, OR, NOT, XOR, Shift Left and Shift Right Operations.

Text Books

1. Bryon S.Gottfried, *Programming with C Language*.

Reference Books

1. Balaguruswamy, *Programming in ANSI C*,
2. Deitel, *How to Program C*
3. Kamthane, *Programming with ANSI and Turbo C*



MT 010 306 MINERAL DRESSING

Teaching scheme

Credits: 4

3 hours lecture and 1 hour tutorial per week

Objectives

To provide an understanding of some of the properties of common minerals, the concepts necessary for mineral exploration and discuss the various mining and ore dressing methods emphasizing the need to work in a safe environment.

Module I:

Mineral and Ore- definitions. Physical properties of minerals - transparency, luster, colour, luminescence, specific gravity, hardness, tenacity, brittleness, cleavage, fracture, magnetic, electrical and optical properties, radioactive properties, Physicochemical properties, minerals and their classification.

Economics of mineral processing: Scope and objective of mineral dressing economics of mineral dressing, advantages of mineral dressing, choice of mineral processing methods, Methods based on properties of minerals, Steps in mineral processing, Quantitative representation of mineral processing operations, recovery, ratio of concentration, efficiency of ore processing operation, economic recovery.

Pretreatment and sampling of ores: Methods of weighing, Washing and scrubbing, Hand and mechanical sorting, Breaking and sampling of ores. Size of samples to be taken. Sampling of mill products.

Module II:

Liberation, sizing, screening: Liberation size, minerals of equal and unequal abundance, Screening and factors affecting screening efficiency, Laboratory sizing and equipments, presentation of sieve analysis, sub-sieve sizing, elutriation, sedimentation, infra-sizing, permeability method, microscopic measurement. Industrial screening- roll, flat, bar, punched screens, reels, woven wire cloth, shaking, vibratory, wet screens. Latest developments. Operating characteristics of screens.

Comminution of ores- Grinding: - Introduction. Objectives. Types of grinding – Batch or continuous, differential, Dry and wet, open or closed circuit, primary and secondary grinding. Types of mills – Tumbler, screening mill and its capacity, grinding bodies in tumbling mill, theory and practice of ball mills, types of ball mills, rod mill, pebble mill, tube mill, Hadsel mill, disintegration by internal forces. Special grinding methods- micronizer, fluid energy mill, electrical methods, centrifugal grinders. Calculation of charge volume, motor size, mill size matching to required power. Optimum size of grinding media-rods, pebbles, balls and consumption of grinding media. Recent developments in crushing and grinding methods.

Attributes of comminution-shape of comminuted particles. Crushing and grinding efficiency-thermodynamic definition,

Determination of new surface produced, specific surface energy of solids, order of magnitude of grinding efficiency, crushing and grinding laws (Kick and Rittinger laws), practical measures of grinding efficiency, crushing resistance of minerals.



Module III:

Movement of solids in fluids:- Elementary concepts of movement of solids in fluids- Fluid resistance and terminal velocity – settling of fine spheres and Stoke's law, settling of coarse spheres and Newton's law, settling particles of intermediate range, factors affecting theoretical treatment of falling particles, Reynold's number, equal settling of particle s, settling of large spheres in a suspension of fine spheres, hindered settling (effect of simultaneous movement of many particles).Mechanism, settling velocity in classifiers. Classifiers- types and operation. Sizing classifiers- mechanical and non mechanical and non mechanical types, performance and efficiency of classifiers, cyclones, classifiers as concentration devices.

Quantifying concentrating operations:- Direct statement, Recovery, Rejection, Losses,, efficiency of a concentrating operation, economic recovery, coal washing efficiency, screen and classifier efficiencies.,

Heavy fluid separation (dense media separation DMS):- Introduction, mechanism, types of media, cleaning and recirculation of media, operation of heavy fluid separation , Lab use of heavy fluids, Industrial DMS processes using heavy liquids- Lessing process, Bertrand process, Du Pont Process. Industrial DMS processes using heavy suspensions- Chance process, Vooy's process, Wuench process, Huntington-Heberlein sink – float process, differential density process, Akins process, counter current dense media separator, Stripa process, Wemco process, heavy media separation in cyclones, Dry fluid bed separator. Washability characteristics of coal.

Gravity concentration in vertical currents:- Introduction to Jigging, Theory of Jigging, Operation of Jig, Factors affecting stratification, Rate of stratification, Jigging cycles, stratification during Jigging, Jigging methods, Types of Jigging – hand jig, fixed screen jig, movable screen jig, pneumatic jig, advantages and limitations of jigs.

Gravity concentration in vertical currents:-Theory of flowing film concentration. Devices for flowing film concentration-devices with stationary and moving separating surfaces. Principle and operation of shaking tables, factors controlling operation and construction of shaking table., Wilfley tables, Dry tables, treatment of slimes, applications of flowing film concentration, recent developments.

Module IV:

Ore concentration- Flotation and agglomeration:-Introduction, Flotation processes- froth, film, oil, ion flotation processes, gravitational method. Physical chemistry of flotation-particle size and its modification, surface energy of particles, surface activation, water-mineral reactions, solubility of minerals in water, reaction of sulphide minerals with oxygen and carbon dioxide, reactions between mineral surface and dissolved components, wettability, contact angle. Floatability test. Mineralization of air bubbles. Aeration and froth formation-Neo bubble, phase system, structure and properties of froth, froth stability. Flotation kinetics, speed of flotation and factors affecting flotation.

Flotation reagents and practice:- Function and mechanism, Collectors- anions and cation collectors, non polar collectors, reaction of collector with minerals – mechanism, Factors affecting this reaction,. Frothers- mechanism and factors affecting frothing action. Modifying agents and their action. Flotation practice:-Sequence of operation. Flotation Machines. Determination of size and number of cells. Determination of quantity of pulp and its density. Auxiliary equipments. Designing of flotation machines. Flotation schemes.Process control and measurement. Recent developments in flotation.



