ANNA UNIVERSITY :: CHENNAI 600 025

UNIVERSITY DEPARTMENTS

R - 2008

B.E. MATERIALS SCIENCE AND ENGINEERING

FROM III TO VIII SEMESTERS CURRICULUM AND SYLLABI

SEMESTER – III

CODE NO.	COURSE TITLE	L	T	P	C
THEORY					
MA9211	Mathematics III	3	1	0	4
ML9201	Foundry and Machining Processes	3	0	0	3
ML9202	Thermodynamics and Kinetics of Materials	3	1	0	4
ML9203	Strength and Testing of Materials	3	1	0	4
ML9204	Materials Structure and Properties	3	0	0	3
ME9306	Metrology and Measurements	3	0	0	3
PRACTICAL					
CE9214	Strength of Materials Laboratory	0	0	3	2
ML9205	Microstructure Analysis Laboratory	0	0	3	2
	TOTAL	**18**	**3**	**6**	**25**

SEMESTER – IV

CODE NO.	COURSE TITLE	L	T	P	C
THEORY					
ML9251	Mechanical Metallurgy	3	1	0	4
ML9252	Primary Processing of Iron and Steel	3	0	0	3
ML9253	Non-Ferrous Metallurgy	3	0	0	3
ML9254	Powder Metallurgy	3	0	0	3
ML9255	Solid State Physics	3	1	0	4
ML9256	Polymer Process Engineering	3	0	0	3
PRACTICAL					
ME9209	Metrology and Measurements Lab	0	0	3	2
ML9257	Manufacturing Technology Laboratory	0	0	3	2
	TOTAL	**18**	**2**	**6**	**24**

SEMESTER – V

CODE NO.	COURSE TITLE	L	T	P	C
THEORY					
ML9301	Theory and Applications of Metal Forming	3	1	0	4
ML9302	Materials Aspects in Design	3	1	0	4
ML9303	Characterization of Materials	3	0	0	3
ML9304	Heat Treatment of Metals and Alloys	3	0	0	3
ML9305	Introduction to Nanotechnology	3	0	0	3
ML9306	Corrosion and Surface Engineering	3	0	0	3
PRACTICAL					
ML9307	Heat Treatment Laboratory	0	0	3	2
ML9308	Materials Processing Laboratory	0	0	3	2
ML9309	Presentation Skills and Technical Seminar	0	0	2	1
	TOTAL	**18**	**2**	**8**	**25**

SEMESTER – VI

CODE NO.	COURSE TITLE	L	T	P	C
THEORY					
ML9351	Bio and Smart Materials	3	0	0	3
ML9352	Creep and Fatigue Behavior of Materials	3	1	0	4
ME9351	Finite Element Analysis	3	1	0	4
ML9353	Composite Materials	3	0	0	3
MG9362	Industrial Management	3	0	0	3
	Elective – I	3	0	0	3
PRACTICAL					
ML9354	Composite Materials Laboratory	0	0	3	2
GE 9371	Communication Skills and Soft Skills Laboratory	0	0	2	1
ML9355	Advanced Materials Characterization Laboratory	0	0	3	2
	TOTAL	**18**	**2**	**8**	**25**

SEMESTER – VII

CODE NO.	COURSE TITLE	L	T	P	C
THEORY					
GE9022	Total Quality Management	3	0	0	3
ML9401	Computer Applications in Materials Science	3	1	0	4
ML9402	Non Destructive Materials Evaluation	3	0	0	3
ML9403	Welding Metallurgy	3	0	0	3
	Elective - II	3	0	0	3
	Elective - III	3	0	0	3
PRACTICAL					
ME9403	Computer Aided Simulation and Analysis Laboratory	0	0	3	2
ML9404	Comprehension	0	0	2	1
ML9405	Material Design Project	0	0	4	2
ML9406	Industrial/ Field Training*	0	0	0	1
	TOTAL	**18**	**1**	**9**	**25**

*Four weeks industrial training during sixth semester holidays

SEMESTER – VIII

CODE NO.	COURSE TITLE	L	T	P	C
THEORY					
	Elective – IV	3	0	0	3
	Elective – V	3	0	0	3
PRACTICAL					
ML9451	Project Work	0	0	12	6
	TOTAL	**6**	**0**	**12**	**12**

TOTAL CREDIT: 188

LIST OF ELECTIVES FOR B.E MATERIALS SCIENCE AND ENGINEERING

ELECTIVES – I

CODE NO.	COURSE TITLE	L	T	P	C
ML9021	Metallurgy of Tool Materials	3	0	0	3
ML9022	Physical Metallurgy of Ferrous and Aluminum Alloys	3	0	0	3
ML9023	Automotive Materials	3	0	0	3
ML9024	Biomedical Materials	3	0	0	3
ML9025	Ceramics and Refractory Materials	3	0	0	3
ML9026	Electron Microscopy and Diffraction Analysis of Materials	3	0	0	3
ML9027	Modeling and Simulation in Materials Engineering	3	0	0	3
MA9262	Numerical Methods	3	1	0	4
ML9028	Experimental Techniques in Machining	3	0	0	3
ML9029	Fuels, Furnaces and Refractories	3	0	0	3
ML9030	Experimental Stress Analysis	3	0	0	3
ME9030	Industrial Tribology	3	0	0	3
ML9031	Micro and Nanomechanical Properties of Materials	3	0	0	3
ML9032	Alloy Casting Processes	3	0	0	3
ML9033	Rolling and Forging Technology	3	0	0	3
MF9030	Micro Machining Processes	3	0	0	3
ML9034	Laser Processing of Materials	3	0	0	3
ML9035	Cryogenic Treatment of Materials	3	0	0	3
ML9036	Materials Handling Systems	3	0	0	3
ML9037	Principles of Metal Cutting	3	0	0	3
GE9021	Professional Ethics in Engineering	3	0	0	3
ML9038	Computer Aided Design	3	0	0	3
ML9039	Polymer Rheology	3	0	0	3
ML9042	Fracture Mechanics and Failure Analysis	3	0	0	3
ME9032	Computational Fluid Dynamics	3	0	0	3
IE9401	Design of Experiments	3	1	0	4

MA 9211 **MATHEMATICS III** **L T P C**
(Common to all branches of BE / B.Tech Programmes) **3 1 0 4**

AIM:
To facilitate the understanding of the principles and to cultivate the art of formulating physical problems in the language of mathematics.

OBJECTIVES:
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems
- To acquaint the student with Fourier transform techniques used in wide variety of situations in which the functions used are not periodic
- To introduce the effective mathematical tools for the solutions of partial differential equations that model physical processes
- To develop Z- transform techniques which will perform the same task for discrete time systems as Laplace Transform, a valuable aid in analysis of continuous time systems

UNIT I FOURIER SERIES **9+3**
Dirichlet's conditions – General Fourier series – Odd and even functions – Half-range Sine and Cosine series – Complex form of Fourier series – Parseval's identity – Harmonic Analysis.

UNIT II FOURIER TRANSFORM **9+3**
Fourier integral theorem – Fourier transform pair-Sine and Cosine transforms – Properties – Transform of elementary functions – Convolution theorem – Parseval's identity.

UNIT III PARTIAL DIFFERENTIAL EQUATIONS **9+3**
Formation – Solutions of first order equations – Standard types and Equations reducible to standard types – Singular solutions – Lagrange's Linear equation – Integral surface passing through a given curve – Solution of linear equations of higher order with constant coefficients.

UNIT IV APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS **9+3**
Method of separation of Variables – Solutions of one dimensional wave equation and one-dimensional heat equation – Steady state solution of two-dimensional heat equation – Fourier series solutions in Cartesian coordinates.

UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS **9+3**
Z-transform – Elementary properties – Inverse Z-transform – Convolution theorem – Initial and Final value theorems – Formation of difference equation – Solution of difference equation using Z-transform.

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

TEXT BOOK:
1. Grewal, B.S. "Higher Engineering Mathematics", Khanna Publications (2007)

REFERENCES:
1. Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education (2007)
2. Ramana B.V., "Higher Engineering Mathematics" Tata McGraw Hill (2007).
3. Bali N.P. and Manish Goyal, "A Text Book of Engineering" 7th Edition (2007) Lakshmi Publications (P) Limited, New Delhi.

ML9201 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.

ML9202 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.

ML9203 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.

ML9204 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.

ME9306 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.

CE9214 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

ML9205 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

ML9251 MECHANICAL METALLURGY L T P C
3 1 0 4

OBJECTIVE

The students having studied the basics of material structures and properties and strength of materials, shall be introduced to dislocation theories of plasticity behaviour, various strengthening mechanisms and fracture mechanics. It will expose students to failure mechanisms due to fatigue and creep as well as their testing methods.

UNIT I ELASTIC AND PLASTIC BEHAVIOUR 10

Elastic behavior of materials - Hooke's law, plastic behaviour: dislocation theory - Burger's vectors and dislocation loops, dislocations in the FCC, HCP and BCC lattice, stress fields and energies of dislocations, forces on and between dislocations, dislocation climb, intersections of dislocations, Jogs, dislocation sources, multiplication of dislocations, dislocation pile-ups, Slip and twinning.

UNIT II STRENGTHENING MECHANISMS 10

Elementary discussion of cold working, grain size strengthening. Solid solution strengthening. martensitic strengthening, precipitation strengthening, dispersion strengthening, fibre strengthening, examples of above strengthening mechanisms from ferrous and non-ferrous systems, simple problems. Yield point phenomenon, strain aging and dynamic strain aging

UNIT III FRACTURE AND FRACTURE MECHANICS 9

Types of fracture, basic mechanism of ductile and brittle fracture, Griffith's theory of brittle fracture, Orowan's modification. Izod and Charpy Impacts tests, Ductile to Brittle Transition Temperature (DBTT), Factors affecting DBTT, determination of DBTT.

Fracture mechanics-introduction, modes of fracture, stress intensity factor, strain energy release rate, fracture toughness and determination of K_{IC}, introduction to COD, J integral.

UNIT IV FATIGUE BEHAVIOUR AND TESTING 8

Fatigue: Stress cycles, S-N curves, effect of mean stress, factors affecting fatigue, structural changes accompanying fatigue, cumulative damage, HCF / LCF, thermomechanical fatigue, application of fracture mechanics to fatigue crack propagation, fatigue testing machines.

UNIT V CREEP BEHAVIOUR AND TESTING 9

Creep curve, stages in creep curve and explanation, structural changes during creep, creep mechanisms, metallurgical factors affecting creep, high temperature alloys, stress rupture testing, creep testing machines, parametetric methods of extrapolation. Deformation Mechanism Maps according to Frost/Ashby .

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

TEXT BOOKS

1. Dieter, G.E., "Mechanical Metallurgy", McGraw-Hill, SI Edition, 1995.
2. Davis.H. E., Troxell G.E., Hauck.G. E. W., "The Testing of Engineering Materials", McGraw-Hill, 1982.

REFERENCES

1. Hayden, H. W. W. G. G. Moffatt, J. Moffatt and J. Wulff, The Structure and Properties of Materials, Vol.III, Mechanical Behavior, John Wiley & Sons, New York, 1965.
2. Wulff, The Structure and Properties of Materials, Vol. III "Mechanical Behavior of Materials", John Wiley and Sons, New York, USA, 1983.
3. Honeycombe R. W. K., "Plastic Deformation of Materials", Edward Arnold Publishers, 1984.
4. Suryanarayana, A. V. K., "Testing of Metallic Materials", Prentice Hall India, New Delhi, 1979.

ML9252 PRIMARY PROCESSING OF IRON AND STEEL LT P C
3 0 0 3

OBJECTIVE

The course covers the production of iron and steel from raw material, primary processing to refinement to special steels.

UNIT I RAW MATERIALS AND BURDEN PREPARATION 8

Iron ore classification, Indian iron ores, limestone and coking coal deposits, problems associated with Indian raw materials, Iron Ore beneficiation and agglomeration, theory and practice of sintering and pelletizing, testing of burden materials, burden distribution on blast furnace performance.Recycling os steel products.

UNIT II BLAST FURNACE OPERATION AND REACTIONS 10

Blast furnace parts, construction and design aspects, ancillary equipment for charging, preheating the blast, gas cleaning, pig casting, blast furnace instrumentation and control of furnace. Blast furnace operation, irregularities and remedies. Compositional control of metal and slag in blast furnace, modern trends in blast furnace practice. Reduction of iron ores and oxides of iron by solid and gaseous reductions-thermodynamics and kinetics study of direct and indirect reduction, Gruner's theorem, blast furnace reactions. C-O and Fe-C-O equilibria, Rist diagrams, material and heat balance.

UNIT III PRINCIPLES OF STEEL MAKING 9

Development of steel making processes, physico-chemical principles and kinetic aspects of steel making, carbon boil, oxygen transport mechanism, desulphurisation, dephosphorisation, slag-functions, composition, properties and theories, raw materials for steel making and plant layout.

UNIT IV BESSEMER, OPEN HEARTH AND OXYGEN STEEL MAKING PROCESSES 9

Acid and Basic Bessemer processes, Side Blown Converter, O.H- constructional features, process types, operation, modified processes, duplexing, pre-treatment of hot metal. Top Blown processes-L.D, L.D.A.C., bottom blown processes, combined blown processes, rotating oxygen processes-kaldo and rotor, modern trends in oxygen steel making processes.

UNIT V CAST IRON, LADLE METALLURGY AND ELECTRIC STEEL MAKING **9**

Arc and Induction furnace-constructional features. Production practice for plain carbon steels, low alloy – Cast irons and ductile iron, stainless, tool and special steels, modern developments. Secondary steel making processes, continuous steel making processes – Deoxidation and teeming practice. Principle, methods and their comparison, killed, rimmed and capped steels, degassing practices, ingot production, ingot defects and remedies, continuous casting. Indian steel industry and global trends in steel making technology.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Tupkary,R.H., "Modern Iron Making", 3rd edition, Khanna Publishers, New Delhi, 2000.
2. Tupkary, R.H., "Modern Steel Making", 3rd Edition, Khanna Publications, New Delhi, 2000.

REFERENCES

1. Biswas, A.K., "Principles of blast furnace iron making – theory and practice", SBA Publications, Kolkata, 1994.
2. Bashforth, G. R., "Manufacture of Iron and Steel", Vol. I, Chapman and Hall London, 1964.
3. Bashforth, G. R., "Manufacture of Iron and Steel", Vol.2, 3rd Edition, Chapman & Hall, London, 1964.
4. "Making, Shaping and Treating of Steel", US Steel Corporation, 11th edition, 1994.

ML9253 NONFERROUS METALLURGY **L T P C**
3 0 0 3

OBJECTIVES:

To understand the structure, property relations of non-ferrous alloys with special emphasis on engineering applications.

