UNIT III PARTIAL DIFFERENTIAL EQUATIONS 9 + 3

Formation of partial differential equations – Lagrange's linear equation – Solutions of standard types of first order partial differential equations - Linear partial differential equations of second and higher order with constant coefficients.

UNIT IV APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9 + 3

Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two-dimensional equation of heat conduction (Insulated edges excluded) – Fourier series solutions in cartesian coordinates.

UNIT V Z -TRANSFORMS AND DIFFERENCE EQUATIONS 9 + 3

Z-transforms - Elementary properties – Inverse Z-transform – Convolution theorem - Formation of difference equations – Solution of difference equations using Z-transform.

LECTURES: 45 TUTORIALS : 15 TOTAL : 60 PERIODS

TEXT BOOKS

1. Grewal, B.S, 'Higher Engineering Mathematics' 40th Edition, Khanna publishers, Delhi, (2007)

REFERENCES

1 Bali.N.P and Manish Goyal 'A Textbook of Engineering Mathematics', Seventh Edition, Laxmi Publications(P) Ltd. (2007)

2. Ramana.B.V. 'Higher Engineering Mathematics' Tata Mc-GrawHill Publishing Company limited, New Delhi (2007).
3. Glyn James, 'Advanced Modern Engineering Mathematics', Third edition-Pearson Education (2007).
4. Erwin Kreyszig 'Advanced Engineering Mathematics', Eighth edition-Wiley India (2007).

ML3202 FOUNDRY AND MACHINING PROCESSES LT P C
3 0 0 3

OBJECTIVE

Foundry and machining, which are important processes to give shape to components, are introduced to students. The students are exposed to various stages of foundry and machining operations

UNIT I PATTERN PREPARATION AND MOULDING 9

Introduction to foundry operations, patterns – functions, types, allowances, selection of pattern materials, colour codes, core boxes, moulding practice, ingredients of moulding sand and core sand, Testing of moulding sands, sand preparation, Sand moulding green sand moulding, dry sand moulding, skin dry sand moulding, core sand moulding, loam moulding, fluid sand process, shell moulding, pit and floor moulding, carbon-oxide process.

UNIT II MELTING PRACTICE AND CASTING TECHNIQUES 9

Melting practice and special precautions for steels, alloy steels, cast irons, aluminum alloys, copper alloys and magnesium alloys, safety considerations, fluxing degassing and inoculation. Sand casting, permanent mould casting, die casting, centrifugal

casting, plaster mould casting, investment casting, continuous casting, squeeze casting, full mould process.

UNIT III FUNDAMENTALS OF CUTTING 9

Mechanics of chip formation – Types of chips produced in cutting – Mechanics of Orthogonal and Oblique cutting – Cutting forces and power – Temperature in cutting - tool nomenclature – Tool life – Cutting fluid – tool wear and failure - Surface finish and integrity – Machinability.

UNIT IV TURNING, DRILLING AND RELATED PROCESSES 9

Turning parameters – Lathe and lathe operations – High speed machining – Ultra precision machining and hard turning – Cutting screw threads – Boring and boring machines – Drilling and drills – Drilling machines – Reaming and reamers – Tapping and taps – Design consideration for drilling, reaming and tapping – Deep drilling.

UNIT V MILLING, SHAPING AND RELATED PROCESSES 9

Milling operations – Milling machines – Planning and shaping – Broaching and broaching machines – Sawing – Filling and finishing – Gear manufactured by machining.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Heine,R.W., Loper,C.R., Rosenthal,P.C. “Principles of Metal Cutting”, Tata McGraw Hill Publishing Co., Ltd., New Delhi.
2. Jain,P.L., “Principles of Foundry Technology”, Tata McGraw Hill Co., Ltd., New Delhi, 2003

REFERENCES

1. Serope Kalpakjain, Steven R.Schmid, “Manufacturing Engineering and Technology”, Pearson Education, 2003.
2. Sharma P.C., “A Text Book of Production Engineering”, S.Chand & Co., Ltd., 6th Edition, 2005.
3. Ramana Rao, T. V., “Metal Casting Principles and Practice”, New Age Publishing Co., New Delhi, 1st Reprint 2007.
4. Peter R. Beeley., “Foundry Technology”, Elsevier, 2001.
5. Srinivasan, N. K., “Foundry Engineering”, Khanna Tech. Publications, New Delhi, 1994.
6. ASM Metals Hand Book, Vol.15, “Casting”, ASM International, 10th Edition, 1991.