Magnetic and electrical separation:-Mechanism of magnetic separation, Minerals responding to magnetic separation, Magnetic separators – Dry and wet methods, Demagnetization. Electrical methods:-Mechanism, Conductivity of minerals, Electrical separation processes- electrostatic and high tension separators, Dielectric separation method.

Solid- fluid separation:- Thickening , flocculation- mechanism and factors affecting, sedimentation and dewatering of floccules, thickening equipments. Solid – and disc filters, centrifugal and electrophoretic filters. Dust elimination from air / gases, Water removal. Floto-flocculation for treating waste water.

Chemical processing of ores:- Mechanism and methods of Leaching , Ion exchange, Solvent extraction , Roasting, Sintering. Recovery of gold by Cyanide and amalgamation processes. Treating of Nickel oxide, Uranium, Thorium ores, Chemical beneficiation of ilmenite and concentrating Manganese ores. Auxiliary operations:- Storage, Conveying, Feeding, Sampling, Weighing.

Module V:

Ore microscopy:- Evaluation of mineralogical composition and association of various elements, Quantitative analysis of minerals for ore testing, texture of ore minerals, Optical methods- stereo microscope. Sampling, Screening, Sample preparation, Microscopic counting. Employing microscopes in ore processing. Microscopic studies of minerals of gold, copper, lead, zinc, molybdenum, nickel; tin, tungsten, uranium and their role in beneficiation process.

Process and flow charts of ores:- Aluminium (Bauxite, Kyanite) , Arsenic, Antimony, Asbestos, Beryllium, Chromite ore, Clay, Coal, Copper, Diamond, Gold, Graphite ,Iron, Lead, Lead-zinc, Manganese, Mica, Molybdenum, Nickel, Phosphate rock, Tin, Tungsten.

Sampling, Mill control and automation in ore processing:-Sampling and control of ore and products at different stages of process, Sampling errors, Sampling and control of pulp, flotation products, cynidation products, DMS products,. Automatic measurements and instrumentation in mineral processing, Automation of Mineral processing plants, General awareness of use of computers in Mineral processing.

Mineral processing plant:- General awareness of Location and factors to be considered-Layout objectives, principles, effects. Criteria for a good layout. Basics of Selection of equipments

References,.

1. S.K.Jain, Mineral Processing”, , CBS Publishers & Distributors P Ltd, New Delhi, 2012
2. Joseph Newton, ‘Extractive Metallurgy’, 1st Edition, Wiley Eastern,1967
3. A. M. Gaudin Principles of Mineral Dressing” , Tata Mc Graw Hill, 1993
4. J.D Gilchrist., ‘Extraction Metallurgy’, 2nd Edition, Pergamon Press, 1980
5. Barry Wills, Tim Napier- Munn: Wills' Mineral Processing Technology, 4th Edition, Elsevier, 2005.



University Examination Pattern

PART A: Short answer questions (one/two sentences)

All questions are compulsory. There should be at least one question from each module. $5 \times 3 \text{ marks} = 15 \text{ marks}$

PART B: Analytical/Problem solving questions

Candidates have to answer five questions out of seven. There should be at least one question from each module and not more than two questions from any module. $5 \times 5 \text{ marks} = 25 \text{ marks}$

PART C: Descriptive/Analytical/Problem solving questions

Two questions from each module with choice to answer one question. $5 \times 12 \text{ marks} = 60 \text{ marks}$

Maximum Total Marks: 100



MODEL QUESTION PAPER

MT 010 306 MINERAL DRESSING

PART A (5x3 = 15 Marks)

1. What are the different mineral processing methods based on their properties.
2. What do you understand by the term liberation in mineral processing? What is meant by the degree of liberation?
3. Discuss the factors affecting settling of solids in a fluid
4. What is Flocculation? What are the various factors affecting flocculation?
5. How ore samples are prepared for microscopic studies

PART B (5x5 =25 marks)

6. Name the different sampling methods of ores and products.
7. What are the different techniques of sizing operation? Explain their operating principle in detail
8. Derive stokes equation for terminal velocity? What are its assumptions and limitations?
9. What is understood by solvent extraction method?
10. Draw flow sheet for (a) cyanidation (b) Amalgamation

PART C (5x12 = 60 Marks)

11. Describe briefly the physical and physicochemical of minerals

OR

12. Explain the principle steps involved in mineral processing
13. (a) Give the expression for the speed of a ball in a ball mill. Explain the various terms involved in the expression. (b) With a neat sketch explain, the motion of charge in a tumbling ball mill indicating the important zones in the mill.

OR

14. a) Distinguish between 'short hand' and standard cone crusher. (b) What is angle of nip?
15. Explain the significance of angle of nip in roll crushers. Derive an expression for the angle of nip in roll crusher.
- (a) What are the different factors that control the operation of shaking tables? Explain them fully. (b) Discuss the factors the influence the capacity of shaking tables.

OR

16. (a) What is Heavy media separation and what is its principle? (b) Discuss about the different media. What are their advantages and disadvantages? (c) Give a flow chart or steps in Heavy media separation?



17. (a) What is flotation? Explain the principle of flotation in detail.(b) Distinguish between direct flotation and reverse flotation.(c) Compare and contrast 'cohesion' and 'adhesion'.(d) What is work of adhesion? Explain.