UNIT I COPPER ALLOYS **9**

Properties and applications of metallic copper: Major alloys of Copper: Brasses, Cu-Zn alloys, Phase diagram of industrially relevant portion, different compositions, characteristics and uses. Bronzes, Tin bronze, compositions, properties and uses, other bronzes like Cu-Al. Cu-Si. Cu-Mn and Cu-Be alloying systems. Their special properties and applications, Cu-Ni alloys. Cu-Cr alloys.

UNIT II ALUMINIUM AND ITS ALLOYS **9**

Aluminium - Properties and uses of metallic aluminum. Alloys of aluminium, Classification, Wrought and Cast alloys, Heat treatable and Non, heat treatable, Age hardening. Overaging – Al-Cu, Al-Mg-Si, Al-Zn-Mg, and Al-Li alloys.

UNIT III MAGNESIUM AND TITANIUM ALLOYS **9**

Magnesium - properties and uses of Magnesium alloys. Titanium -Unique characteristics of the metal – α, α-β and β Titanium alloys - major types, Titanium aluminides their properties and uses.

UNIT IV NICKEL AND ZINC ALLOYS 9

Properties of nickel and uses of nickel, alloys of nickel, nickel in special alloys and magnetic materials, Nickel aluminides, Use of zinc in corrosion protection of ferrous materials, Zinc alloys, properties and uses, Die, casting qualities.

UNIT V LEAD, TIN, ANTIMONY AND PRECIOUS METALS 9

Major characteristics and applications, low melting nature and solder alloys. Gold, Silver and Platinum, Nobility of these metals, Engineering properties and applications of these metals and their alloys.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Balram Gupta, “Aerospace Materials”, Vol. 1, 2 & 3. S. Chand & Co., New Delhi, 1996.
2. Brick R. M., Gordon R. A. and Phillips A., “Structure and Properties of Engineering Materials”, McGraw-Hill Book Co., New York, 1992.

REFERENCES

1. Clark and Varney, “Physical Metallurgy for Engineers”, Affiliated East West Press, New Delhi, 1987.
2. Willam F. Smith, “Structure and Properties of Engineering Alloys”, McGraw-Hill, USA, 1993.
3. W. H. Dennis,“ Metallurgy of the Non-Ferrous Metals”, Sir Isaac Pitman and Sons, London, 1967.

ML9254 POWDER METALLURGY L T P C
3 0 0 3

OBJECTIVE

This course teaches powder preparation, characterization, compaction and sintering. This knowledge is essential to understand powder metallurgy applications in aerospace, automobile and machining materials.

UNIT I CHARACTERISTICS AND TESTING OF METAL POWDERS 10

Sampling, chemical composition purity, surface contamination etc. Particle size. and its measurement, Principle and procedure of sieve analysis, microscopic analysis: sedimentation, elutriation, permeability. adsorption methods and resistivity methods: particle shape, classifications, microstructure. specific surface area. apparent and tap density. green density. green strength, sintered compact density, porosity, shrinkage.

UNIT II POWDER MANUFACTURE AND CONDITIONING 10

Mechanical methods Machine milling, ball milling, atomization, shotting. chemical methods, condensation, thermal decomposition, carbonyl. reduction by gas-hydride, dehydride process, electro deposition, precipitation from aqueous solution and fused salts, hydrometallurgical method. Physical methods: Electrolysis and atomisation processes, types of equipment, factors affecting these processes, examples of powders produced by these methods, applications, powder conditioning, heat treatment, blending and mixing, types of equipment, types of mixing and blending

UNIT III POWDER COMPACTION 7

Pressureless compaction: slip casting and slurry casting. pressure compaction-lubrication, single ended and double ended compaction, isostatic pressing, powder rolling, forging and extrusion, explosive compaction.

UNIT IV SINTERING 8

Stage of sintering, property changes, mechanisms of sintering, liquid phase sintering and infiltration, activated sintering, hot pressing and Hot Isostatic Pressing HIP, vacuum sintering, sintering furnaces and sintering atmosphere, finishing operations – sizing, coining, repressing and heat treatment.

UNIT V APPLICATIONS 10

Major applications in aerospace. nuclear and automobile industries. Bearing Materials-types, self lubrication and other types, methods of production, properties, applications. Sintered Friction Materials-clutches, brake linings, Tool Materials- cemented carbides, oxide ceramics, Cermets- Dispersion strengthened materials.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Sinha A. K., “Powder Metallurgy”, Dhanpat Rai & Sons. New Delhi, 1982.
2. Ramakrishnan, P.,“ Powder Metallurgy”,New Age International Publishers,1st edition, 2007

REFERENCES:

1. ASM Handbook. Vol. 7, “Powder Metallurgy”, Metals Park, Ohio, USA, 1990.
2. Animesh Bose., “Advances in Particulate Materials”, Butterworth - Heinemann. New Delhi, 1995.
3. Kempton. H Roll., “Powder Metallurgy”, Metallurgical Society of AMIE, 1988.
4. Ramakrishnan. P., “Powder Metallurgy Opportunities for Engineering Industries”, Oxford and IBH Publishing Co., Pvt. Ltd, New Delhi, 1987.
5. Erhard Klar., “Powder Metallurgy Applications, Advantages and Limitations”, American Society for Metals, Ohio, 1983.
6. Sands. R. L. and Shakespeare. C. R. “Powder Metallurgy”, George Newes Ltd. London, 1966

ML9255 SOLID STATE PHYSICS L T P C
3 1 0 4

OBJECTIVES:

This subject provides the insight to physics of material starting with basics of matter waves, lattice vibrations and band theories to understand properties of metals, semiconductors, electric conductors, dielectrics, ferroelectrics, superconductors and thermal properties of materials

UNIT I INTRODUCTION TO MODERN PHYSICS AND LATTICE DYNAMICS 9

Matter waves – Heisenberg’s uncertainity principle - Schrodinger’s time independent wave equation – Physical significance of wave function (y) – Application to a particle in a one dimensional box (infinite potential well)- Interatomic forces and lattice dynamics and simple metals, ionic and covalent crystals. Elastic waves in one dimensional array of identical atoms, vibrational modes of a diatomic linear lattice and dispersion relations, acoustic and optical modes, phonon dispersion relation.

UNIT II BAND THEORY OF SOLIDS AND SEMICONDUCTOR PHYSICS 9

Fermi- Dirac distribution function, density of states, temperature dependence of Fermi energy, specific heat, use of Fermi- Dirac statistics in the calculation of thermal conductivity and electrical conductivity, Widemann -Franz ratio, susceptibility, width of conduction band, Drude theory of light, absorption in metals. Bloch theorem. Behaviour of electrons in periodic potentials, Kronig-Penny model, E vs k relation, Density of states in a band, effective mass of electron, physical basis of effective mass, Intrinsic semiconductors. Band model, Fermi level, Expressions for electron and hole concentration in intrinsic and extrinsic semiconductors, Thermal ionization of impurities, Hall effect in semi conductors (p-type and n-type).

UNIT III DIELECTRICS AND FERROELECTRICS 9

Macroscopic description of the static dielectric constant. The electronic and ionic polarizabilities of molecules, orientational polarization, Measurement of the dielectric constant of a solid. The internal field of Lorentb, Clausium-Mosotti relation. Behaviour of dielectrics in an alternating field, elementary ideas on dipole relaxation, classification of ferroelectric crystals -BaTiO3 and KDP. Thermodynamics of ferroelectric crystals - Devonshire theory.

UNIT IV MAGNETISM 9

Larmor diamagnetism. Paramagnetism, Curie Langevin and Quantum theories. Susceptibility of rare earth and transition metals. Ferromagnetism : Domian theory, Weiss molecular field and exchange, spin waves: dispersion relation and its experimental determination by inelastic neutrons scattering, heat capacity. Nuclear Magnetic resonance: Conditions of resonance, Bloch equations

UNIT V SUPERCONDUCTIVITY 9

Occurrence of superconductivity, Destruction of superconductivity by magnetic fields Meissner effect, Heat capacity, Energy gap and Isotope effect. London's equations, Penetration depth, Coherence length, Cooper-pairs; elements of BCS theory, Giaver tunneling, Josephson effects (basic ideas), Elements of high temperature superconductivity (basic concepts only).

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

TEXT BOOKS

1. S. O. Pillai,“ Solid state physics”, New age International Pvt Ltd, 6th edition, 2005
2. Wahab, M. A.,“ Solid State Physics”, Narosa Publishing, 2nd Edition, 2005

REFERENCES

1. Charles Kittel.,“ Introduction to Solid State Physics”, John Wiley, 8th edition
2. Ibach, Harald, Lüth, Hans,“ An Introduction to principles of Materials Science”, Springer, 2003.
3. James D. Patterson, Bernard C. Bailey,“ Solid State Physics: Introduction to the theory”, Springer-Verlag, edition 1, 2005
4. Mckelvy, J. P.,“ Solid State and Semi-conductor Physics”, Harper International, 1966
5. Federick Reif,“ Fundamentals of Statistical and Thermodynamical Physics”, McGraw-Hill, 1965

ML9256 POLYMER PROCESS ENGINEERING L T P C
3 0 0 3

OBJECTIVE

The subject exposes students to the basics of polymer structure and their properties. Apart from Thermodynamics, the course imparts knowledge on processing polymers, i.e. by extrusion, moulding and fiber spinning.

UNIT I BASICS OF POLYMER PROCESS ENGINEERING 9

Fundamentals of polymers – Classification – Characterization – Polymer Structure & behaviour – Effect of temperature – Molecular weight – MWD – GPC – Branching – Crosslinking – Polarity – Flexibility – Crystallinity - Orientation.

UNIT II THERMODYNAMICS OF POLYMER 8

Rheology of Polymers – Dissolution of Polymers – Solubility parameter and its significance – Thermodynamic relations - Interrelation between polymer processing, structure and properties.

UNIT III EXTRUSION AND EXTRUSION BASED PROCESS 9

Features of Single screw extruder – Flow mechanism – Analysis of flow – Screw design – Basics of twin & multiscrew extruders – Vented extruders – Cross head extrusion – Tubular blown film process - Coextrusion.

UNIT IV INJECTION MOULDING AND OTHER MOULDING PROCESS 10

Injection Moulidng systems – process – Moulding cycle – machine units – Two plate & three plate moulds – Design aspects – Problems in Quality – Effects of Shear, hear and pressure – Orientation – Shrinkage – Spruless Moulding – Other Processes – Compression & Transfer Moulding - Blow Moulding – Rotational Moulding – Thermoforming – Vacuum forming.

UNIT V CALENDERING, FIBER SPINNING PROCESS AND OTHER PROCESS 8

Calendering principle & process – Fiber Spinning process – Process & mechanism of Melt, Dry , Wet & Reaction spinning – Structural Foam Moulding (SF) – Sandwich Moulding (SM) – RIM & RRIM – Processing for Thermosets – Methods for FRP.

TOTAL : 45 PERIODS

TEXT BOOKS

1. R. G. Griskey,“ Polymer Process Engineering”, Chapman & Hall, New York (1995).
2. D. H. Morton Jones,“ Polymer Processing”, Chapman & Hall, New York (1995).

REFERENCES

1. Rodringuez, “Principles of Polymer Systems”, Tata McGraw Hill,1970.
2. Billmayer Jr. and Fred. W., “Textbook of Polymer Science”, WileyTappers, 1965.
3. David, J. W., “Polymer Science and Engineering”, Prentice Hall,1971.
4. Schmidt, A. K. and Marlies, G. A., “High Polymers - Theory and Practice”, McGraw Hill, 1948.
5. McKelvey, J. M., “Polymer Processing,” John Wiley, 1962.

ME9209 METROLOGY AND MEASUREMENTS LABORATORY L T P C
0 0 3 2

OBJECTIVES:
Students should have knowledge on common metrological Instruments.

LIST OF EXPERIMENTS

1. Sine bar
2. Tool Makers Microscope
3. Rolling Gear tester
4. Comparator
5. Co-ordinate Measuring Machine
6. Surface finish measurement
7. Machine Vision System
8. Force Measurement
9. Torque Measurement

TOTAL : 45 PERIODS

ML9257 MANUFACTURING TECHNOLOGY LABORATORY L T P C
0 0 3 2

OBJECTIVE
The practical knowledge is imparted to students in major areas of machining which has been studies in theory.

LIST OF EXPERIMENTS

1. Taper Turning
2. External Thread Cutting
3. Knurling
4. Shaping exercise – example hexagonal and square prisms
5. Drilling and Tapping
6. Determination of cutting forces in Turning and Milling Operations
7. Contour Milling using vertical milling machine
8. Gear hobbing
9. Gear shaping
10. Hexgonal machining using horizontal milling machine

TOTAL : 45 PERIODS

ML9301 THEORY AND APPLICATIONS OF METAL FORMING LT P C
3 1 0 4

OBJECTIVES:
The basic knowledge on plasticity taught in mechanical metallurgy is extended to theory and applications of metal forming. Various metal forming process and their analysis are studied in detail.

UNIT I STRESS / STRAIN RATE TENSOR 10

State of stress, components of stress, symmetry of stress tensor, principle stresses, stress deviator, Von Mises, Tresca Yield criteria, comparison of yield criteria, Octahedral shear stress and shear strain, Forming load calculations. Strain Rate Tensor.

UNIT II FUNDAMENTALS OF METAL FORMING 10

Classification of forming process, Mechanics of metal working, Flow stress determination, Effect of temperature, strain rate and metallurgical structure on metal working, Slip, twining, Friction and lubrication. Deformation zone geometry, Workability, Residual stresses.

UNIT III FORGING AND ROLLING 9

Forging-types of presses and hammers. Classification, Open die forging and Closed die forging, die design, forging in plane strain, calculation of forging loads, forging defects-causes and remedies, residual stresses in forging. Rolling: Classification of rolling processes, types of rolling mills, hot and cold rolling, rolling of bars and shapes, forces and geometrical relationship in rolling, analysis of rolling load, torque and power, rolling mill control, rolling defects – causes and remedies.

UNIT IV EXTRUSION AND DRAWING 7

Direct and indirect extrusion, variables affecting extrusion, deformation pattern, equipments, port-hole extrusion die, hydrostatic extrusion, defects and remedies, simple analysis of extrusion, tube extrusion and production of seamless pipe and tube. Drawing of rods, wires and tubes.

UNIT V SHEET METAL FORMING AND OTHER PROCESSES 9

Forming methods – Shearing, blanking, bending, stretch forming, deep drawing. Types of dies used in press working defects in formed part, sheet metal formability, formability limit diagram.

High velocity forming: Comparison with conventional forming, Explosive forming, Electro hydraulic, Electro Magnetic forming, Dynapak and Petroforge forming.