ML3203 THERMODYNAMICS AND KINETICS OF MATERIALS LT P C
3 1 0 4

OBJECTIVE

The knowledge of thermodynamics is the basic requirement for understanding various alloy systems, phase transformations and interpreting properties. It also covers kinetics of reactions as well as heat and mass transfer in different systems.

UNIT I INTRODUCTION TO THERMODYNAMICS 8

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

UNIT II LAWS OF THERMODYNAMICS 10

The Second law of thermodynamics, entropy degree of reversibility and irreversibility, criteria of equilibrium, auxiliary functions, combined statements, Maxwell's relations, transformation formula, Gibbs-Helmoltz equation. Concept of Third law, temperature dependence of entropy, statistical interpretation of entropy, Deby and Einstein concept of heat capacity, relation between Cp and Cv, Consequences of third law.

UNIT III THERMODYNAMICS OF REACTIONS 10

Solutions, partial molal quantities, ideal and non-ideal solutions, Henry's law, Gibbs - Duhem equation, regular solution, quasi-chemical approach to solution, statistical treatment. Change of standard state. Phase relations and phase rule-its applications. Free energy composition diagrams for binary alloy systems, determination of liquidus, solidus and solvus lines. Effect of pressure on phase transformation and phase equilibria. Thermodynamics of electrochemical cells, solid electrolytes. Thermodynamics of point defects in solids.

UNIT IV INTRODUCTION TO METALLURGICAL KINETICS 10

Heterogeneous reaction kinetics-gas-solid, solid-liquid, liquid-liquid and solid-solid systems. Solid state diffusion- Ficks law, mechanism of diffusion, uphill diffusion, kirkendall effect, steady an transient diffusion, external mass transfer – fluid flow and its relevance to mass transfer, general mass transport equation, concept of mass transfer coefficient, models of mass transfer- film theory and Higbie’s penetration theory, Internal mass transfer- ordinary and Knudsen diffusion, mass transfer with reaction, adsorption-physical adsorption vs. chemisorption.

UNIT V ELETROCHEMICAL KINETICS 7

Concept of polarization, activation over potential, Butler-Volmer and Tafel’s equation, applications in Electrodeposition and corrosion, concentration over potential, limiting current, electro-winning and corrosion

TOTAL : 60 PERIODS

TEXTBOOKS

1. David R Gaskell, Introduction to Metallurgical Thermodynamics, McGraw-Hill series, Taylor and Francis, 2003
2. Prasad, Krishna Kant, Ray, H.S. and Abraham, K.P, Chemical and Metallurgical Thermodynamics, 2006

REFERENCES

1. Kenneth G. Denbigh, Principles of chemical equilibrium (Fourth edition), Cambridge University Press, 1981.
2. Arthur W. Adamson and Alice P. Gast, Physical chemistry of surfaces (Sixth edition), John Wiley, 1997.
3. Herbert B. Callen, Thermodynamics and an introduction to thermostatistics (Second edition), John Wiley, 1985.
4. David L. Goodstein, States of matter, Dover, 1985.
5. Federick Reif, Fundamentals of statistical and thermal physics, McGraw Hill, 1965.
6. Irving M. Klotz and Robert M. Rosenberg, Chemical thermodynamics*: Basic* theory and methods, Benjamin/Cummings, 1986.
7. Peter W. Atkins and Julio DePaula, Physical chemistry (Seventh edition), Oxford University Press, 2001.
8. Keith J. Laidler and John H. Meiser, Physical chemistry (Second edition), Houghton Mifflin, 1995.
9. Upadhyaya, G.S. and Dube, R.K., “Problems in Metallurgical Thermodynamics and Kinetics”, Pergamon Press, London, 1977.

CE3205 STRENGTH AND TESTING OF MATERIALS L T P C
3 1 0 4

OBJECTIVES

The students are introduced to various methods of analysis and evaluation of mechanical properties in terms of stress, strain and deformation in different loading modes: tension, compression, shear and torsion. This knowledge is essential for understanding mechanical behaviour of materials. Testing of materials for determination of properties is dealt with in detail.

UNIT I STRESS STRAIN AND DEFORMATION OF SOLIDS 9

Rigid and deformable bodies – Strength, Stiffness and Stability – stresses; tensile, compressive and shear – deformation of simple and compound bars under axial load – thermal stress – elastic constants – strain energy and unit strain energy – Strain energy in uniaxial loads.

UNIT II BEAMS - LOADS AND STRESSES 9

Types of beams: supports and loads – shear force and bending moment in beams – cantilever, simply supported and overhanging beams – stresses in beams – theory of simple bending – stress variation along the length and in the beam section.