OR

18. Describe the methods of thorium ore enrichment

19. Explain the processing of nickel ore with the help of a flowchart

OR

20. What are the guidelines used in making a good plant layout? Describe.



MT010 307: COMPUTER PROGRAMMING LABORATORY

(Common with ME010 307, PE010 307 and AU010 307)

Objectives

- *To provide experience in programming with C language.*
- *To familiarize with operating systems. File directories, editors, compilers and file managers etc.*
- *To obtain exposure to computer programming languages for technical computation like MatLab.*
- *Programming experiments in C to cover control structures functions, arrays, structures, pointers and files.*

- i. Counting characters, lines and words
- ii. Checking leap year
- iii. Finding sum of digits and reversing a number
- iv. Generating Prime numbers, Fibonacci numbers and Angstrom numbers
- v. Sine and Cosine series generation
- vi. Implementation of Numerical Integration using Simpson's and Trapezoidal rules
- vii. Sorting of numbers, strings and records
- viii. Matrix addition and multiplication
- ix. Implementation of dynamic memory allocation
- x. Implementation of linked lists
- xi. Problems related to files
- xii. Problems related to command line arguments



**MT010 308 ELECTRICAL AND ELECTRONICS
ENGINEERING LABORATORY**

(Same syllabus as ME 010 508 and PE 010 508 - *Electrical and Electronics Laboratory*)

Teaching scheme

Credits: 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To conduct various tests on Electrical Machines and to study their performance.*
- *To conduct various tests on practical electronic circuits*

PART A

1. Study of 3-point and 4-point starters for D.C machines
2. OCC of self excited D.C machines – critical resistances of various speeds. Voltage built-up with a given field circuit resistance. Critical speed for a given field circuit resistance
3. OCC of separately excited D.C machines
4. Load test on shunt generator – deduce external, internal and armature reaction characteristics.
5. Load test on compound generator
6. Swinburne's test on D.C machines
7. Brake test on D.C shunt motors and determination of characteristics.
8. Brake test on D.C series motors and determination of characteristics.
9. Brake test on D.C compound motors and determination of characteristics.
10. O.C and S.C tests on single phase transformers – calculation of performance using equivalent circuit – efficiency, regulation at unity, lagging and leading power factors.
11. Load test on single phase transformers.
12. Alternator regulation by emf and mmf methods
13. Study of starters for three phase induction motors
14. Load tests on three phase squirrel cage induction motors



15. Load tests on three phase slip ring induction motors

16. Load tests on single phase induction motors

PART B

1. Design and testing of clipping and clamping circuits

2. Design and testing of of RC integrator and differentiator circuits.

3. Design and testing of rectifier circuits – Half wave – Full wave (centre – tapped and bridge) circuits. Filter circuits.

4. Design and testing of RC coupled amplifier– frequency response. Sweep circuits

5. Design and Testing of RC phase-shift Oscillator

References

1. Dr. P S Bimbira, *Electrical Machinery*, Khanna Publishers
2. R K Rajput, *A text book of Electrical Machines*, Laxmi publishers
3. A.P. Malvino, *Electronic Principles– TMH*
4. Floyd, *Electronic Devices*, Pearson Education, LPE



FOURTH SEMESTER



EN010 401 ENGINEERING MATHEMATICS - IV

(Common with all branches)

Teaching scheme

Credits: 4

2 hours lecture and 2 hours tutorial per week

Objectives: *Apply standard methods of mathematical & statistical analysis*

MODULE 1 Fourier series (12 hours)

Dirichlet conditions – Fourier series with period 2π and $2l$ – Half range sine and cosine series –

Harmonic Analysis – r.m.s Value.

MODULE 2 Fourier Transform (12 hours)

Statement of Fourier integral theorem – Fourier transforms – derivative of transforms-convolution theorem (no proof) – Parseval's identity.

MODULE 3 Partial differential equations (12 hours)

Formation by eliminating arbitrary constants and arbitrary functions – solution of Lagrange's equation – Charpit's method – solution of Homogeneous partial differential equations with constant coefficients.

MODULE 4 Probability distribution (12 hours)

Concept of random variable, probability distribution – Bernoulli's trial – Discrete distribution – Binomial distribution – its mean and variance- fitting of Binomial distribution – Poisson distribution as a limiting case of Binomial distribution – its mean and variance – fitting of Poisson distribution – continuous distribution- Uniform distribution – exponential distribution – its mean and variance – Normal distribution – Standard normal curve- its properties.

MODULE 5 Testing of hypothesis (12 hours)

Populations and Samples – Hypothesis – level of significance – type I and type II error – Large samples tests – test of significance for single proportion, difference of proportion, single mean, difference of mean – chi-square test for variance- F test for equality of variances for small samples.

References

1. Bali & Iyengar – A text books of Engg. Mathematics – Laxmi Publications Ltd.
2. M.K. Venkataraman – Engg. Mathematics vol II 3rd year part A & B – National Publishing
3. I.N. Sneddon – Elements of partial differential equations – Mc Graw Hill
4. B.V. Ramana – Higher Engg. Mathematics – Mc Graw Hill
5. Richard A Johnson – Miller Fread's probability & Statistics for Engineers- Pearson/ PHI
6. T. Veerarajan – Engg. Mathematics – Mc Graw Hill
7. G. Haribaskaran – Probability, Queueing theory and reliability Engg. – Laxmi Publications

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B. Tech in Metallurgy – Scheme and Syllabi



8. V. Sundarapandian - Probability, Statistics and Queuing theory – PHI
9. H.C.Taneja – Advanced Engg. Mathematics Vol II – I.K.International
10. A.K.Mukhopadhyay - Mathematical Methods for Engineers and Physicists-I



EN010 402 (MT 010 402): PRINCIPLES OF MANAGEMENT

Common syllabus with EN010 402(ME)

Teaching scheme

3 hours lecture and 1 hour tutorial per week

Credits: 4

Objectives

- To develop an understanding of different functional areas of management.
- To understand the functions and duties an individual should perform in an organisation.