T : 45+15 , TOTAL : 60 PERIODS

TEXT BOOKS

1. Dieter, G. E., “Mechanical Metallurgy”, McGraw-Hill Co., SI Edition, 1995.
2. Nagpal,G. R., “Metal Forming Processes”, Khanna Pub., New Delhi, 2000.
3. Surender Kumar, “Technology of Metal Forming Processes”, PHI, New Delhi, 2008.

REFERENCES

1. Kurt Lange, “Handbook of Metal Forming”, Society of Manufacturing Engieners, Michigan, USA, 1988.
2. Avitzur, “Metal Forming – Process and Analysis”, Tata McGraw-Hill Co., New Delhi, 1977.

ML9302 MATERIAL ASPECTS IN DESIGN L T P C
3 1 0 4

OBJECTIVE

Material Properties have to suit the purpose of an application. When designing a machine or component, many factors have to be considered and optimised. This course covers most issues for mechanical design optimisation.

UNIT I MATERIAL SELECTION IN DESIGN 9

Introduction – relation of materials selection to design – general criteria for selection – performance characteristics of materials – materials selection process – design process and materials selection – economics of materials – recycling and materials selection

UNIT II MATERIALS PROCESSING AND DESIGN 9

Role of Processing in Designing – classification of manufacturing processes – types of processing systems – factors determining process selection. Design for manufacturability, assembly, machining, casting, forging and welding

UNIT III MANUFACTURING CONSIDERATIONS IN DESIGN 9

Surface finish – texture – dimensional tolerances in fitting – interchangeability – selective assembly – geometric tolerance. Selection of fits and tolerances

UNIT IV MATERIALS PROPERTIES AND DESIGN 12

Stress – Strain diagram – design for strength, rigidity – design under static loading, variable loading, eccentric loading – stress concentration. Design examples with shaft design, spring design and C-frames.

UNIT V MATERIALS IN DESIGN 6

Design for brittle fracture, fatigue failure, corrosion resistance. Designing with plastics, brittle materials

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

TEXT BOOKS

1. Dieter George E, Engineering Design, A materials and processing approach, McGraw Hill, 3rd edition, 2000
2. Bhandari, Design of Machine Elements, Tata McGraw Hill, 2006

REFERENCES

1. CES Materials Selector, GRANTA Design and M. F. Ashby, 2007

ML9303 CHARACTERIZATION OF MATERIALS L T P C
3 0 0 3

OBJECTIVE

Characterisation of materials is very important for studying the structure of materials and to interpret their properties. The students study the theoretical foundations of metallography, X- ray diffraction, electron diffraction, scanning electron microscopy, chemical and thermal analysis.

UNIT I METALLOGRAPHIC TECHNIQUES 8

Resolution, depth of focus and components of microscope, polarized light, phase contrast, interference microscopy, hot stage and quantitative metallographic techniques, specimen preparation techniques.

UNIT II X-RAY DIFFRACTION TECHNIQUES 10

Crystallography basics, characteristic spectrum, Bragg's law, Diffraction methods – Laue, rotating crystal and powder methods. Stereographic projection. Intensity of diffracted beams –structure factor calculations and other factors. Cameras- Laue, Debye-Scherer cameras, Seeman-Bohlin focusing cameras.

UNIT III APPLICATION OF X-RAY DIFFRACTION 9

Diffractometer – general feature and optics, proportional, scintillating and Geiger counters. X-ray diffraction application in the determination of crystal structure, lattice parameter, phase diagram and residual stress – quantitative phase estimation, ASTM catalogue of Materials identification

UNIT IV ELECTRON MICROSCOPY 9

Construction and operation of Transmission electron microscope – Diffraction effects and image formation, specimen preparation techniques. Construction, modes of operation and application of Scanning electron microscope, EDX. Electron probe micro analysis, basics of scanning Tunneling Microscope (STM) and Atomic Force Microscope.

UNIT V ADVANCED CHEMICAL AND THERMAL ANALYSIS 9

Basic principles, practice and applications of X-ray spectrometry, X-ray photoelectron spectrometry, Auger spectroscopy, Differential thermal analysis DTA, Differential scanning calorimetry DSC and thermogravimetric analysis TGA

TOTAL : 45 PERIODS

TEXT BOOKS

1. Cullity, B. D.," Elements of X-ray diffraction", Addison-Wesley Company Inc., New York, 3rd Edition, 2000.
2. Cherepin and Malik, "Experimental Techniques in Physical Metallurgy", Asia Publishing Co. Bombay, 1968.

REFERENCES

1. Brandon D. G, "Modern Techniques in Metallography", Von Nostrand Inc. NJ, USA, 1986.
2. Thomas G., "Transmission electron microscopy of metals", John Wiley, 1996.
3. Weinberg, F., "Tools and Techniques in Physical Metallurgy", Volume I & II, Marcel and Decker, 1970.
4. Phillips, V. A., "Modern metallographic techniques and their application", John-Wiley & sons, 1972.
5. Haines, P. J., "Principles of Thermal Analysis and Calorimetry", Royal Society of Chemistry (RSC), Cambridge, 2002.

ML9304 HEAT TREATMENT OF METALS AND ALLOYS LT P C
3 0 0 3

OBJECTIVE

This laboratory is elaborating on the multitude of heat treatment techniques, mainly applicable to iron, steel. It gives a comprehensive understanding of the changes in microstructure and property created by controlled heat treatment.

UNIT I TRANSFORMATIONS IN STEELS 8

Iron - carbon equilibrium diagram**:** Transformations on heating and cooling, influence of alloying elements, general principles of heat treatment of steels, isothermal and continuous cooling transformations in steels. Continuous cooling curves TTT and CCT diagrams. mechanism of pearlitic, bainitic and martensitic transformations.

UNIT II HEAT TREATMENT PROCESSES 10

Annealing, Normalizing, Hardening - retained austenite - measurement and methods of its elimination, hardenability studies- Jominy end quench test, Grossman's experiments Tempering- Hollomon & Jaffe tempering correlations, Austempering and Martempering, Precipitation hardening, thermomechanical treatment, intercritical heat treatment, other heat treatment processes - splat cooling.

UNIT III CASE HARDENING 8

Introduction, carburising: principle, carbon potential, mechanism, application of Fick's law, depth of carburization and its control, methods of carburising, heat treatment after carburising, structure, properties and common problems in carburising. Nitriding: introduction, steels used, mechanism, effect of microstructure, white layer, nitriding methods, ion nitriding and nitro-carburising. Induction and flame hardening: principle, methods, operating variables. Measurement of case depth.

UNIT IV HEAT TREATMENT EQUIPMENT 8

Various heating media used for heat treatment. Temperature and atmosphere control, carburising atmosphere and carbon potential measurement, nitriding gas atmospheres. Quenching media and their characteristics. Various heat treatment furnaces, fluidized bed furnaces, cryo chamber, cryo treatment of steels, sealed quenched furnace, plasma equipment.

UNIT V HEAT TREATMENT OF SPECIFIC ALLOYS 11

Heat treatment of carbon steels, various types of tool steels, high speed steels, maraging steels and die steels. Heat treatment of gray cast irons, white cast irons, malleabilising and S.G.irons, austempering of S.G.Iron. Heat treatment of aluminium alloys. copper alloys and nickel alloys. Defects in heat treated parts: causes and remedies.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Rajan.T. V., Sharma C.P., Ashok Sharma., "Heat Treatment Principles And Techniques" Prentice-Hall of India Pvt. Ltd., New Delhi, 2002
2. Vijendra Singh, "Heat Treatment of Metals", First edition, Standard Publishers Distributors New Delhi, 1998.

REFERENCES

1. American Society for Metals, "Metals Handbook Vol.4", ASM Metals Parks. Ohio, USA, 1991
2. Prabhudev. K H. "Handbook of Heat Treatment of Steels", Tata McGraw-Hill Publishing Co., New Delhi, 1988.

3. Novikov,.I., “Theory of Heat Treatment of Metals”, MIR Publishers, Moscow, 1978
4. Thelning K.E., “Steel and its heat treatment”, Bofors Handbook, 1975.

ML9305 INTRODUCTION TO NANOTECHNOLOGY L T P C
3 0 0 3

OBJECTIVE

This subject imparts basics of nanotechnology, their importance and tools to characterise nanostructures. The student are introduced to carbon nanotubes and few other nanostructured materials and their applications.

UNIT I INTRODUCTION 10

Moore’s law, silicon micro fabrication techniques such a photolithography/electron beam lithography and their advantages and limitations, importance of nanotechnology and its potential impacts, historical milestones in nanotechnology, prerequisites to make transition into nanotechnology era, proposed futuristic applications in nanotechnology and current state of the art.

UNIT II SCANNING PROBE MICROSCOPY 10

Tool for performing structural analysis at the nanometer scale and as a tool for nanopositioning. Operating principle of Scanning Tunnelling Microscope (STM), Atomic Force Microscope (AFM) and Scanning near Field Optical Microscope (SNFOM) and their applications by drawing on practical research examples. Advantages and disadvantages of SPM technique. Potentiality of SPM to overcome other complementary techniques.

UNIT III CHARACTERISATION OF NANOMATERIALS 7

Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM) - applicability to characterize nanostructured materials.

UNIT IV CARBON NANOTUBES 8

Types of carbon nanotubes such as single-walled and multi-walled nanotubes, fabrication, physical and chemical properties, applications. Other carbon morphologies, bucky balls, graphenes.

UNIT V NANOSTRUCTURED MATERIALS 10

Liquid crystal templates: surfactants and their phase behaviour: formation of micelles and liquid crystal phases, for use as nanoscale moulds for templating, electroplating of nanostructured mesoporous films - physical properties of mesoporous nanostructured materials and applications (current and potential).

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Mark A. Ratner and Daniel Ratner, “Nanotechnology: A Gentle Introduction to the Next Big Idea” Prentice Hall, 2003
2. Bandyopadhyay, A. K.,“ Nanomaterials”, New Age International Publishers, 1st edition, 2007

REFERENCES:

1. Bamberg, D., Grundman, M. and Ledentsov, N. N.," Quantum Dot Heterostructures", Wiley, 1999
2. Chow, G. M. and Noskova, N. I. (eds.)," Nanostructured Materials: Science and Technology", NATO Advanced Study Institute Series, High Technology-Vol. 50, Kluwer Publications, the Netherlands, 1998.
3. Jan Korvink and Andreas Greiner," Semiconductors for micro and nanotechnology: an introduction for engineers Jan Korvink & Andreas Greiner", Weinheim Cambridge: Wiley-VCH, 2001
4. N John Dinardo," Nanoscale characterisation of surfaces & interfaces", Weinheim Cambridge: Wiley-VCH, 2000 2nd ed G. Timp (ed)," Nanotechnology", AIP press/Springer, 1999
5. Bhusan, Bharat (Ed),"Springer Handbook of Nanotechnology", 2nd edition, 2007.

ML9306 CORROSION AND SURFACE ENGINEERING L T P C
3 0 0 3

OBJECTIVE

The subject provides knowledge on various types of corrosion, their kinetics, testing and methods of protection as well as introduction to tribology.

UNIT I INTRODUCTION 12

Introduction tribology, surface degradation, wear and corrosion, types of wear, adhesive, abrasive, oxidative, corrosive, erosive and fretting wear, roles of friction and lubrication-, expressions for corrosion rate. emf and galvanic series - merits and demerits -Pourbaix diagram for iron, magnesium and aluminium. Forms of corrosion - Uniform, pitting, intergranular, stress corrosion. corrosion fatigue. dezincification. erosion corrosion, crevice corrosion - Cause and remedial measures - Pilling Bedworth ratio - High temperature oxidation.

UNIT II KINETICS OF CORROSION 8

Exchange current density, polarization - concentration, activation and resistance, Tafel equation; passivity, electrochemical behaviour of active/passive metals, Flade potential, theories of passivity, Effect of oxidising agents

UNIT III CORROSION IN INDUSTRIAL PRACTICE 8

Atmospheric, pitting, dealloying, stress corrosion cracking, intergranular corrosion, corrosion fatigue, fretting corrosion and high temperature oxidation; causes and remedial measures, Corrosion failure – Inspection and analysis of corrosion damage

UNIT IV TESTING 8

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

UNIT V PROTECTION METHODS 8

Electroless plating and Anodising - Cathodic protection, metallic, organic and inorganic coatings, corrosion inhibitors - principles and practice - inhibitors for acidic neutral and

other media. Special surfacing processes - CVD and PVD processes, sputter coating. Laser and ion implantation. Arc spray. plasma spray. Flame spray. HVOF.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Fontana and Greene. "Corrosion Engineering". McGraw Hill Book Co. New York. USA 1983.
2. Raj Narayan. "An Introduction to Metallic Corrosion and its prevention". Oxford & 1BH. New Delhi. 1983.

REFERENCES

1. Kenneth G Budinski. "Surface Engineering for Wear Resistance". Prentice Hall Inc.. Engelwood Cliff., New Jersey. USA 1988
2. Uhlig. H.H . "Corrosion and Corrosion Control". John Wiley & Sons. New York. USA. 1985.
3. ASM Metals Handbook. Vol.5. "Surface Engineering". ASM Metals Park. Ohio. USA. 1994.
4. ASM Metals Handbook. Vol.l3,"Corrosion".ASM Metals Park. Ohio. USA. 1994

ML9307 HEAT TREATMENT LABORATORY L T P C
0 0 3 2

OBJECTIVE

This laboratory course offers practical knowledge of heat treatment applicable to iron and steel and studies microstructural 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. Identification of defects in heat treated materials
11. Heat treatment of cast iron
12. Heat treatment of alloy steels
13. Heat treatment of non-ferrous alloys
14. Microstructure of heat treated steels

TOTAL : 45 PERIODS

ML9308 MATERIALS PROCESSING LABORATORY L T P C
0 0 3 2

OBJECTIVE
The students will learn to select an appropriate method and understand the process parameters influencing material processing. The student's theoretical knowledge gained from powder metallurgy, polymer processing and heat treatments will guide them in understanding materials processing.

LIST OF EXPERIMENTS:

1. Hardness testing
2. Particle size distribution of powders
3. Liquid penetrant test
4. Ericson cup tester
5. Powder compaction
6. Sintering of powder compacts
7. Testing of Sintered powder compact
8. Casting experiments
9. Bulk forming experiments
10. Chemical route synthesis of powders

TOTAL : 45 PERIODS

ML9309 PRESENTATION SKILLS & TECHNICAL SEMINAR L T P C
0 0 2 1

To enrich the communication skills of the student and presentations of technical topics of interest, this course is introduced. In this course, a student has to present three Technical papers or recent advances in engineering/technology that will be evaluated by a Committee constituted by the Head of the Department.

ML9351 BIO AND SMART MATERIALS L T P C
3 0 0 3

OBJECTIVE
The students are introduced to functional materials such as smart and bio materials in this course.