Elastic curve of neutral axis of the beam under normal loads – Evaluation of beam deflection and slope: Double integration method, Macaulay Method, and Moment-area method – Columns – End conditions – Equivalent length of a column – Euler equation – Slenderness ratio – Rankine formula for columns

UNIT III TENSILE TESTING 10

Engineering stress and engineering strain curve, true stress and true strain curve, instability in tension, effect of strain rate and temperature on flow properties, tensile specimens and testing machines. Notch tensile test, anisotropy of tensile properties.

UNIT IV HARDNESS TESTING AND IMPACT TESTING 9

Brinell, Vickers, Rockwell, Rockwell superficial, rebound, micro hardness tests and testing machines. hardness conversion. Impact, IZOD, Charpy, Instrumented Impact, relation to K_{IC}

UNIT V TORSION AND TORSION TESTING 8

Analysis of torsion of circular bars – Shear stress distribution – Bars of solid and hollow circular section – Stepped shaft – Twist and torsion stiffness – Compound shafts – Fixed and simply supported shafts – Application to close-coiled helical springs – Maximum shear stress in spring section including Wahl Factor – Deflection of helical coil springs under axial loads – Design of helical coil springs – stresses in helical coil springs under torsion loads

L : 45, T : 15 , TOTAL : 60 PERIODS

TEXT BOOKS:

1. Popov, E. P, “Engineering Mechanics of Solids”, 2nd edition, Prentice Hall, 1998.
2. Beer F. P. and Johnston R, “Mechanics of Materials”, 3/e, McGraw-Hill 2002.

REFERENCES:

1. Nash W. A, “Theory and problems in Strength of Materials”, Schaum Outline Series, 01/e, Tata McGraw-Hill Book Co, New York, 1995
2. Kazimi S.M.A, “Solid Mechanics”, Tata McGraw-Hill Publishing Co, New Delhi, 1981.
3. Ryder, G. H, “Strength of Materials”, Macmillan India Ltd., Third Edition, 2002.
4. Ray, Hulse, Keith Sherwin & Jack Cain, “Solid Mechanics”, Palgrave ANE Books, 2004.
5. Singh, D. K “Mechanics of Solids” Pearson Education, 2002.
6. Timoshenko S. P, “Elements of Strength of Materials”, Affiliated East-West Press Pvt. Ltd 5th edition. 1968.

ML3205 MATERIALS STRUCTURE AND PROPERTIES L T P C
3 0 0 3

OBJECTIVE

The subject introduces the correlation of properties of materials and their structure. It revises student’s knowledge of crystal structure and phase diagrams of various alloy systems. The course not only covers metals, mainly ferrous and non-ferrous alloys, but also structures and properties of ceramics, polymers and composites.

UNIT I STRUCTURE OF MATERIALS 8

Structure of atom – Atomic models – Bonding in solids – Bonding forces and energies – Ionic, Covalent, metallic and van der Waals Bond - Crystal structure - Unit Cell – Bravais lattice – BCC – FCC – HCP - Interstitial sites – NaCl crystal – CsCl crystal – Perovskite structure – Diamond structure – Graphite – Crystal directions and planes.

UNIT II STRUCTURE OF METALS AND ALLOYS 8

Imperfection in crystals – Point defects – Dislocations – Slip plane – Movement of dislocations – Planar defects and grain boundaries – solid solutions – Hume Rothery

rule – Phase diagram – Lever rule – Gibb's phase rule – Phase diagram for binary alloys – Eutectic – Peritectic – Eutectoid – Zone refining.

UNIT III FERROUS AND NON FERROUS ALLOYS 10

Allotropy and phase change of pure iron – Classification of steels and cast iron – iron – carbon equilibrium diagram – Microstructure of iron and steel - Ferrous alloys and their applications –Heat treatment - Factors affecting conductivity of a metal – Electrical Resistivity in alloys – Thermal conductivity of metals and alloys – Silver, Copper and aluminum – High Resistivity alloys – nichrome, manganin, constantan and kanthal and their composition and applications – Super hard materials - Tungsten carbide and Boron nitrides.

UNIT IV CERAMIC AND COMPOSITE MATERIALS 10

Advanced Ceramic Materials - Crystal Structures - Silicate Ceramics - Glasses – Glass Ceramics – Functional properties and applications of ceramic materials – Classification of composites - Fiber reinforced materials – Law of mixtures – Continuous fibers – discontinuous fibers – Particle-reinforced materials – Cermets – Dispersion strengthened materials – Laminates - Application of composites in electrical and mechanical components – nuclear industry.