Module I (12 hours)

Management Concepts: Vision, Mission, Goals and Objectives of management-MBO Scientific management- Functions of management- Planning- Organizing- Staffing- Directing- Motivating- Communicating- Coordinating- Controlling- Authority and Responsibility- Delegation- Span of control- Organizational structure- Line, Line and staff and Functional relationship.

Module II (12 hours)

Personnel Management: Definition and concept- Objectives of personnel management- Manpower planning- Recruitment and Selection of manpower- Training and development of manpower- Labour welfare- Labour turnover- Quality circle- Industrial fatigue- Industrial disputes- Method of settling disputes- Trade unions.

Module III (12 hours)

Production management: Objectives and scope of production management- Functions of production department- production management frame work- product life cycle-Types of production- Production procedure- Project planning with CPM and PERT- Basic concepts in network.

Module IV (12 hours)

Financial Management: Objectives and Functions of Financial Management- Types of Capital- Factors affecting working capital- Methods of financing.

Cost Management: Elements of cost- Components of cost- Selling Price of a product.

Module V (12 hours)

Sales and Marketing Management: Sales management- Concept- Functions of sales department- Duties of sales engineer- Selling concept and Marketing concept- Marketing- Definition and principles of marketing- Marketing management and its functions- Sales forecasting- Pricing- Advertising- Sales promotion- Channels of distribution- Market research.

Text Books

1. Koontz and Weihrich, *Essentials of Management*, Tata McGraw Hill.
2. Mahajan M., *Industrial Engineering and Production Management*, Dhanpat Rai and Co.
3. Kemthose and Deepak, *Industrial Engineering and Management*, Prentice Hall of India.



Reference Books

1. Martand Telsang, *Industrial Engineering and Production Management*.
2. Khanna O.P., *Industrial Engineering and Management*, Dhanpat Rai and Co.
3. Philip Kotler, *Marketing Management*, Prentice Hall of India.
4. Sharma S. C. & Banga T. R., *Industrial Organisation and Engineering Economics*, Khanna Publishers.
5. Prasanna Chandra, *Financial Management*, Tata McGraw Hill.

University Examination Pattern

PART A: Short answer questions (one/two sentences)

All questions are compulsory. There should be at least one question from each module. $5 \times 3 \text{ marks} = 15 \text{ marks}$

PART B: Analytical/Problem solving questions

Candidates have to answer five questions out of seven. There should be at least one question from each module and not more than two questions from any module. $5 \times 5 \text{ marks} = 25 \text{ marks}$

PART C: Descriptive/Analytical/Problem solving questions

Two questions from each module with choice to answer one question. $5 \times 12 \text{ marks} = 60 \text{ marks}$

Maximum Total Marks: 100



MT 010 403 MECHANICAL BEHAVIOR AND TESTING

Teaching scheme

Credits: 4

3 hours lecture and 1 hour tutorial per week

Objectives:

To provide an understanding of mechanical behavior of materials under various loading conditions and fundamental methods of mechanical testing for property determination.

Module I

Strength of Materials – Basic assumptions, Elastic and Plastic Behavior, Average stress and strain, Tensile deformation of ductile metal, Ductile Vs Brittle Behavior, Concept of stresses and the type of stresses, Concept of strain and types of strain, Units of stress and other quantities - **problems.**

Stress and strain relationship for elastic behavior - Description of stress at a point – State of Stress in two dimensions (plane stress), Mohr's Circle of stresses-two dimensions, State of stress in three dimensions Stress Tensor, Mohr' Circle-three dimensions, description of strain at a point-Mohr Circle of strain, Hydrostatic and Deviator components of Stress, Elastic stress-strain relation, Calculation of stresses from elastic strains, strain energy, anisotropy of elastic behavior, problems, stress concentration.

Module II

Basic of theory of Plasticity- Flow curve, True stress and True strain, Yielding criteria for ductile metals, Von-Mises' criterion, Tresca Criterion, problems, Combined stress tests, the yield locus, anisotropy in yielding, yield surface and normality, Octahedral shear stress and shear strain, invariants of stress and strain, Plastic stress strain relations- Levi-Mises Equations, Prandtl-Reuss equations, two dimensional plastic flow – slip line field theory – problems.

Deformation behavior of single crystals: critical resolved shear stress (CRSS). Slip planes and slip directions, Strain hardening of single crystals. Deformation of poly-crystals, stress-strain behavior and theories of work hardening in polycrystals - **Strengthening mechanisms:** strengthening from grain boundaries-equicohesive temperature-Hall-Petch relation, solid solution strengthening, precipitation strengthening, dispersion strengthening, strain hardening, superplasticity-

Module III

Fracture: **Types of fracture in metals**, theoretical cohesive strength of metals, Griffith theory, fracture of single crystals, Metallographic aspects of fracture, Fractography, dislocation theories of brittle fracture, theory of ductile to brittle transition, ductile fracture, Notch effects, Concept of the fracture curve, fracture under combined stresses, effect of high hydrostatic pressure on fracture - **Fracture Mechanics:-** Strain energy release rate, stress intensity factor, fracture toughness in design, K_{IC} plain strain toughness testing, Plasticity corrections, Crack opening Displacement (COD), J- integral, R- Curve, toughness of materials.

Module IV

Material Testing: - Static Testing Tension and compression tests, Bauschinger effect, stress–



strain diagram – elastic region, yield point, plastic deformation, instability in tension, necking and fracture. Analysis of stress- strain diagram, Measurement of mechanical properties, work hardening index. Effect of strain rate and temperature on flow properties, Notch tensile test-notch strength ratio (NSR) - **Hardness tests:** Scope and applicability of hardness tests, Vickers, Rockwell, Brinell, Meyer, Knoop and micro hardness tests. Relation between various systems of hardness numbers, relation of hardness to tensile strength. Hardness at elevated temperatures, **Creep test:** Creep curve, Effect of stress and Temperature on creep curve - **Torsion tests:** Mechanical properties in torsion, modulus of rupture, modulus of rigidity types of torsion failures, torsion test vs tension test, hot torsion testing.