UNIT I INTRODUCTION 9
Intelligent / Smart materials – Functional materials – Polyfunctional materials – Structural materials, Electrical materials, bio-compatible materials etc. – Intelligent biological materials – Biomimetics – Wolff's Law – Biocompatibility – Material response: swelling and leaching, corrosion and dissolution, deformation and failure, friction and wear – host response: the inflammatory process – coagulation and hemolysis – approaches to thrombo resistance materials development.

UNIT II ELECTRO-RHEOLOGICAL AND PIEZOELECTRIC SMART MATERIALS 9

The principal ingredients of smart materials –microsensors- hybrid smart materials - an algorithm for systhesizing smart materials – active, passive reactive actuator based smart structures- suspensions and electro-rheological fluids - Bingham body model – principal characteristics of electro-rheological fluids – charge migration mechanism for the dispersed phase – electro-rheological fluid domain – fluid actuators- design parameter – application of Electo-rheological fluids – PZT – PVDF – PVDF film – properties of commercial piezoelectric materials – properties of piezoelectric film.

UNIT III SHAPE MEMORY (ALLOYS) SMART MATERIALS 9

Nickel – Titanium alloy (Nitinol) – Materials characteristics of Nitinol –martensitic transformations – austenitic transformations – thermoelastic martensitic transformations – cu based SMA, chiral materials – applications of SMA – continuum applications of SMA fastners – SMA fibers – reaction vessels, nuclear reactors, chemical plant, etc. – micro robot actuated by SMA – SMA memorization process (Satellite Antenna Applications) SMA blood clot filter – Impediments to applications of SMA – SMA plastics – Primary moulding – secondary moulding – potential applications of SMA plastics.

UNIT IV ORTHOPAEDIC AND CARDIOVASCULAR MATERIALS 9

Bone composition and properties – temporary fixation devices – joint replacement – biomaterials used in bone and joint replacement metals and alloys- blood clotting – blood rheology – blood vessels – The heart – aorta and valves – geometry of blood circulation – The lungs – vascular implants: vascular graft, cardiac valve prostheses, cardiac pacemakers – blood substitutes – extracorporeal blood circulation devices.

UNIT V DENTAL AND OTHER MATERIALS 9

Tooth composition and mechanical properties – Fillings and restoration materials – Materials for oral and maxillofacial surgery – detantal cements and dental amalgams – dental adhesives – Biomaterials in opthalmology – tissue grafts - skin grafts – connective tissue grafts – tissue adhesives – drug delivery methods and materials.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Sujata V., Bhat.,“ Biomaterials”, Narosa Publication House, New Delhi, 2002
2. M. V. Gandhi and B. S. Thompson,“ Smart Materials and Structures”, Chapman and Hall, London, First Edition, 1992.

REFERENCES

1. Deurig,T.W., Melton,K.N, Stockel,D. and Wayman,C.M.,“ Engineering aspects of Shapememory Alloys”, Butterworth – Heinemann, 1990.
2. Rogers,C.A., Smart Materials,“ Structures and Mathematical issues”, Technomic Publishing Co., U.S.A, 1989.
3. Jonathn Black,“ Biological Performance of Materials: Fundamentals of biocompatibility”, Marcel Dekker Inc., New York, 1992.
4. Williams, D.F. (editor), “Materials Science and Technology: A comprehensive treatment”, Volume 14, Medical and Dental Materials, VCH Publishers Inc. New York, 1992.
5. Silver, F. and Doillon,C.,“ Biocompatibility: Interactions of Biological and implantable materials”. Volume I - Polymers, VCH Publishers Inc. New York, 1989.
6. Hench, L.L. and Ethridge, E.C.,“ Biomaterials: An Interfacial Approach”, Academic Press, 1982.

ML9352 CREEP AND FATIGUE BEHAVIOR OF MATERIALS L T P C
3 1 0 4

OBJECTIVE

The useful life of components are often limited by the fracture, fatigue and creep properties of the materials used. The students study the fundamental processes leading to failure of technical components.

UNIT I INTRODUCTION 9

Strength of perfect crystal - Lattice resistance to dislocation movement – Elastic properties of dislocation – Dislocation multiplication – Slip and twinning in crystalline solid.

UNIT II HIGH – TEMPERATURE DEFORMATION RESPONSE 9

Creep Of Solids – Temperature stress – Strain rate relation- Deformation mechanism – Super plasticity deformation mechanism maps – Extrapolation procedure for creep rupture data – materials for elevated temperature rules.

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UNIT III CYCLIC STRESS AND STRAIN FATIGUE 9

Macrofractrography fatigue failures - cyclic stress and strain controlled fatigue - Fatigue life estimation for notched components – Crack initiation mechanisms.

UNIT IV FATIGUE CRACK PROPAGATION 9

Stress and crack lengths correlations with FCP – Fracture modes in Fatigue – Microscopic fracture mechanisms – Crack growth behavior at Δk extremes – Influences – Micro structural aspects of FCP in metal alloys.

UNIT V ANALYSIS OF ENGINEERING FAILURES 9

Typical defects – Microscopic surface examination – metallographic and fractographic examination – Component failure analysis – Fracture surface preservation – Cleaning and replication techniques and image interpretation.

TOTAL : 60 PERIODS

TEXT BOOKS

1. Richard. W. Hertzberg,“ Deformation and Fracture Mechanism of Engineering Materials”, John Willey and Sons, 4th edition, 1996.
2. Anderson, T. L.,“ Fracture Mechanics: Fundamentals and Applications”, CRC Press, 2nd edition, 1995

REFERENCES

1. Courtney, T. H.,“ Mechanical Behaviour of Materials”, McGraw-Hill, 1990
2. Jones, D. R. H,“ Engineering Materials 3, Materials Failure Analysis- Case Studies and Design Implications”, Pergamon, 1993.
3. Hull & Bacon "Introduction to Dislocations", 3rd ed., Pergamon Press, 1984.
4. Frost & Ashby, "Deformation - Mechanism Maps", 1st ed., Pergamon Press, 1982.
5. Suresh, S.,“ Fatigue of Materials”, Cambridge University Press, 2 nd edition, 1998.
6. Cadek, J.,“ Creep in Metallic Materials”, Elsevier, 1988.
7. Ashok Saxena,“ Nonlinear Fracture Mechanics for Engineers”, CRC Press, 1998.

ME9351 FINITE ELEMENT ANALYSIS L T P C
3 1 0 4

OBJECTIVES

- To introduce the concepts of Mathematical Modeling of Engineering Problems.
- To appreciate the use of FEM to a range of Engineering Problems.

UNIT I INTRODUCTION 9

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems – Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT II ONE-DIMENSIONAL PROBLEMS 9

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors. Assembly of Matrices solution of problems from solid mechanics and heat transfer. Fourth Order Beam Equation – Transverse deflections and Natural frequencies of beams.

UNIT III TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS 9

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation – Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts – Quadrilateral elements – Higher Order Elements.

UNIT IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS 9

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements.

UNIT V ISOPARAMETRIC FORMULATION AND MISCELLANEOUS TOPICS 9

Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

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

TEXT BOOKS

1. Seshu. P. “Textbook of Finite Element Analysis” Prentice Hall of India, 2003.
2. J. N. Reddy, “Finite Element Method” Tata McGraw Hill, 2003.

REFERENCES

1. Chandrupatla and Belegundu, “Introduction to Finite Elements in Engineering” PHI / Pearson Education, 2003.
2. Logan. D.L. “A first course in Finite Element Method”, Thomson Asia Pvt. Ltd., 2002.
3. Cook R.D., Malkus. D.S. Plesha, ME., “Concepts and Applications of Finite Element Analysis”, John – Wiley Sons 2003.
4. S.S. Rao, “The Finite Element Method in Engineering “Butter worth Heinemann, 2001.

ML9353 COMPOSITE MATERIALS L T P C
3 0 0 3

OBJECTIVE

Composites are a relatively new class of materials. In this course the students learn about the benefits gained when combining different materials into a composite.

UNIT I INTRODUCTION TO COMPOSITES 8

Fundamentals of composites - need for composites – enhancement of properties - classification of composites – Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Reinforcement – particle reinforced composites, Fibre reinforced composites. Applications of various types of composites.

UNIT II POLYMER MATRIX COMPOSITES 12

Polymer matrix resins – thermosetting resins, thermoplastic resins – reinforcement fibres – rovings – woven fabrics – non woven random mats – various types of fibres. PMC processes - hand lay up processes – spray up processes – compression moulding – reinforced reaction injection moulding - resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fibre reinforced plastics (FRP), glass fibre reinforced plastics (GRP).

UNIT III METAL MATRIX COMPOSITES 9

Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement - volume fraction – rule of mixtures. Processing of MMC – powder metallurgy process - diffusion bonding – stir casting – squeeze casting.

UNIT IV CERAMIC MATRIX COMPOSITES 9

Engineering ceramic materials – properties – advantages – limitations – monolithic ceramics - need for CMC – ceramic matrix - various types of ceramic matrix composites- oxide ceramics – non oxide ceramics – aluminium oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering - Hot pressing – Cold isostatic pressing (CIP) – Hot isostatic pressing (HIP).

UNIT V ADVANCES IN COMPOSITES 7

Carbon /carbon composites – advantages of carbon matrix – limitations of carbon matrix carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol-gel technique. Composites for aerospace applications.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Mathews F. L. and Rawlings R. D., “Composite Materials: Engineering and Science”, Chapman and Hall, London, England, 1st edition, 1994.
2. Chawla K. K., “Composite materials”, Springer Verlag, Second Edition, 1998.

REFERENCES

1. Clyne, T. W. and Withers, P. J., “Introduction to Metal Matrix Composites”, Cambridge University Press, 1993.
2. Strong,A.B., “Fundamentals of Composite Manufacturing”, SME, 1989.
3. Sharma,S.C., “Composite materials”, Narosa Publications, 2000.
4. Broutman, L. J. and Krock,R.M., “Modern Composite Materials”, Addison-Wesley, 1967

MG9362 INDUSTRIAL MANAGEMENT LT P C
3 0 0 3

OBJECTIVE

To provide a clear understanding of basic management principles that leads to corporate building. Industrial Management deals with not only functions of management but also organizational structure and dynamics and includes modern concepts of Industrial Management

UNIT I INTRODUCTION 9

Technology Management - Definition – Functions – Evolution of Modern Management – Scientific Management Development of Management Thought. Approaches to the study of Management, Forms of Organization – Individual Ownership – Partnership – Joint Stock Companies – Co-operative Enterprises – Public Sector Undertakings, Corporate Frame Work – Share Holders – Board of Directors – Committees – Chief Executive – Line and Functional Managers, Constraints – Environmental – Financial – Legal – Trade Union–

UNIT II FUNCTIONS OF MANAGEMENT 9

Planning – Nature and Purpose – Objectives – Strategies – Policies and Planning Premises – Decision Making – Organizing – Nature and Process – Premises – Departmentalization – Line and staff – Decentralization – Organizational culture, Staffing - selection and training – Placement – Performance appraisal – Career Strategy – Organizational Development. Leading – Managing human factor – Leadership – Communication, Controlling - Process of Controlling – Controlling techniques, productivity and operations management – Preventive control, Industrial Safety.

UNIT III ORGANIZATIONAL BEHAVIOUR 9

Definition – Organization – Managerial Role and functions – Organizational approaches, Individual behaviour – causes – Environmental Effect – Behavior and Performance, Perception – Organizational Implications. Personality – Contributing factors – Dimension – Need Theories – Process Theories – Job Satisfaction, Learning and Behavior – Learning Curves, Work Design and approaches.

UNIT IV GROUP DYNAMICS 9

Group Behavior – Groups – Contributing factors – Group Norms, Communication – Process – Barriers to communication – Effective communication, leadership – formal and informal characteristics – Managerial Grid – Leadership styles – Group Decision Making – Leadership Role in Group Decision, Group Conflicts – Types –Causes – Conflict Resolution – Inter group relations and conflict, Organization centralization and decentralization – Formal and informal – Organizational Structures – Organizational Change and Development – Change Process – Resistance to Change – Culture and Ethics.

UNIT V MODERN CONCEPTS 9

Management by Objectives (MBO) –, Management by Exception (MBE), Strategic Management - Planning for Future direction – SWOT Analysis – Evolving development strategies, information technology in management – Decisions support system – Management Games – Business Process Re-engineering(BPR) – Enterprises Resource Planning (ERP) – Supply Chain Management (SCM) – Activity Based Management (ABM) – Global Perspective - Principles and Steps – Advantages and disadvantages

TOTAL : 45 PERIODS

TEXT BOOK

1. Herald Knottz and Heinz Weihrich, 'Essentials of Management', McGraw Hill Publishing Company, Singapore International Edition, 1980.

REFERENCES:

1. S.Chandran, Organizational Behaviours, Vikas Publishing House Pvt.. Ltd, 1994
2. Ties, AF, Stoner and R.Edward Freeman, 'Management' Prentice Hall of India Pvt. Ltd. New Delhi 110011, 1992
3. Joseph J, Massie, 'Essentials of Management' Prentice Hall of India Pvt. Ltd. 1985.

ML9354 COMPOSITE MATERIALS LABORATORY L T P C
0 0 3 2

OBJECTIVE

Students learn the fabrication processes of different composite materials and the mechanical characterization of these materials.

List of experiments

1. Fabrication of Continuous Fiber reinforced Polymer Composites
2. Fabrication of Dis-continuous Fiber reinforced Polymer Composites
3. Tensile Testing
4. Flexural strength
5. Hardness testing
6. Impact testing
7. Environmental Testing (Humidity and temperature)

TOTAL : 45 PERIODS

GE9371 COMMUNICATION SKILLS AND SOFT SKILLS LAB L T P C
0 0 2 1

AIM:

To enhance the overall capability of students and to equip them with the necessary Communication Skills and Soft Skills that would help them excel in their profession.

OBJECTIVES:

- ❖ To equip students of engineering and technology with effective speaking and listening skills in English.
- ❖ To help them develop their soft skills and interpersonal skills, which will make the transition from college to workplace smoother and help them excel in their job.
- ❖ To enhance the performance of students at Placement Interviews, Group Discussions and other recruitment exercises.

1. PC based session

A. Career Lab (15 periods) Viewing and discussing audio-visual materials

1. Resume / Report Preparation / Letter Writing: (3)

Letter writing – Job application with Resume - Project report - Email etiquette.

2. **Presentation skills:** (3)
   Elements of effective presentation – Structure of presentation - Presentation tools – Body language.

3. **Soft Skills:** (3)
   Time management – Stress management – Assertiveness – Negotiation strategies, Psychometrics - Analytical and logical reasoning.

4. **Group Discussion:** (3)
   Group discussion as part of selection process, Structure of group discussion – Strategies in group discussion – Mock group discussions.