UNIT V POLYMER MATERIALS 9

Classification of polymer – Mechanisms of polymerisation - Some commercially important individual polymer – Thermoplastics - Elastomers – Thermosets – Engineering plastics - Liquid crystal polymers - Conductive polymers – High Performance fibers - Biomedical applications – Photonic polymers.

TOTAL : 45 PERIODS

TEXT BOOKS

1. William D. Callister, Jr., Materials Science and Engineering an Introduction, 2/e Edition , John Wiley & Sons, Inc., 2007.
2. V.Raghavan, Materials Science and Engineering, Prentice –Hall of India Pvt. Ltd., 2007

REFERENCES

1. Sidney H. Avner, Introduction to physical metallurgy, Tata Mc-Graw-Hill, Inc.,2/e, 1997.
2. W.Bolton, Engineering materials technology, 3rd Edition, Butterworth & Heinemann, 2001.
3. Donald R. Askeland, Pradeep P. Phule, The Science and Engineering of Materials 5th Edition, Thomson Learning, First Indian Reprint, 2007.
4. F.N.Billmayer, Test Book of polymer science, John Wiley & Sons, New York,1994.
5. William F.Smith, Structural Properties of Engineering Alloys, Tata Mc-Graw-Hill, Inc., 1993.
6. Kingery. W.D., Bowen H.K. and Uhlmann D.R., Introduction to Ceramics, 2nd Edition, John Wiley & Sons, New York, 1976.

ME3206 METROLOGY AND MEASUREMENTS L T P C
3 0 0 3

OBJETCTIVE

- To provide knowledge on various Metrological equipments available to measure the dimension of the components.
- To provide knowledge on the correct procedure to be adopted to measure the dimension of the components.

UNIT I .BASICS OF METROLOGY 5

Introduction to Metrology – Need – Elements – Work piece, Instruments – Persons – Environment – their effect on Precision and Accuracy – Errors – Errors in Measurements – Types – Control – Types of standards.

UNIT II LINEAR AND ANGULAR MEASUREMENTS 10

Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – gauge design – terminology – procedure – concepts of interchange ability and selective assembly – Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar – Angle alignment telescope – Autocollimator – Applications.

UNIT III ADVANCES IN METROLOGY 12

Basic concept of lasers Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment. Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Element – Applications.

UNIT IV FORM MEASUREMENT 10

Principles and Methods of straightness – Flatness measurement – Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications.

UNIT V MEASUREMENT OF POWER, FLOW AND TEMPERATURE 8

Force, torque, power - mechanical , Pneumatic, Hydraulic and Electrical type. Flow measurement: Venturimeter, Orifice meter, rotameter, pitot tube – Temperature: bimetallic strip, thermocouples, electrical resistance thermometer – Reliability and Calibration – Readability and Reliability.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Jain R.K. “Engineering Metrology”, Khanna Publishers, 2005.
2. Gupta. I.C., “Engineering Metrology”, Dhanpatrai Publications, 2005.

REFERENCES

1. Shot bolt, “Metrology for Engineers”, McGraw Hill, 1990.
2. Backwith, Marangoni, Lienhard, “Mechanical Measurements”, Pearson Education , 2006.

CE3207 STRENGTH OF MATERIALS LABORATORY L T P C
0 0 3 2

OBJECTIVE:
To study the properties of materials when subjected to different types of Loading.

1. Tension test on mild steel rod
2. Double shear test on metals
3. Torsion test on mild steel rod.
4. Impact test on metal specimen
5. Hardness test on metals
6. Compression test on helical spring
7. Deflection test on carriage spring

TOTAL : 45 PERIODS

ML3208 MICROSTRUTURE ANALYSIS LABORATORY L T P C
0 0 3 2

OBJECTIVE
The students having studied phase diagrams and microstructure evolution of various alloy system, experience the manifestation in samples studied by the metallographic technique. This lab is designed to expose students to specimen preparation and microstructure analysis of various commonly used metals and alloys.

List of Experiments

1. Specimen preparation for metallographic observation - working of metallurgical microscope.
2. Grain size measurements.
3. Macro etching - cast, forged and welded components.
4. Sulphur printing and phosphor printing.
5. Microstructure cast iron-gray, nodular and malleable iron - unetched.
6. Microstructure of gray, nodular and white iron - etched.
7. Microstructure of iron, steel (low carbon, medium carbon, high carbon, hypo and hypereutectoid steels).
8. Microstructure of stainless steels and high speed steels.
9. Over heated structure and banded structure in steels.
10. Microstructure of copper alloys
11. Microstructure of aluminium alloys
12. Microstructure of lead alloys

TOTAL: 45 PERIODS