Module V

Dynamic Testing - Fatigue: Types of cyclic load, Characteristics of fatigue failure, initiation and propagation of fatigue cracks, S-N curves, fatigue limit, fatigue strength, Basquin equation, Effect of mean stress on fatigue, Goodman diagram, cyclic stress strain curve, factors affecting fatigue strength and methods of improving fatigue behavior, Low cycle fatigue: Coffin-Manson relation, strain-life equation, structural features of fatigue, fatigue crack propagation- Paris law, Design criteria for fatigue, corrosion fatigue, fretting fatigue and thermal fatigue - **Notched Bar Impact Testing:** - Charpy & Izod impact testing, ductile-Brittle Transition Temperature (DBTT). Metallurgical factors affecting DBTT.

Text Books

1. G.E Dieter. Mechanical Metallurgy
2. RWK. Honeycomb, The Plastic Deformation of Metals
3. Joachim Roesler et al, Mechanical Behavior of Engineering Materials,
4. JR Davis, Tensile Testing, ASM International

References

1. Mechanical Behaviour of Materials, Meyers & Chawala (Prentice Hall)
2. N.E. Dowling, Mechanical Behavior of Materials,
3. H.E. Davis et al, Testing and Inspection of Engineering Materials,
4. Martin. J, Mechanical Behavior of Engineering Materials
5. Testing of materials, A.V.K. Suryanarayana, Prentice hall of India.

University Examination Pattern

PART A: *Short answer questions (one/two sentences)*

All questions are compulsory. There should be at least one question from each module. $5 \times 3 \text{ marks} = 15 \text{ marks}$

PART B: *Analytical/Problem solving questions*

Candidates have to answer five questions out of seven. There should be at least one question from each module and not more than two questions from any module. $5 \times 5 \text{ marks} = 25 \text{ marks}$

PART C: *Descriptive/Analytical/Problem solving questions*

Two questions from each module with choice to answer one question. $5 \times 12 \text{ marks} = 60 \text{ marks}$

Maximum Total Marks: 100



MODEL QUESTION PAPER

MT 010 403 MECHANICAL BEHAVIOR AND TESTING

PART A (5x3=15 Marks)

1. What is Poisson's ratio?
2. What is critical resolved shear stress? Explain using a diagram
3. What are the different types of fracture? What are the metallographic features?
4. What is hardness of a material? What are the different methods to determine hardness of a material
5. What is ductile brittle transition temperature? How it is determined?

PART B (5x5=25 Marks)

6. Draw a schematic tensile stress strain curve and explain what is resilience and toughness
7. What is true stress and true strain? How it is related to engineering stress and engineering strain?
8. What is stress intensity factor? How it is related to design of components?
9. Draw a typical creep curve. Explain its various stages
10. Draw S-N curve for Iron and Aluminum? Explain Fatigue limit and endurance limit

PART C (5x12 = 60 Marks)

11. An annealed steel Tensile specimen ($E=200$ GPa) has a 12 mm dia and 50 mm gauge length. Maximum Load is 7000 kg and fracture occurs at 4500 kg. What is the tensile strength? Why does fracture occur at a lower load than the maximum load? What is the deformation when a tensile stress of 100 MPa is applied?

OR

12. Construct a Mohr's circle of stress for the following plane stress condition $\sigma_x = +340$ MPa, $\sigma_y = +34$ MPa and $\tau_{xy} = -55$ MPa
13. What are the different strengthening mechanisms in an alloy? Explain.

OR

14. Write a note on strain hardening of single crystals
15. Explain Griffith's Theory of Brittle fracture

OR

16. Explain the methodology adopted in K_{IC} plane strain toughness testing.
17. What are the effects of temperature on the flow properties of material?

OR

18. What is strain rate sensitivity? How it is related to superplasticity?
19. Describe the various factors affecting fatigue strength and methods of improving fatigue behavior of a material

OR

20. What are the various stages of fatigue? How crack growth rate is related to stress intensity factor range? Draw a diagram and explain



MT 010 404 PHASE TRANSFORMATIONS AND HEAT TREATMENT

Teaching scheme

Credits: 4

3 hours lecture and 1 hour tutorial per week

Objectives:

To provide an understanding on the phase transformation and microstructure development on cooling and heat treatment of a binary alloy system

MODULE 1

Diffusional Transformations in Solids:-phenomenological and atomistic approach. Nucleation and Growth kinetics- Nucleation and growth theories of vapor to liquid, liquid to solid and solid to solid transformations, Heterogenous nucleation, Diffusion controlled growth, Interference of growing precipitate particles, Interface controlled growth, Dissolution of a precipitate.

MODULE 2

Diffusional transformations in solids:-Homogenous and heterogenous nucleation, Precipitate growth, Overall transformation kinetics -TTT diagram, Precipitation in age hardenable alloys, GP zones, Al-Cu alloys, Al-Ag alloys, Quenched in vacancies, Spinodal decomposition, Coarsening of particles. The Iron Carbon System:-Precipitation of ferrite from austenite, cellular precipitation, Eutectoid transformation, Austenite to pearlite transformation, Effect of temperature on pearlite transformation, Time temperature transformation curve for steel, Bainitic transformation, Transformation shears, complete TTT diagram for eutectoid steel, Slowly cooled hypoeutectoid steel , Isothermal transformation diagrams for non eutectoid steels, continuous cooling diagrams, Massive transformations, ordering transformations

MODULE 3

Diffusionless transformations:- Characteristics of diffusionless transformations, Martensite, Bain distortion, Martensitic transformation in Indium-Thalium alloy, Athermal transformation, Crystallographic features of martensite transformation, Habit plane, Iron Nickel martensite, Isothermal formation of martensite, Stabilisation, Theories of martensite nucleation and growth, Effect of stress, plastic deformation and grain size on martensite plate growth.