5. **Interview Skills:** (3)
   Kinds of interviews – Interview techniques – Corporate culture – Mock interviews.

TOTAL 30 PERIODS

II. Class Room Session

1. **Resume / Report Preparation / Letter writing**: Students prepare their own resume and report. (9)

2. **Presentation Skills:**Students make presentations on given topics. (12)

3. **Group Discussion**: Students participate in group discussions. (12)

4. **Interview Skills**: Students participate in Mock Interviews (12)

Note: Classroom sessions are practice sessions.

REFERENCES

1. Prakash P, Verbal and Non-Verbal Reasoning, Macmillan India Ltd., 2nd Edition, New Delhi, 2004.
2. John Seely, The Oxford Guide to Writing and Speaking, Oxford University Press, New Delhi 2004.
3. Paul V Anderson, Technical Communication, Thomson Wadsworth , 6th Edition, New Delhi, 2007.
4. Edgar Thorpe and Showick Thorpe, Objective English, Pearson Education, 2nd Edition, New Delhi 2007.
5. David Evans, Decision maker, CUP, 1997

Lab Requirement:

1. Teacher console and systems for students.
2. English Language Lab Software
3. Tape recorders

ML9355 ADVANCED MATERIALS CHARACTERIZATION LABORATORY **L T P C 0 0 3 2**

OBJECTIVE

This laboratory gives practical exposure characterization techniques and teaches to interpret results with knowledge gained from the theory subject on characterization of materials.

LIST OF EXPERIMENTS:

1. Identification of phase
2. Cell parameters calculation
3. Biphasic composition weight percentage based on X-ray diffraction
4. Nanosize determination
5. SEM topography
6. Indexing of selected area electron diffraction pattern
7. Image analysis of microstructures

TOTAL : 45 PERIODS

GE9022 TOTAL QUALITY MANAGEMENT **L T P C 3 0 0 3**

AIM

To provide comprehensive knowledge about the principles, practices, tools and techniques of Total quality management.

OBJECTIVES

- To under the various principles, practices of TQM to achieve quality
- To learn the various statistical approaches for quality control.
- To understand the TQM tools for continuous process improvement.
- To learn the importance of ISO and Quality systems.

UNIT I INTRODUCTION **9**

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of manufacturing and service quality - Basic concepts of TQM - Definition of TQM – TQM Framework - Contributions of Deming, Juran and Crosby – Barriers to TQM.

UNIT II TQM PRINCIPLES **9**

Leadership – Strategic quality planning, Quality statements - Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement – PDSA cycle, 5s, Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS & TECHNIQUES I **9**

The seven traditional tools of quality – New management tools – Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

UNIT IV TQM TOOLS & TECHNIQUES II 9

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Cost of Quality – Performance measures.

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000- ISO 9000-2000 Quality System – Elements, Documentation, Quality auditing- QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – Case studies of TQM implementation in manufacturing and service sectors including IT.

TOTAL : 45 PERIODS

TEXT BOOK

1. Dale H.Besterfiled, et at., "Total Quality Management", Pearson Education Asia,Third Edition, Indian Reprint (2006).

REFERENCES

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 6th Edition, South-Western (Thomson Learning), 2005.
2. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, 3rd Edition, 2003.
3. Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd.,2006.
4. Janakiraman,B and Gopal, R.K, "Total Quality Management – Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.

ML9401 COMPUTER APPLICATIONS IN MATERIALS SCIENCE L T P C
3 1 0 4

OBJECTIVES

Computer applications have become important to solve, approximate, interpret and visualize problems in Materials Science. After reviewing the mathematical foundation, applications in Materials Science are introduced.

UNIT I SOLUTIONS OF EQUATIONS AND INTERPOLATION 9

Application for the fitting and interpolation of experimental data in Materials.
Science Roots of equations – Methods of bisection and false position – Newton-Raphson method – Simultaneous equations – Gauss elimination – Gauss Jordan method - Newton's and Langrange's interpolation methods.

UNIT II PARTIAL DIFFERENTIAL EQUATIONS 9

Applications in diffusion and mass transport in materials.
Type of equations – Elliptic equations – Laplace's equation – Hyperbolic equations – Wave equations – The Lax method – Eulerian and Lagrangian methods - Parabolic Equations – Diffusion – The Dufort-Frankel Method – Conservative methods – The Equation of continuity – The Diffusion equations.

UNIT III MONTE CARLO METHODS AND SIMULATION 9

Monte Carlo Method for simulating nucleation and growth of grains in materials.
Monte Carlo – Random Number Generators – Monte-Carlo Integration – The Metropolis Algorithm – Thermodynamic Averages – Quantum Monte-Carlo – Molecular Dynamics – General Principles.

UNIT IV MATRIX ALGEBRA 9

Study of anisotropy in materials.

Introduction – types of matrix– simple matrix problems – elliptic equations – Poisson's equation – systems of equations and matrix inversion – Exact Methods – Iterative Methods - The Jacobi Method – The Gauss-Seidel Method – Matrix Eigenvalue Problems – Schrödinger's equation – Full and Partial Diagonalisation - Sturm Sequence.

UNIT V SELECTED APPLICATIONS IN MATERIALS SCIENCE 9

Modeling and property prediction.

T : 45 + 15 , TOTAL: 60 PERIODS

TEXTBOOKS

1. Venkatraman, M. K., "Numerical Methods in Science and Engineering", National Publishing Company, Madras, 1996.
2. Sastry, S. S.," Introductory Methods of Numerical Analysis", Prentice Hall of India, New Delhi, 1992.

REFERENCES

1. Samuel S M Wong," Computational Methods in Physics and Engineering", 2nd Edition
2. Wilkinson J H," The Algebraic Eigenvalue Problem", Clarendon Press Oxford, 1964.
3. Chandra. S.,"Computer Applications in Physics: with Fortran, Basic and C", Narosa Publications 2nd edition, 2006
4. Brenner, D. W.," Computer Applications in Materials Science and Engineering", John Wiley & Sons, 2007
5. Julian, Maureen M., "Foundations of crystallography with computer applications", CRC, 1st edition, 2008
6. Ghosh Dastidar, P. S., "Computer Simulation of Flow and Heat Transfer", Tata McGraw Hill, New Delhi, 1998

ML9402 NON DESTRUCTIVE MATERIALS EVALUATION LT P C
3 0 0 3

OBJECTIVE

Study most important Non Destructive Testing methods, theory and their industrial application.

UNIT I INTRODUCTION TO NON DESTRUCTIVE TESTING 7

Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Comparison of advantages and limitations of different NDT methods. Visual inspection

UNIT II SURFACE NDT, LIQUID PENETRANT (LT), MAGNETIC PARTICLE TESTING (MT) 8

PT: Physical Principals, Penetrant Systems, Applications.

MT: Magnetisation methods, evaluation of results.

UNIT III THERMOGRAPHY AND EDDY CURRENT TESTING (ET) 10

Active and Passive Thermography, Application in flaw detection.

ET: Principles, permeability and conductivity, Testing for defects, material

characterisation and sorting

UNIT IV ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE) 10

Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction.

UNIT V RADIOGRAPHY (RT) 10

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, Computed Radiography, Computed Tomography

TOTAL: 45 PERIODS

TEXT BOOKS

1. Prakash Ravi, "Nondestructive Testing Techniques", New Age International Publishers, 1st edition, 2007
2. Paul E Mix, "Introduction to nondestructive testing: a training guide", Wiley, 2nd edition New Jersey, 2005

REFERENCES

1. Baldev Raj, B. Venkataraman, D. J. Varde, Nerulikar, "Practical Magnetic Particle Testing", Narosa Publishing House, 2007
2. Charles, J. Hellier," Handbook of nondestructive evaluation", McGraw Hill, New York 2001.
3. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook, Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.

ML9403 WELDING METALLURGY L T P C
3 0 0 3

AIM

To enable students to study the process of joining by welding in detail.

OBJECTIVES

Welding is one of the most important fabrication processes in industry and requires both theoretical understanding and experience of materials used in industry. This can be achieved in this course.

UNIT I WELDING METALLURGY PRINCIPLES 9

Thermal cycles in welding: basic heat transfer equations, temperature distributions and cooling curves, dependence of cooling rate on heat input, joint geometry, preheat and other factors. Comparison of welding processes based on these considerations.

UNIT II PHYSICAL METALLURGY OF WELDING 9

Welding of ferrous materials: Iron - carbon diagram, TTT and CCT diagrams, effects of steel composition, formation of different microstructural zones in welded plain-carbon steels. Welding of C-Mn and low-alloy steels, phase transformations in weld and heat - affected zones, cold cracking, role of hydrogen and carbon equivalent, formation of acicular ferrite and effect on weld metal toughness.

UNIT III WELDING OF ALLOY STEELS 9

Welding of stainless steels, types of stainless steels, overview of joining ferritic and martensitic types, welding of austenitic stainless steels, hot cracking, sigma phase and

chromium carbide formation, ways of overcoming these difficulties, welding of cast iron.

UNIT IV WELDING OF NON-FERROUS METALS 9

Welding of non-ferrous materials: Joining of aluminium, copper, nickel and titanium alloys, problems encountered and solutions.

UNIT V DEFECTS AND WELDABILITY 9

Defects in welded joints: Defects such as arc strike, porosity, undercut, slag entrapment and hot cracking, causes and remedies in each case. Joining of dissimilar materials, testing of weldability.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Linnert. G. E. "Welding Metallurgy". Vol. 1 and 2. 4th edition. A W S. USA, 1994.
2. Lancaster J. F. "Metallurgy of Welding", 4th Londre: George Allen & Unwin.1987.

REFERENCES:

1. Saferian D. "The Metallurgy of Welding". Chapman and Hall, UK, 1985.
2. "AWS Welding Hand book", 8th edition, Vol-1,"Welding Technology", 1998.
3. Sindo Kuo," Welding Metallurgy", John Wiley & Sons, 2003
4. Henry Granjon,"Fundamentals of Welding Metallurgy", Abington Pub, 1991
5. Robert W. Messler, "Principles of Welding: Processes, Physics, Chemistry, and Metallurgy", Wiley, 1999.

ME9403 COMPUTER AIDED SIMULATION AND ANALYSIS LABORATORY L T P C 0 0 3 2

LIST OF EXPERIMENTS

A. SIMULATION

MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables

Use of Matlab to solve simple problems in vibration and Laplace Transforms

B. Analysis (Simple Treatment only)

1. Stress analysis of a plate with a circular hole.
2. Stress analysis of rectangular L bracket
3. Stress analysis of plane strain problems
4. Stress analysis of an axi-symmetric components
5. Stress analysis of beams (Cantilever, Simply supported, Fixed ends)
6. Mode frequency analysis of a 2 D component
7. Mode frequency analysis of beams (Cantilever, Simply supported, Fixed ends)
8. Harmonic analysis of a 2D component
9. Transient analysis of spring mass system
10. Spectrum analysis of spring mass system
11. Thermal stress analysis of a axisymmetric component
12. Conductive heat transfer analysis of a 2D component
13. Convective heat transfer analysis of a 2D component

TOTAL : 45 PERIODS

ML9404 **COMPREHENSION** **L T P C**
0 0 2 1

The objective of this comprehension is to achieve an understanding of the fundamentals of contemporary manufacturing systems including materials, manufacturing process, product and process control and quality assurance. The students work in groups and solve a variety of problems given to them. The problems given to the students should be of real life industrial problems selected by a group of faculty members of the concerned department. A minimum of three small problems have to be solved by each group of students. The evaluation is based on continuous assessment by a group of Faculty Members constituted by the professor in – charge of the course.

TOTAL : 30 PERIODS

ML9405 **MATERIALS DESIGN PROJECT** **L T P C**
0 0 4 2

OBJECTIVE

The main objective is to impart hands on training to the students in the fabrication of one or more component of a complete working model, which has been designed by them. The transfer of concepts studied in the Materials Science Programme to a practical application is important.

Students get familiarized in the field of material synthesis or processing, metal joining or casting or forming, or mechanical behavior of materials or material characterization or material testing and analysis. The project can also focus on the selection and optimization of materials in design of on a purely material oriented project such as the development and characterization of an alloy.

The students may be grouped in small groups and work under a project supervisor. The components to be fabricated may be decided in consultation with the supervisor and if possible with an industry. A project report to be submitted by the group, which will be evaluated by a Committee which will be constituted by the Head of the Department

TOTAL : 60 PERIODS

ML9406 **INDUSTRIAL/ FIELD TRAINING** **L T P C**
0 0 0 1

OBJECTIVE

This course is mandatory to gain exposure to applications in industry.

The students have to undergo practical industrial training for six weeks (during vacation at the end of VI semester) in recognized industrial establishments. At the end of the training they have to submit a report with following information:
Profile of the Industry

1. Product range
2. Organization structure

3. Plant layout
4. Processes/Machines/Equipment/devices
5. Personnel welfare schemes
6. Details of the training undergo
7. Projects undertaken during the training, if any
8. Learning points.
9. End Semester examination will be a Viva-Voce Examination.

ML9451 PROJECT WORK L T P C
0 0 12 6

OBJECTIVES:
In the project work the students demonstrate their ability to apply knowledge studied during the course. Students show their ability to collect information from literature, design, perform and interpret experiments. The successful project work is documented in a formal project report and technical presentation.

A project topic must be selected either from published lists or the students themselves may propose suitable topics in consultation with their guides. The aim of
the project work is to deepen comprehension of the principles by applying them to a new problem which may be the design and manufacture of a device, a research investigation, a computer or management project or design problem. The problem may be selected in areas of material synthesis or processing, material characterization, material joining, metal forming or casting or mechanical behaviour of materials or material testing and analysis.

The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department.

A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.

ML9021 METALLURGY OF TOOL MATERIALS L T P C
3 0 0 3

OBJECTIVE
Tooling materials require special considerations in production and application. Students will learn the metallurgical processes and applications in producing toolings.

UNIT I CLASSIFICATION AND MANUFACTURE OF TOOL STEELS 8
Classification - AISI system, production techniques – problems in melting - powder metallurgy route, Refining methods like VAR and ESR - forming of tool steels.

UNIT II HEAT TREATMENT OF TOOL STEELS 10
Spheroidising – selection of quenching and tempering parameters – precautions - Effect of retained austenite - Multiple tempering, sub-zero treatment and cryo treatment - surface treatments - defects in tool steels - Over heated and burnt structures - Decarburization.