MODULE 4

Basics of Hardening of steel:-Iron Carbon diagram, continuous cooling transformation, Stress relieving, Equilibrium heat treatment:-normalizing, annealing, spheroidising Hardenability:- Austenitic grain size, Effect of grain size , Effect of Carbon content , Significance ,Influence of alloying elements, Microstructure Evolution during Austenite Decomposition, Allotriomorphic Ferrite, Widmanstatten Ferrite, Martensitic transformation:- types, hardness of Fe-C martensite, Dimensional changes during martensitic transformation, Quenching and quench cracks, Tempering:- carbon segregation, epsilon carbide formation, cementite, alloy carbides, effect of retained austenite, temper embrittlement, Effect of tempering on properties, Interrelation between tempering time and temperature, secondary hardening, Step quenching:-Martempering, Austempering, cold treating and cryogenic treatment, Solution treatment, Maraging, Inter critical annealing Thermomechanical processing



Effects of Alloying Elements on the Heat Treatment of Steel:- Effects of Alloying Elements on Heat Treatment Processing of Iron–Carbon Alloys, Effect of Alloying Elements on Austenite Transformations, Influence of Alloying on Ferrite and Pearlite Interaction, Effect on Martensite Transformation,, Retained Austenite, Effect on Bainite Transformation, Transformation Diagrams for Alloy Steels, Tempering of Alloy Steels, Structural Changes on Tempering, Effect of Alloying Elements, Transformations of Retained Austenite (Secondary Tempering), Estimation of Hardness after Tempering.

MODULE 5

Basics of Surface hardening methods:- Introduction to surface hardening of steels, flame, laser, electron beam surface hardening methods, Gas, pack, liquid, vacuum, plasma Carburising methods, carburized steel, microstructure and properties of CarboNitriding, Gas, liquid, plasma nitriding, gas and plasma nitrocarburising Carbonitriding, boronising, Measuring case depth.

Heat treating equipments:-Types of furnaces, salt bath and fluidized bed heat treating equipments, Vacuum furnaces Basics of efficient heat treating furnace design.

Basics of Temperature control in heat treating, Furnace atmosphere and their control, control of surface carbon content of steel parts, Defects and distortion in heat treated parts, furnace safety.

REFERENCES.

- 1) J.W.Christian The Theory of Transformations in Metals and Alloys
- 2) F.J.Humphreys, M.Hatherly, Recrystallisation and Related Annealing Phenomena.

University Examination Pattern

PART A: *Short answer questions (one/two sentences)*

All questions are compulsory. There should be at least one question from each module. $5 \times 3 \text{ marks} = 15 \text{ marks}$

PART B: *Analytical/Problem solving questions*

Candidates have to answer five questions out of seven. There should be at least one question from each module and not more than two questions from any module. $5 \times 5 \text{ marks} = 25 \text{ marks}$

PART C: *Descriptive/Analytical/Problem solving questions*

Two questions from each module with choice to answer one question. $5 \times 12 \text{ marks} = 60 \text{ marks}$

Maximum Total Marks: 100



MODEL QUESTION PAPER

MT 010 404 PHASE TRANSFORMATIONS AND HEAT TREATMENT

PART A (5x3 = 15 Marks)

1. Distinguish between homogeneous and heterogeneous nucleation
2. What do you mean by pearlite and cementite?
3. Why we are not hardening mild steel.
4. What is temper embrittlement?
5. What are the applications of carbonitriding?

PART B (5x5=25 Marks)

6. Write a short note on the transformations that occur on heating
7. What is spinoidal decomposition?
8. What are the crystallographic features of martensite ?
9. Write notes on martempering, austempering, ausforming
10. Give a brief account of various carburizing methods

PART C (5x12=60 Marks)

11. Briefly explain the growth kinetics in solid state

OR

12. Describe the kinetics of dissolution of a precipitate on heating
13. How to develop the TTT diagram? Draw the TTT diagram for an eutectoid steel and explain the various factors affecting it.

OR

14. (a) Discuss in detail the heat treatment temperature, holding time, microstructural changes for annealing, normalising, hardening and tempering for a 0.2% carbon steel, 0.8% carbon steel, 1.2% carbon steel.

15. (a) Explain the theories of martensite nucleation and growth; (b) What are the effects of stress, plastic deformation and grain size on martensite plate growth.

OR

16. What are the characteristics of diffusionless transformations, Give a brief account of martensitic transformation in Indium-Thalium alloy

17. What are the effect of alloying elements in steel

OR

18. Explain with respect to iron-carbon diagram the following: Stress relieving, normalizing, annealing, and spheroidising.



19. (a) Give a detailed account of gas carburizing. (b) Explain in detail different methods of Nitriding and give the advantages and limitations.

OR

20. (a) Discuss in detail precipitation hardening of an aluminium copper alloy.
(b) List the various defects normally observed in heat treated parts and discuss the causes and remedies for any four such defects.



MT 010 405 ELECTRICAL, ELECTRONICS, MAGNETIC AND OPTICAL MATERIALS

Teaching scheme

Credits: 4

3 hours lecture and 1 hour tutorial per week

Objectives:

To get acquainted with the materials employed in electrical, electronic, magnetic and optical fields and the applications of these materials for engineering purpose.

MODULE 1

Free electron theory- Band theory-discussion on specific materials used as conductors- Dielectric phenomena-concept of polarization dielectric loss-dielectric breakdown-ferro electricity-piezo electricity and pyro electricity.

MODULE II

Introduction to Dia, Para, Ferri, Antiferri and Ferro magnetism, Properties of magnetic materials: - curie temperature, magnetic permeability, coercive field, Magnetic anisotropy, magnetic domain walls, magnetic losses, magnetostriction, Hard and soft magnetic materials,- Iron-Silicon alloys, Iron – Nickel alloys, Ferrites, Garnets, Alnico alloys,- (Ag-Mg-Al) alloys-(Cu-Ni-Co) alloys-fine particle magnets.

MODULE III

Semiconducting materials: -band theory, -classification of semiconductors, intrinsic and extrinsic types, motion of electrons and holes, Hall effect. Semiconducting devices, Semiconductivity in ceramic materials. Concept of superconductivity, discussion on specific superconducting materials and engineering applications.

MODULE IV

Conducting materials: Classification and basic properties of conducting materials, high conductivity materials, superconductors and hyperconductors, various metals, alloys, solders and nonmetallic conductors

MODULE V

Light interaction with solids: - electron polarization, electron energy transition, optical properties of metals and non metals, optical absorbance in metals semiconductors and dielectrics. Applications of optical devices, propagation of light in a fiber. Advantages and applications of optical fiber communication. LED Materials. Basics of lasers and its applications, Principles of photoconductivity and luminescence. Thermography and its applications

REFERENCES

1. M.S.Tyag, Introduction to Semiconducting Materials and Devices- John Wiley And Sons.
2. J.Wilson, J.F.B.Hawkes , Optoelectronics- An Introduction- Prentice Hall ,India.
3. Charles Kittel, Introduction to Solid State Physics – Wiley.
4. J.D.Patterson, Solid State Physics – Springer.
5. Dekker A.J, Solid State Physics – Mcmillan India Ltd



6. S.M. Sze , VLSI Technology – Mcgraw Hill International
7. C.D Yesudin, D.G.Harris Samuel, Material Science and Metallurgy – Scitech Publications
8. Pradeep Fulay - Electronic, Magnetic and Optical Materials- CRC Press
9. Robert M.Ross, Lawrence A.Sheppard, John Wulff – Electronic Properties – Wiley Eastern Private Limited.
10. K.H.J.Buschow, F.R. De Boer – Physics of Magnetism and Magnetic Materials- Kluwer Academic Publishers, Moscow

University Examination Pattern

PART A: Short answer questions (one/two sentences)

All questions are compulsory. There should be at least one question from each module. $5 \times 3 \text{ marks} = 15 \text{ marks}$

PART B: Analytical/Problem solving questions

Candidates have to answer five questions out of seven. There should be at least one question from each module and not more than two questions from any module. $5 \times 5 \text{ marks} = 25 \text{ marks}$

PART C: Descriptive/Analytical/Problem solving questions

Two questions from each module with choice to answer one question. $5 \times 12 \text{ marks} = 60 \text{ marks}$

Maximum Total Marks: 100



MODEL QUESTION PAPER

**MT 010 405 ELECTRICAL, ELECTRONICS, MAGNETIC AND
OPTICAL MATERIALS**

PART A (5 x 3 = 15 Marks)

1. State general properties of dielectric materials
2. Describe Para, Ferro, Antiferro and Ferri magnetism. Describe them schematically
3. What is superconductivity? Name two examples
4. Name two non-metallic conductors. Where they are used. How they differ from metallic conductors?
5. Describe briefly applications of fiber optics

PART B (5 x 5 = 25 Marks)

6. Explain dielectric breakdown
7. Explain magnetostriction
8. What is Hall Effect? Explain.
9. Name two low resistivity copper alloys. Mention their practical applications with reasons for the same
10. Explain different kinds of luminescence

PART C (5 x 12 = 60 Marks)

11. What are ferro electric, piezo electric and pyro electric effects? State name of such materials and their important applications.

OR

12. Draw a schematic of the band diagrams for a typical metal, semiconductor and insulator and discuss
13. What are soft and hard magnetic materials? Name three in each category with their applications.

OR

14. Explain the properties of magnetic materials
15. What are intrinsic and extrinsic semiconductors? Explain with examples

OR

16. What are the various semiconductor devices? Explain any four of them briefly
17. (a) What is super conductivity? Outline the experimental facts about this phenomenon.
(b) Explain about Meissner effect. (c) Explain the important property changes that occur in materials when they change from normal to superconducting state.

OR

18. What are high resistivity materials; name four materials. Describe their engineering applications
19. (a) Give a brief account of important lasers (b)write a brief account of laser applications

OR

20. What is thermography? Describe some of its applications



MT 010 406 TRANSPORT PHENOMENA

Teaching scheme

Credits: 4

3 hours lecture and 1 hour tutorial per week

Objectives:

To provide basic understanding with the transport phenomena of momentum, heat and mass and its applications in metallurgical systems

MODULE I

Introduction:-Basic principles of transport phenomena, Basic principles of reaction kinetics, Units and Dimensions. Flow of fluids:- Nature of fluid flow, viscosity (gases, liquids, metals, alloys, slags), Differential mass & momentum balances, applications of differential balance equations, overall or macroscopic balance, high speed flow of gases, high velocity jets, flow through packed beds, flow through fluidized beds, motion of gas bubbles in liquids.

MODULE II

Heat transfer:-Conduction – thermal conductivity, heat conductive equation & applications, Convection- heat transfer coefficient, Radiation-thermal radiating & related basic properties of materials, emissivity, absorptivity of substances, Heat exchange between infinitely long and parallel plates, and between surfaces of finite area, Calculation of radiant heat transfer of black body surfaces, Flames and furnaces.

MODULE III

Mass transfer:-Diffusion of gases, liquids, solids, convective mass transfer, overall mass balance, concept of mass transfer coefficient, mass transfer coefficient for flow through packed beds and for spherical objects, Interfacial mass transfer, two film theory, surface renewal model, film penetration theory.