UNIT III PROPERTIES AND TESTING OF TOOL STEELS 10

Mechanical propertiess of tool steels, strength, hardness and toughness – properties at elevated temperature – microstructure - distribution of carbides - coating thickness – micro hardness – adhesion and scratch resistance

UNIT IV ADVANCED TOOL MATERIALS 10

Sintered tungsten carbide tools - ISO classification – Uses of P, M and K grades – cermet – ceramics, mixed and reinforced grades – cubic boron nitride – poly crystalline diamond – manufacturing techniques – properties

UNIT V SURFACE TREATMENTS AND COATINGS 7

Sulphidising of tool steels – TiN coating by PVD – coating of carbide tools – mono and multi layer coatings of TiC, TiN, Alumina and DLC by PVD and CVD processes - selection of tool materials

TOTAL : 45 PERIODS

TEXT BOOK

1. Payson, Peter, “Metallurgy of Tool Steels”, John Wiley and Sons, New York, 1962.

REFERENCES

1. Robert Wilson, “Metallurgy and Heat Treatment of Tool Steels”, McGraw-Hill, New York, 1975
2. Roberts, Haymaker and Johnson, “Tool Steels”, 3rd edition, ASM, 1962.
3. Joseph R. Davis,“ Tool Materials”, ASM International, 1995

ML9022 PHYSICAL METALLURGY OF FERROUS AND ALUMINUM ALLOYS L T P C 3 0 0 3

OBJECTIVES

Students of Materials Science and Engineering are offered an in depth study of the physical metallurgy of ferrous and aluminum alloys.

UNIT I PHASE TRANSFORMATION 8

Basics of thermodynamics, kinetics and diffusion mechanisms.

UNIT II DIFFUSION CONTROLLED PHASE TRANSFORMATION 10

Nucleation and growth - Types of nucleation - Concept of free energy during solidification - Thermodynamics of homogeneous nucleation - critical nucleus size and critical free energy change - constitutional supercooling - Extension to heterogeneous nucleation - Nucleation rate and growth rate - overall transformation rate. Concept of Activation energy - Arrhenius equation - Johnson Mehl - Avrami equation. Pearlitic transformations.

UNIT III DIFFUSIONLESS TRANSFORMATIONS 10

Martensite transformation - Definition - characteristic features of Martensitic transformation in steels - morphology of Martensite - lath and acicular martensite - Crystallography of martensitic transformation - Martensite in non-ferrous systems - Thermoelastic martensite - Shape Memory effect - Examples and applications of shape memory alloys.

UNIT IV PRECIPITATION REACTIONS 7

Precipitation from solid solutions, thermodynamic considerations, structure and property during ageing, sequence of ageing, formation of G-P zones and intermediate precipitates, theories of precipitation hardening, effect of time, temperature and alloy compositions, precipitation free zones, crystallographic aspects of transformation, coarsening kinetics.

UNIT V ANNEALING 8

Cold working and hot working. Recovery - polygonization and dislocation movements in polygonization. Recrystallisation - effect of time, temperature, strain and other variables, mechanism of nucleation and growth. Grain growth – Grain growth law, geometrical collisions, preferred orientation, secondary recrystallisation.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Raghavan. V., “Phase Transformations”, Prentice - Hall of India, New Delhi, 2007.
2. Romesh C. Sharma, “Phase transformation in Materials”, CBS Publishers & Distributors, New Delhi, 2002.

REFERENCES:

1. Reed Hill. R. E. “Physical Metallurgy Principles”, Affiliated East West Press. New Delhi. 1992.
2. Thomas H. Courtney, “Mechanical Behaviour of Materials”, McGraw-Hill Co., NY. 1990.
3. George E. Totten and D. Scott MacKenzie,“ Handbook of Aluminum: Vol. 1: Physical Metallurgy and Processes”, CRC; 1 edition, 2003.
4. Anil Sinha, “Physical Metallurgy Handbook”, McGraw-Hill Professional; 1 edition, 2002.
5. William F. Hosford, “Physical Metallurgy, materials engineering series”, Vol. 26, Taylor & Francis CRC Press, 2005.

ML9023 AUTOMOTIVE MATERIALS L T P C
3 0 0 3

OBJECTIVE

The students study the processes and special requirements of the Automotive Industry.

UNIT I PROPERTIES OF MATERIALS 10

Technologically important properties of materials, Physical, Chemical, Mechanical and Electrical properties of metals, Criteria of selection of materials like properties, cost, manufacturing process, availability, legal and safety factors.

UNIT II MATERIALS FOR CORROSION AND WEAR RESISTANCE 8

Materials for atmospheric, soil, water, acid and alkaline resistance, Corrosion prevention coatings, material for Chemical and Petroleum industries, materials and coatings for wear resistance.

UNIT III MATERIALS FOR HIGH AND LOW TEMPERATURES 8

High temperature strength and stability, Hot hardness requirements, High temperature steels and super alloys, ductile to brittle transition-HSLA steel, low temperature materials.

UNIT IV MATERIALS FOR AUTOMOTIVE INDUSTRY 10

Materials for engine components, cylinder block, head, Liner, piston, ring, pin, connecting rod, crank shaft, exhaust, cam shaft, rocker arm and tappet, etc. Materials for chasis

UNIT V NEW MATERIALS 9

New Materials and processes Rheology, Recycling requirements.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Gladius Lewis, “Selection of Engineering Materials", Prentice Hall Inc. New Jersey USA, 1995.
2. Charles J A and Crane. F A.A., “Selection and Use of Engineering Materials”, 3rd Edition, Butterworth’s, London UK, 1996.

REFERENCES

1. James A. Jacobs, Thomas F. Kilduff., “Engineering Materials Technology: Structure, Processing, Properties & Selection”, Prentice Hall, USA, 1996.
2. ASM Handbook, "Selection of Materials Vol. 1 and 2", ASM Metals Park, Ohio. USA, 1991.
3. Daniel P. Henkel, Alan Pense., “Structure and Properties of Engineering Materials”, 5th edn., McGraw-Hill Book Co., New York, USA, 2001.
4. ASM Handbook. “Materials Selection and Design”, Vol.20- ASM Metals Park Ohio. USA, 1997.
5. Murthy, V.S.R., Jena, A.K., Gupta, K.P. and Murthy, G.S., “Structure and Properties of Engineering Materials”, Tata McGraw-Hill, New Delhi, 2003.
6. Cantor,“ Automotive Engineering: Lightweight, Functional, and Novel Materials”, Taylor & Francis Group, London, 2006.

ML9024 BIOMEDICAL MATERIALS LT P C
3 0 0 3

OBJECTIVES

Students are learning medical and biomedical applications of materials. Biocompatibility

UNIT I BIOLOGICAL PERFORMANCE OF MATERIALS 9

Biofunctionality and biocompatibility - material response - deformation and failure - friction and wear -Host response-Inflammatory process-capsule formation - coagulationand hemolysis - approach to thromboresistant material development-chemical and foreign body carcinogenesis.

UNIT II ORTHOPAEDIC MATERIALS 9

Materials for bone and joint replacement-cemented and cementless total joint replacement- metals and alloys; stainless steel, cobalt based alloys, titanium based materials -ceramics - bioinert ceramics -carbon, alumina, zircona and titania -bioactive ceramics -bioactive glass and glass ceramics, calcium phosphate ceramics - polymers, grouting materials – PMMA bone cement, articulating component–UHMWPE composites, matrix and filler components -mechanical properties.

UNIT III DENTAL AND CARDIOVASCULAR MATERIALS 9

Dental restorative materials - dental cements – zinc oxide and phosphate cements - Dental composite materials - polymer/ceramic composites –composite component, polymerization, properties – glass isomer cements
cement components; setting reaction,structure and properties - dental amalgams: composition, microstructure, physical properties and degradation process - cardiovascular prostheses: vascular -graft materials, cardiac valve Prostheses, cardiac assist devices and cardiac pacemakers.

UNIT IV ARTIFICIAL ORGANS AND OTHER MATERIALS 9

Artificial kidney and urological prostheses ~Blood-gas exchangers - artificial pancreas - structure and use of collagen -material for skin and nerve regeneration -collagen/GAG graftcopolymers -tissue adhesives-fibrin and cyanoacryllc tissue adhesives-materials for Ophthalmology - contact lens and intraocular lens materials-materials for drug delivery.

UNIT V MATERIALS CHARACTERIZATION TECHNIQUES 9

Electron microscopic methods - SEM, TEM, spectroscopic methods -IR; visible, UV and x-ray methods, differential thermal analysis, differential thermogravimetric analysis, NDTmethods.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Sujata V., Bhat.," Biomaterials", Narosa Publication House, New Delhi, 2002
2. Ratner, B.D, Hoffman,A. S., Sckoen,F.J. and Emons, J.E.L. (Eds)," Biomaterials Science, An Introduction to Materials in Medicine", Academic Press, second edition, 2004.

REFERENCES

1. Jonathan Black," Biological Performance of materials, Fundamentals of Biocompatibility", Marcel Dekker Ind., New, York, 1992.
2. Williams, D. F., (editor)," Material Science and Technology -A comprehensive treatment", Vol. 14, Medical and Dental Materials, VCH Publishers Inc.; New York, 1992.
3. Davis, J. R.," Handbook of Materials for Medical Devices", ASM international, 2003.

ML9025 CERAMICS AND REFACTORY MATERIALS LT P C
3 0 0 3

OBJECTIVE

In this course the structure and properties of ceramics, classes and refractory materials is studied in detail.

UNIT I FUNDAMENTALS 9

Ceramic crystal structures. NaCl, CsCl, Al2O3 Phase diagram SiO2 – K2O – Al2O3. Classifications by application (density, porosity), composition (oxides, carbides, nitrides), properties

UNIT II RAW MATERIALS AND CHARACTERIZATION 9

Mineralogy, Phase analysis, powder classification

UNIT III GLASS 9

Silica-soda-lime glasses. Structure, composition, raw materials, furnaces, melting reactions, production routes, Products (flat, containers), optical glass, optical fibers

UNIT IV CERAMICS 9

Requirements of tool materials-properties of HSS - advances in tool materials- carbides and coated carbides, ceramic, cermets, CBN, Diamond, PCD - ISO-specifications for inserts and tool holders - -Need for chip breakers – types of chip breakers

UNIT V ADVANCED CERAMICS 9

Applications in structural (ICE, gas turbines, cutting tools), bioceramics (implants), electrical (insulators, substrates, piezoceramics), ceramic coatings (thermal barriers), nuclear (cermets), process (filters, catalyst)

TOTAL : 45 PERIODS

TEXT BOOK

1. Kingery, W. D., H. K. Bowen and D. R. Uhlmann, “Introduction to Ceramics”, 2nd Edition, John Wiley and Sons, New York, 1976.

REFERENCES

1. Barsoum,“ Fundamentals of Ceramics”, CRC Press, 1997.
2. Yet-Ming Chiang, Dunbar P Birnie and W David Kingery,“ Physical ceramics: principles for ceramic science and engineering”, NY: John Wiley, 1997.
3. Kumar, S. (editor) "Hand Book of Ceramics" Vol. 1 - 4; Kumar & Associates, Calcutta, India, 1994.

ML9026 ELECTRON MICROSCOPY AND DIFFRACTION ANALYSIS OF MATERIALS L T P C 3 0 0 3

OBJECTIVE

The study of microstructure and microscopic properties are important tools for the understanding of material behaviour. This course covers, crystal structure, X-Ray methods and spectroscopy as well as scanning and transmission electron microscopy.

UNIT I CRYSTALLOGRAPHY 7

Symmetry elements, operations – translational symmetries – point groups – space groups – close packed structures – voids – important crystal structures – defects in crystals – polymorphism and twinning – polarizing microscope and uses.

UNIT II DIFFRACTION AND CHARACTERISTICS X-RAYS 9

X-ray generation, properties – sealed tube, rotating anode, synchrotron radiation – absorption – filters and monochromators. Atomic scattering factor. Fourier transformation and structure factor – anomalous dispersion – Bragg’s law – reciprocal lattice concept – Laue conditions – Ewald and limiting spheres – diffraction symmetry.

UNIT III SINGLE CRYSTAL DIFFRACTION 10

Laue, rotation / oscillation methods – interpretation of diffraction patterns – cell parameter determination – indexing – Powder diffraction: Debye method – uses. Single crystal X-ray diffractometer – double crystal X-ray diffractometer – Triple and four crystal X-ray diffractometer. X-ray topography – Neutron diffraction.

UNIT IV SPECTROSCOPY 9

Principles and instrumentation for X-ray photoelectron spectroscopy (XPS), Auger Electron spectroscopy (AES) and Secondary ion mass spectroscopy (SIJMS) – proton induced X-ray Emission spectroscopy (PIXE)

UNIT V OPTICAL METHODS AND ELECTRON MICROSCOPY 10

Principles of SEM – instrumentation and working of SEM – Transmission Electron Microscope (TEM) – Scanning transmission Electron Microscope (STEM) – principles, instrumentation and working of Atomic force microscope (AFM) – Photoluminescence – time resolved photoluminescence spectroscopy

TOTAL : 45 PERIODS

TEXT BOOKS

1. Lawrence E. Murr, "Electron and ion microscopy and microanalysis principles and applications", Marcel Dekker Inc. New York 1991.
2. Cullity, B. D., "Elements of X-ray diffraction", Addison-Wesley Company Inc., New York, 3rd Edition, 2000.

REFERENCES

1. Belk, J. A,"Electron microscopy and microanalysis of crystalline materials", Applied Science Publishers, London, 1979.
2. Azaroff, L. V.,"Elements of X-ray Crystallography", McGraw –Hill NY, 1968.

ML9027 MODELING AND SIMULATION IN MATERIALS ENGINEERING L T P C 3 0 0 3

OBJECTIVES:

Modeling and simulation are important tools in understanding physical effects in many technological applications. This course should enable students to use standard packages for modeling and simulation applicable to Materials Science and Engineering.

UNIT I INTRODUCTION TO MODELING AND MATHEMATICAL CONCEPTS 9

Mathematical modeling, physical simulation, advantages and limitations - Review of differential equations, numerical methods, introduction to FEM, FDM- Governing differential equations of elastic, plastic deformation, fluid flow and heat transfer – basic steps in FEM

UNIT II CONSTITUTIVE MODELING 9

Elastic Medium, visco-elastic constitutive equations.

UNIT III CONSTITUTIVE MODELING 9

Plastic Medium.

UNIT IV SOFTWARE PACKAGES 9

Introduction to standard software packages – General purpose FEA packages such as ANSYS, ABAQUS, NASTRAN etc. – Special purpose packages such as DEFORM, OPTIFORM, ProCAST, etc. - Applications of FEA in simulation of sheet metal and bulk forming, solidification of casting and weldment, Concepts of coupled analysis

UNIT V COMPUTER APPLICATIONS IN PHYSICAL METALLURGY 9

Use of computers for the construction of phase diagrams, Features of CALPHAD – Expert system for alloy design and selection of materials – computer applications in crystallography.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Reddy J. N., "An Introduction to Finite Element Method", McGraw-Hill International Student Edition, 1985.
2. AMIE, "Modeling of casting and welding process", Volume I & II, the Metallurgical society of AMIE, 1981&1983.

REFERENCES

1. Piwonoka T.S., Vollen V., Katgerman I., "Modeling of Casting, Welding, and Advanced Solidification Process", 4th edition, TMS-AIME, USA, 1993
2. Stocks G.M., Turchi P.E.A., "Alloy Modeling and Design", the Metals Society, AMIE, USA, 1994.
3. Trivedi R., Sekhar J.A., Majumudar J., "Principles of Solidification and Material Processing", Volume I&II, Oxford and IBH, New Delhi, 1989.
4. Cerjak H., "Mathematical Modeling of Weld Phenomenon-2", The Institute of Materials, 1995.
5. O. C. Zienkiewicz and R. L. Taylor, "The Finite Element Methods, Vol.1. The basic formulation and linear problems", Vol. 1, Butterworth Heineman, 5th Edition, 2000.

MA9262 NUMERICAL METHODS L T P C
3 1 0 4

UNIT I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 10 +3

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton-Raphson method- Solution of linear system of equations - Gauss Elimination method – Pivoting - Gauss-Jordan methods – Iterative methods of Gauss-Jacobi and Gauss-Seidel - Matrix Inversion by Gauss-Jordan method - Eigenvalues of a matrix by Power method and by Jacobi's method.

UNIT II INTERPOLATION AND APPROXIMATION 8 + 3

Interpolation with unequal intervals - Lagrange interpolation – Newton's divided difference interpolation – Cubic Splines - Interpolation with equal intervals - Newton's forward and backward difference formulae.

UNIT III NUMERICAL DIFFERENTATION AND INTEGRATION 9 + 3

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 and Simpson's 3/8 rules – Romberg's method - Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's rules.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 9 + 3

Single step-methods - Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first and second order equations - Multi-

step methods - Milne's and Adams-Bashforth predictor-corrector methods for solving first order equations.

UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 9 + 3

Finite difference methods for solving two-point linear boundary value problems. Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat-flow equation by explicit and implicit (Crank Nicholson) methods - One dimensional wave equation by explicit method.

L: 45 T: 15 TOTAL: 60 PERIODS

TEXT BOOKS

1. Grewal, B.S. and Grewal,J.S., " Numerical methods in Engineering and Science", 6th Edition, Khanna Publishers, New Delhi, 2004.
2. Sankara Rao, K. "Numerical methods for Scientists and Engineers', 3rd Edition Prentice Hall of India Private Ltd., New Delhi, 2007.

REFERENCES

1. Chapra, S. C and Canale, R. P. "Numerical Methods for Engineers", 5th Edition, Tata McGraw-Hill, New Delhi, 2007.
2. Gerald, C. F. and Wheatley, P. O., "Applied Numerical Analysis", 6th Edition, Pearson Education Asia, New Delhi, 2006.
3. Brian Bradie, "A friendly introduction to Numerical analysis", Pearson Education Asia, New Delhi, 2007.

ML9028 EXPERIMENTAL TECHNIQUES IN MACHINING L T P C
3 0 0 3

OBJECTIVES

Students should master the foundation and applications of experimental mechanics which is important for all machining operations.

UNIT I INTRODUCTION 9

Tool materials – high carbons steel – satellite sintered carbides – ceramics – DM-HSS tools carbide tools – Diamond – tool life estimation tool wear – machinability

UNIT II TOOL WEAR EVALUATION 10

Profile projector- optical section microscope surface layer – Single pan balance – Isotope selection and manufacture – Beta – Gamma radiation in carbide and HSS tools – Auto radiographic studies – Micro Isotopes for tool wear.

UNIT III TECHNIQUES FOR STUDYING COMPOSITION AND STRUCTURE 10

Electron probe micro analyzer (EPMA) – Scanning micro analyser, secondary ion emission micro analyzer – Augar electron spectrography (AES). X-ray diffraction – crystallite size – evaluation of residual stresses - work hardening by sub-surface metallurgy.

UNIT IV MEASUREMENT OF CUTTING FORCE AND DYNAMOMETERS 8

Forces involved in machining mechanical – hydraulic and electrical dynamometers – amplifiers and recorders measurement of forces in drilling – dynamometer for milling – dampers for dynamometer.

UNIT V ANALYSIS OF EXPERIMENT DATA 8

Parametric modeling of data – identification with extrapolation – Implicit parameters – Inverse theory for ill conditioned problems – regularization of forms – relocation of data into a grid pattern.

TOTAL : 45 PERIODS

TEXT BOOK

1. Venkatesh, V. C. and Chandrasekaran, A., "Experimental techniques in metal Cutting", Prentice Hall of India Pvt. Ltd., New Delhi, 1987.

REFERENCES

1. Gardiner,W. P. and Gettingby, G, "Experimental Techniques in Statistical Practice", Horwood publishing Manchester – 1998.
2. Warren Richard DeVries," Analysis of Materials Removal Processes", Springer, 1992

ML9029 FUELS, FURNACES AND REFACTORIES L T P C
3 0 0 3

OBJECTIVES

Many industries require process heat in the production and treatment of materials. This course teaches fundamentals and applications of fuels, furnaces and refractories.

UNIT I FUNDAMENTALS 9

Thermal Energy, conversion. Heat Transfer, conduction, radiation, convection. Thermoelectric effect. thermocouples, Peltier effect. Temperature measurement.

UNIT II FUELS 9

Thermal Energy conversion. Fossil fuels, availability, deposits, calorific content. Nuclear Fuels, Solar and geothermal heating.

UNIT III FURNACES 9

Firing, electric Resistance, Radiation, Induction. Temperature control - PID. Multi zone furnaces. Batch and tunnel furnaces.

UNIT IV REFRACTORIES 9

Heat resistant materials in steel making and non ferrous production plants. Applications in the power, energy conversion, petroleum and chemical industries.

UNIT V ADVANCED ISSUES 9

Energy and Environment, Environmental optimization, Recycling of thermal energy. Emissions control.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Gupta. O. P., "Elements of Fuels, Furnaces and Refractories", 4th edition, Khanna Publishers, New Delhi, 2000.
2. Nandi, D. N., "Handbook on Refractories", Tata McGraw-Hill, 1987.

REFERENCES:

1. Yeshvant V. Deshmukh," Industrial Heating: Principles, Techniques, Materials, Applications, and Design", CRC Press, 2005
2. Gilchrist, J. D., "Fuels, Furnaces and Refractories", Pergamon Press, 1977.
3. Nandi, D. N., "Handbook on Refractories" Tata McGraw-Hill Publishing Co. Ltd., New Delhi, India.

ML9030 EXPERIMENTAL STRESS ANALYSIS L T P C
3 0 0 3

OBJECTIVES

After studying stress and strain in the core mechanical subjects, this elective should train the students to apply practical methods of experimental stress analysis.

UNIT I INTRODUCTION 7

Basic Equations and plane elasticity theory – plane elastic problems - plane strain approach – plane stress – Airy's stress function – in cartesian co-ordinate. Two dimensional.

UNIT II BRITTLE COATING METHODS 7

Coating stresses – Failure theories. Brittle coating crack patterns – direct load – Defrigeration Techniques. Brittle – coating crack patterns produced by releasing the load, double crack pattern – crack detection.

UNIT III PHOTO ELASTICITY METHODS 8

Stress optic law in two dimensions at normal incidence – Effect of stress model in a plane polariscope - Circular polariscope (Dark field – light field) – Fringe multiplication by photographic methods. Holography

UNIT IV STRAIN MEASUREMENTS 12

Definition of strain and its relation to experimental determinations – Basic characteristic of strain gage – Moire method – Grid method of strain analysis. Electrical resistance strain gages, gage construction – temperature compensation gage sensitivities and cage factor – semi conductor strain gages – Delta rosette.

UNIT V STRAIN GAGE CIRCUITS 11

Potentiometer and its applications to strain measurement - range and sensitivity of potentiometer circuit – Temperature compensation – Load effects on the potentiometer circuits – Wheat stone bridge – Null –balance bridge – Criteria for circuit selection.

TOTAL : 45 PERIODS

TEXT BOOK:

1. James W. Dally and Willan F. Riley, " Experimental Stress Analysis", 4th edition, College House Enterprise, 2005

REFERENCES:

1. James F. Doyle, "Modern Experimental stress analysis: Completing the solution of partially specified problems", John Wiley and Sons Ltd., 2004.
2. Dally, Riley, and McConnell," Instrumentation for Engineering Measurements", Wiley & Sons, 1984
3. Wieringa, H.," Experimental Stress Analysis", Springer, 1986.

ME9030 INDUSTRIAL TRIBOLOGY L T P C
3 0 0 3

UNIT I SURFACES AND FRICTION 9

Topography of Engineering surfaces- Contact between surfaces - Sources of sliding Friction – Adhesion-Ploughing- Energy dissipation mechanisms Friction Characteristics of metals - Friction of non metals. Friction of lamellar solids - friction of Ceramic materials and polymers - Rolling Friction - Source of Rolling Friction – Stick slip motion - Measurement of Friction.

UNIT II WEAR 9

Types of wear - Simple theory of Sliding Wear Mechanism of sliding wear of metals - Abrasive wear – Materials for Adhesive and Abrasive wear situations - Corrosive wear - Surface Fatigue wear situations - Brittle Fracture - wear - Wear of Ceramics and Polymers - Wear Measurements.

UNIT III LUBRICANTS AND LUBRICATION TYPES 9

Types and properties of Lubricants - Testing methods - Hydrodynamic Lubrication – Elasto-hydrodynamic lubrication- Boundary Lubrication - Solid Lubrication- Hydrostatic Lubrication.

UNIT IV FILM LUBRICATION THEORY 9

Fluid film in simple shear - Viscous flow between very close parallel plates - Shear stress variation Reynolds Equation for film Lubrication - High speed unloaded journal bearings - Loaded journal bearings – Reaction torque on the bearings - Virtual Co-efficient of friction - The Sommerfield diagram.

UNIT V SURFACE ENGINEERING AND MATERIALS FOR BEARINGS 9

Surface modifications - Transformation Hardening, surface fusion - Thermo chemical processes – Surface coatings - Plating and anodizing - Fusion Processes - Vapour Phase processes - Materials for rolling Element bearings - Materials for fluid film bearings - Materials for marginally lubricated and dry bearings.

TOTAL : 45 PERIODS

TEXT BOOK:

1. A.Harnoy " Bearing Design in Machinery "Marcel Dekker Inc,NewYork,2003

REFERENCES:

1. M.M.Khonsari & E.R.Booser, " Applied Tribology",John Willey &Sons,New York, 2001
2. E.P.Bowden and Tabor.D., " Friction and Lubrication ", Heinemann EducationalBooks Ltd., 1974.
3. A.Cameron, " Basic Lubrication theory ", Longman, U.K.., 1981.
4. M.J.Neale (Editor), " Tribology Handbook ", Newnes. Butterworth-Heinemann, U.K., 1995.

ML9031 MICRO AND NANOMECHANICAL PROPERTIES OF MATERIALS LT P C
3 0 0 3

OBJECTIVES

Many materials have different properties on a micro and nano scale as compared to bulk material. This difference and special properties only relevant to nano scale material are elaborated on in this course and should be mastered by the students.

UNIT I INTRODUCTION 5

Overview of the composition, structure, chemical and mechanical properties of surfaces and how these properties affect mechanical and tribological properties of surfaces.

UNIT II MICROMECHANICS 5

Multiscale interactions between surfaces; fractal nature of surface topography; interfacial forces, adhesion, and principles of micromechanics; techniques for surface characterization.

UNIT III DEFORMATION MECHANISMS 15

Stress and strain of material; Elastic deformation: Young's modulus, Poisson's ratio, stress-strain relation, stiffness/compliance matrix; Dislocations: Edge/screw/mixed dislocation, burgers vectors, twining, stress field of dislocation, dislocation interaction; Plastic deformation of single and polycrystalline materials: Schmid's law, plastic flow; Inelastic deformation: Viscosity, deformation of inorganic glasses, deformation of nanocrystalline and crystalline polymers; Mechanical fracture: ductile and brittle facture, creep, fatigue;

UNIT IV TESTING METHODS 5

Various Testing methods - Experimental determination of Mechanical Properties –Types of Hardness testing of Metals and Strength of Metals, Polymers, Ceramics and Composites.

UNIT V NANOMECHANICAL PROPERTIES 10

Determination of surface mechanical properties (AFM/nanoindentation), simple friction theories - effects of surface composition and structure on friction, environmental and temperature effects, relationship with surface chemistry, mixed and boundary lubrication, failure mechanisms

TOTAL : 45 PERIODS

REFERENCES:

1. Ashby M. F. and Jones DRH (1998) Engineering Materials 1, An Introduction to Their Properties and Applications, Second Edition. Butter worth Heinemann.
2. Bharat Bhushan (ed.) Handbook of Nanotechnology, Springer, 2004.

ML9032 ALLOY CASTING PROCESSES L T P C
3 0 0 3

OBJECTIVE

The casting of metals is the focus of this course and covers not only steels, but also light metals like Magnesium and Aluminum. The casting of Zinc and Copper alloys is also treated in detail.

UNIT I MAGNESIUM ALLOYS 8

Introduction to different types of Magnesium alloys – Process for Manufacturing Magnesium alloys – Production considerations – Die casting consideration – die life productivity – applications of Magnesium alloy cast parts.

UNIT II ALUMINIUM ALLOYS 10

Introduction to different types of Aluminum alloys – Process for Manufacturing Aluminum alloys - Production considerations – die life – productivity – applications of Aluminum Cast Parts.

UNIT III ALLOY STEELS 10

Introduction to different types of Alloy steels – process for manufacturing alloy steels – production considerations – productivity – applications of alloy cast parts.

UNIT IV ZINC ALLOYS 8

Introduction to different types of Zinc alloys – process for manufacturing Zinc alloys – production considerations – Die casting considerations – die life – productivity – applications of Zinc alloys cast parts.

UNIT V COPPER ALLOYS 9

Introduction to different types of copper alloys. Process for manufacturing copper alloys production considerations. Die casting considerations – die life – productivity – applications of copper alloys cast parts.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Jain, P. L., "Principles of Foundry Technology", Tata McGraw Hill, 1994.
2. Heine, R. W, Loper, C. R. and Rosenthal, "Principles of Metal Casting", Tata McGraw Hill, New Delhi, 1995.

REFERENCES:

1. ASM Hand Book Vol. 5 Casting, ASM International, 1998.
2. Ramana Rao, T. V., "Metal Casting Principles and Practice", 1st edition, New Age International, 1996.
3. Houldcorft, P. T.," Welding process technology", Cambridge University Press, 1985.

ML9033 ROLLING AND FORGING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

This course deals with the bulk forming processes in rolling and forging operations. Students should learn the foundations to be able to apply this knowledge in industrial environments.