MODULE IV

Dimensional Analysis:- Dimensionless numbers, Raliegth's method, Buckingham method, use of differential equations, similarity criteria, applications in physical modeling. Boundary layer theory:- Velocity boundary layer, Thermal boundary layer, Concentration boundary layer, Boundary layer theory for simultaneous heat, mass and momentum transfer. Reaction kinetics:-Basic definitions, concepts, method of equi-fractional part, determination of rate constant, Reaction rate theories, order of reaction, Oxidation of Carbon, Slag metal reaction.

MODULE V

Coupled phenomena: Reynolds analogy between heat and momentum transfer, Reynolds analogy between mass and momentum transfer, Prandtl's analogy between heat and momentum transfer, Prandtl's analogy between mass and momentum transfer, Chilton-Colburn analogy among heat, mass and momentum transfer.

References

1. B.R.Bird, W.E.Steward, E.N.Lightfoot, Transport Phenomena- -Wiley



2. J.C.Slattery, Advanced Transport Phenomena – Cambridge University.

3. J.R Welty, C.E Wicks, R.E Wilson, G Rorrer, Fundamentals of Momentum, Heat and Mass Transport— John Wiley

University Examination Pattern

PART A: Short answer questions (one/two sentences)

All questions are compulsory. There should be at least one question from each module. $5 \times 3 \text{ marks} = 15 \text{ marks}$

PART B: Analytical/Problem solving questions

Candidates have to answer five questions out of seven. There should be at least one question from each module and not more than two questions from any module. $5 \times 5 \text{ marks} = 25 \text{ marks}$

PART C: Descriptive/Analytical/Problem solving questions

Two questions from each module with choice to answer one question. $5 \times 12 \text{ marks} = 60 \text{ marks}$

Maximum Total Marks: 100



MODEL QUESTION PAPER

MT 010 406 TRANSPORT PHENOMENA

PART A (5x3=15 Marks)

1. What are Newtonian fluids?
2. Write the expression for heat transfer coefficient. Also give its unit.
3. Write a brief note on self diffusion in an alloy.
4. What is Buckingham's pi theorem and Nusslet number?
5. Explain Reynold's analogy between momentum and heat transfer
- 6.

PART B (5x5=25 Marks)

6. Briefly explain the general momentum equations.
7. Explain the term film boiling.
8. State and explain Fick's Laws of diffusion.
9. What is understood by Reaction Kinetics? What is a rate equation?
10. Discuss the Chilton-Colburn analogy among heat, mass and momentum transfer

PART C (5x12=60 Marks)

11. (a) Derive the Bernoulli's energy equation for an incompressible fluid flow. (b) Discuss in detail about the properties of fluid like density, viscosity and specific weight.

OR

12. A viscous fluid is in laminar flow in a parallel plates, a distance $2B$ apart. The length and width of the plates are L and W respectively. Obtain the expressions for the distribution of velocity, maximum velocity, average velocity and volumetric flow rate. Assume that the liquid is flowing from top to bottom.
13. Explain black body radiator, emissivity, gray bodies and absorptivity.

OR

14. Derive an expression for the thermal conductivity of gases.
15. Explain the two resistance Mass transfer theory

OR

16. Explain the reduction of iron oxide by gases.
17. Explain the first and second order of reactions.

OR

18. Develop an expression for the thermal boundary layer of a fluid flowing past a plate.
19. (a) Derive the equation between mass and momentum transfers by Prandtl's analogy (b) Compare Reynold's and Prandtl's analogies. Discuss the conditions under which they yield the same results.

OR

20. Hot water at 80°C is flowing over a flat plate at the rate of 5 m/s . Calculate the rate of heat transfer to the plate which is at 40°C . Heat capacity of water 4200 J/kg/K , density of water 1000 kg/m^3 . Corresponding friction factor 0.005 .



**MT 010 407 HEAT TREATMENT OF FERROUS METALS
LABORATORY**

OBJECTIVE

This laboratory course offers practical knowledge of heat treatment applicable to iron and steel and studies micro-structural changes and hardness evolution.

List of Experiments

1. Determination of grain size of low carbon steels
2. Annealing and normalising of carbon steels
3. Spheroidisation annealing of high carbon steels
4. Effect of quenching media on hardening of steel
5. Effect of tempering temperature and time on tempering of steel
6. Carburizing of steel
7. Case hardness depth measurements
8. Austempering treatment
9. Hardenability test (Grossman and/or Jominy)
10. Heat treatment of maraging steel
11. Heat treatment of cast iron
12. Heat treatment of alloy steels
13. Microstructure of heat treated steels
14. Influence of heat treatment on cold worked material
15. Precipitation hardening and interrupted quenching
16. Microstructure study of heated grey and S.G. iron
17. Study of heat treatment defects- grain coarsening, widmanstatten structure, quench cracks, decarburization



MT 010 408 MECHANICAL TESTING LABORATORY

OBJECTIVE

This laboratory course offers practical knowledge of Material testing and evaluation of mechanical properties of engineering materials

List of Experiments

1. Direct tension test on plain carbon steels.
2. Direct tension test on Copper, Aluminum and stainless steel
3. Young's modulus of metal specimen by direct tension test.
4. Vicker's, Brinell's and Rockwell's hardness tests.
5. Compression test.
6. Torsion test to determine the rigidity modulus of a shaft.
7. Fatigue test: S-N Curve.
8. Impact test: Charpy and Izod tests on MS Specimens
9. Bending Test on metallic and nonmetallic specimens
10. Cupping Test on Metal Sheets : Load Deformation characteristics, Cupping load, Cupping number
11. Tests on Helical Springs: Compression, Tension Springs - Load deformation characteristics, stiffness, shear stress, modulus of rigidity, energy.
12. Shear Test on Metals: Direct Shear Strength, Single Shear, Double Shear.