UNIT I BULK AND DEFORMATION PROCESS 9

Characteristics – applications of Bulk Deformation Process, Deformation mechanics – Material requirements – Friction in bulk deformation, environmental factors.

UNIT II ROLLING PROCESS 9

Types of rolling – Advantages and applications – Hot rolling – cold rolling – Equipment based – Mechanics of flat rolling – roll pressure distribution – roll forces and power – effect of friction – vibration and chatter in rolling.

UNIT III SPECIAL ROLLING PROCESS 9

Shape rolling – Thread and gear rolling – tube rolling – rotary tube piercing – cold swaging – defects in rolling.

UNIT IV HOT FORGING PROCESS 9

Types of forging – forging operations – Equipments used – Hydraulic, Mechanical and screw press – drop hammers – Press characteristics – Force and Work of

deformation – deformation zone geometry – forging cylindrical work piece – forces and power – staging making typical forged components – die material.

UNIT V COLD FORGING 9

Advantages and application – forgability of materials test – upsetting and hot twist test – Material for Cold forging – Special forming process – Precision forging – Cold heading – Hubbing – Warm forging.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Dieter, G. E., "Mechanical Metallurgy", McGraw-Hill Co., SI Edition, 1995.
2. Nagpal, G. R., "Metal Forming Processes", Khanna Pub., New Delhi, 2000.
3. Surendrakumar, "Technology of Metal Forming process", PHI, New Delhi – 2008.

REFERENCES:

1. Kalpakjain and Scheroid, "Manufacturing Processes for engineering materials", Pearson education, 4th edition, 2003
2. Altar, Nagile and Sher," Cold and Hot forging", Materials Park, Ohio, 2005.
3. Roy A. Lindberg," Processes and Materials of Manufacture", Prentice Hall of India Pvt. Ltd. 2003.

MF9030 MICRO MACHINING PROCESSES L T P C
3 0 0 3

AIM

The purpose of this subject is understand the principles of various micro fabrication processes.

OBJECTIVES

- Upon completion of this subject, student will be able to:
- Understand principle of micro systems and feed back systems
- Know the different methods of microfabrication.
- Understand the properties and microstructure of materials
- Appreciate Integration processes in detail
- Enhance the knowledge in semiconductor manufacturing processes.

UNIT I INTRODUCTION 8

Introduction to Micro System design, Material properties, micro fabrication technologies. Structural behavior, sensing methods, micro scale transport - feed back systems.

UNIT II MICROMECHANICS 9

Microstructure of materials, its connection to molecular structure and its consequences on macroscopic properties – Phase transformations in crystalline solids including martensite, ferroelectric, and diffusional phase transformations, twinning and domain patterns, smart materials

UNIT III BASIC MICRO-FABRICATION 10

Bulk Processes – Surface Processes – Sacrificial Processes and Bonding Processes– Special machining: Laser beam micro machining – Electrical Discharge Machining – Ultrasonic Machining – Electro chemical Machining. Electron beam machining.

UNIT IV MECHANICAL MICROMACHINING 10

Theory of micromachining – Chip formation – Size effect in micromachining – microturning, micromilling, microdrilling - Micromachining tool design – Precision Grinding – Partial ductile mode grinding – Ultraprecision grinding – Binderless wheel – Free form optics.

UNIT V SEMI CONDUCTORS MANUFACTURING 8

Basic requirements - clean room – yield model – Wafer IC manufacturing – feature micro fabrication technologies – PSM – IC industry – New Materials – Bonding and layer transfer – devices – micro fabrication industries.

TOTAL : 45 PERIODS

TEXT BOOK:

1. Sami Franssile, "Introduction to Micro Fabrication", John Wiley & Sons Ltd., UK, 2004

REFERENCES:

1. Madore Mar J., "Fundamental of Micro Fabrication", CRC Press, 2002
2. Robert W Johnstone and Ash Parmaswaran, "An Introduction to Surface-micromachining", Springer, 1st edition, 2004.
3. Rai Choudhury, P., " Handbook of Microlithography, Micromachining, and Microfabrication". Volume 2: Micromachining and Microfabrication, SPIE-International Society for Optical Engine, 1997.

ML9034 LASER PROCESSING OF MATERIALS L T P C
3 0 0 3

OBJECTIVES

Students are to be trained in modern laser processing methods that include machining and cutting, but also a way of localized heat treatment not available with conventional ways of introducing heat in a metal.

UNIT I LASER SYSTEMS 9

Laser beam characteristics – laser principles – High power lasers for materials applications – principles and working of CO_2, Nd:YAG and Excimer laser – Optics for irradiation

UNIT II THERMAL PROCESS IN INTERACTION ZONES 9

Laser Materials processing parameters – conduction and convection – Analytical models in one dimensional heat flow – depth of irradiation with respect to energy density – reflectivity of material with respect to wave length – rate of heating, cooling and temperature gradient.

UNIT III LASER METALLURGY 9

Laser surface treatment – transformation hardening - rapid quenching – Methods to obtain desired penetration depths – Laser surface alloying – Laser surface cladding – shock hardening – advantages of laser surface treatment – industrial applications-Experimental set up.

UNIT IV LASER CUTTING AND DRILLING 9

Laser instrumentation for cutting and drilling – cut quality and process characteristics – methods of cutting – practical performance – process variations – industrial applications of Laser cutting and drilling.

UNIT V LASER WELDING 9

Process mechanisms (Key hole and Plasmas) – operating characteristics – process variations – imperfections- industrial applications –recent developments

TOTAL : 45 PERIODS

TEXT BOOK:

1. Wilson J., Hawkes J. F. B.,"Optoelectronics – An introduction", Prentice Hall of India Pvt. Ltd., New Delhi, 1996.

REFERENCES:

1. John C. Ion, "Laser Processing of Engineering Materials", Elsevier Butter Worth-Heinemann, Burlington, 2005.
2. Steen W. M., "Laser Materials Processing", Springer Verlag,3 rd edition U.K., 2003.
3. Rykalin, Ugloo A., Kokona A.,"Laser and Electron Beam Material Processing", Handbook, MIR Publishers, 1987.
4. Reddy J. F., "High power laser applications", Academic Press, 1977.
5. Duley W. W., "Laser Processing and Analysis of Materials"; Plenum Press, New York, 1983.

ML9035 CRYOGENIC TREATMENT OF MATERIALS LT P C
3 0 0 3

OBJECTIVE

Students are to study and become familiar with this very specialized form of material treatment at low temperature.

UNIT I INTRODUCTION 9

Insight on Cryogenics-Basics, Properties of Cryogenic fluids, Liquefaction Cycles - Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles. Inversion Curve – Joule Thomson Effect. Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claude Cycle, Dual Cycle.

UNIT II CRYOCOOLERS 9

Cryocooler requirement- Space based communication, Surveillance Imaging, Military applications, Impact of regenerative materials on cooler performance, Impact of materials properties on cryocooler performance-Materials used, Thermal Properties, Electrical Properties, and Mechanical properties.

UNIT III CRYOGENIC PROCESSING 9

Historical Development of Cryogenic Treatment, Cryogenic for Ferrous Metals, Need for cryogenic treatment, Types of low temperature treatment and processors, Benefits of cryogenic treatment-Wear resistance, Stress Relieving, Mechanism for cryogenic treatment, Characterization of cryogenically processed materials.

UNIT IV MATERIALS ENGINEERING 9

Trends and advances in cryogenic materials, History and applications of nonmetallic

materials, Understanding properties and fabrication processes of superconducting Nb_3Sn wires, High temperature superconductors.

UNIT V APPLICATIONS 9

Applications of Cryogenics in Space Programs, Superconductivity, Medical applications, Food Preservation-Individual Quick Freezing.

TOTAL : 45 PERIODS

TEXT BOOK:

1. Randall F. Barron, "Cryogenic Systems", McGraw-Hill, 1985.

REFERENCES:

1. William E. Bryson," Cryogenics", H Anser Gardner Publications,1999.
2. Klaus D. Timmerhaus and Richard P. Reed," Cryogenic Engineering", Springer, 2007.
3. Scott R. B.," Cryogenic Engineering", Van Nostrand and Co., 1962.
4. Jha, A.R.," Cryogenic Technology and Applications", Butterworth-Heinemann, 2006

ML9036 MATERIALS HANDLING SYSTEM L T P C
3 0 0 3

AIM

This subject is expected to imbibe knowledge on materials handling system which are essential for industries ranging from heavy works to semiconductor devices manufacturing.

OBJECTIVE

This course is practically oriented for the needs of industry. Students are to master materials handling systems for flow, transport and assembly operations in production lines.

UNIT I PLANT LAYOUT AND MATERIAL HANDLING PRINCIPLE 9

Plant Layout: Need for layout planning, Layout objectives and Determinants, Types of Layout, Computer Aided Plant Layout Planning: CRAFT, ALDEP, and CORELAP.
Material Handling objective, benefits of better handling, relationship between layout and material handling, principles of Material Handling, Unit load concept, Material Handling Types, Equipment selection and Applications.

UNIT II MECHANIZED ASSEMBLY 9

Principles and operating characteristics of part feeders such as vibratory bowl feeder, Reciprocating tube hopper feeder, Centrifugal hopper feeder, Center board hopper feeder, Orientation of parts : In bowl and out bowl tooling, different types of Escapement, Transfer Systems and Indexing Mechanism.

UNIT III MATERIAL TRANSPORT AND STORAGE SYSTEM 9

Industrial trucks: non powered and powered industrial trucks, AGVS : Types, Vehicle guidance technology, traffic and safety, Monorail and other rail guided vehicles, types of cranes, hoists and elevators.

UNIT IV CONVEYORS TYPES AND STORAGE SYSTEM 9

Belt conveyors, Slat conveyors, Gravity conveyors, Apron, escalators, pneumatic

conveyors, screw conveyors, vibrating conveyor, Analysis of material transport system. Automated Storage system, AS/RS System, Carousel storage system, WIP storage system.

UNIT V PACKAGING AND ECONOMIC ANALYSIS OF MATERIAL HANDLING EQUIPMENTS 9

Packaging: Functions, materials, palletizing, packaging equipments.Economic Analysis of material handling equipment: Factors in material handling selection, break event analysis, equipment operating cost per unit distance, work volume analysis – illustrative problems, productivity / indicator ratios.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Jon R. Immer, "Material Handling", Mc-Graw Hill Company, 1950
2. Sharma, S. C., "Materials Management and Materials Handling " Khanna Publishers.,2004.
3. Dr.K.C.Arora, Vikas . V.Shinde,"Aspects of Materials Handling", Laxmi publishers, 2007.

REFERENCES

1. K.H.E. Kroemer, Karl Kroemer,"Ergonomics Design for Materials Handling systems", CRC Press, 1997.
2. Raymond A.Kulwiec, "Materials handling – Handbook", A Wiley – Inderscience publication" 1984.
3. Apple, J. M.," Plant Layout and material handling system design", John Wiley & Sons, 1995.
4. Francis, L. R. and White J. A., "Facility Layout and Location: An analytical approach", Prentice Hall, Englewood Cliffs, N.J, 1998
5. Alexandrov, M. P.," Material Handling Equipment", MIR Publishers, Moscow, 1981.
6. Rudenko. N," Material Handling Equipment", MIR Publishers, 1981
7. Tompkins, J. and White, J. A., "Facilities Planning", John Wiley & Sons, 2000.

ML9037 PRINCIPLES OF METAL CUTTING L T P C
3 0 0 3

OBJECTIVE

Students are to learn about metal cutting operations from the theoretical and practical perspective.

UNIT I CUTTING TOOL NOMENCLATURE 9

Single point tool-significance of the various angles - Machine reference system- normal tool reference system- ORS – interrelation between different tool nomenclatures - Nomenclature of drills, milling cutters and broaches

UNIT II CHIP FORMATION MECHANISM AND FORCES IN MACHINING 10

Orthogonal and oblique cutting - Mechanisms of formation of chips-types of chips - Merchant's circle diagram-Force and Velocity relationship, shear plane angle, Energy considerations in matching-Ernst Merchant's theory of shear angle relationship - Forces in turning, drilling, milling and grinding- specific cutting pressure-specific horse power-construction and principle of operation of tool dynamometers for turning, drilling and

milling.

UNIT III THERMAL ASPECTS IN MACHINING, TOOL WEAR AND TOOL LIFE 10

Sources of heat generation in machining heat in PSDZ and SDZ – heat flow in cutting tools temperature measurement techniques in machining, Functions of cutting fluid - characteristics of cutting fluid-types - application of cutting fluids - Tool wear, type of tool failure - mechanisms, tool life equation- tool life analysis - machinability - chatter in machining.

UNIT IV CUTTING TOOL MATERIALS 8

Requirements of tool materials-properties of HSS - advances in tool materials- carbides and coated carbides, ceramic, cermets, CBN, Diamond, PCD - ISO-specifications for inserts and tool holders - -Need for chip breakers – types of chip breakers

UNIT V MODELING OF METAL CUTTING 8

Introduction to modeling – empirical models – mechanistic models – FEA based models – artificial intelligence based models for turning, milling and drilling

TOTAL : 45 PERIODS

REFERENCES:

1. Edward M. Trent and Paul K. Wright “Metal Cutting” Butterworth-Heinemann; 4th edition 2000.
2. Boothroyd, G., "Fundamentals of Metal Machining and Machine Tools", McGraw-Hill Co., 1975.
3. Sadasiavm, T.A. and Sarathy, D., “Cutting tools for productive machining” WIDIA India limited, Bangalore, 1999.
4. Milton C. Shaw,“ Metal Cutting Principles”, Oxford University Press, 2nd edition 2004

GE9021 PROFESSIONAL ETHICS IN ENGINEERING L T P C
3 0 0 3

AIM

To sensitize the engineering students on blending both technical and ethical responsibilities.

OBJECTIVES

- Identify the core values that shape the ethical behavior of an engineer.
- Utilize opportunities to explore one’s own values in ethical issues.
- Become aware of ethical concerns and conflicts.
- Enhance familiarity with codes of conduct.
- Increase the ability to recognize and resolve ethical dilemmas.

UNIT I ENGINEERING ETHICS 9

Senses of ‘Engineering Ethics’ – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg’s theory – Gilligan’s theory – Consensus and Controversy – Professions and Professionalism – Professional Ideals and Virtues – Uses of Ethical Theories.

UNIT II ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as Experimentation – Engineers as responsible Experimenters – Research Ethics - Codes of Ethics – Industrial Standards - A Balanced Outlook on Law – The Challenger Case Study

UNIT III ENGINEER'S RESPONSIBILITY FOR SAFETY 9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis – Reducing Risk – The Government Regulator's Approach to Risk - Chernobyl Case Studies and Bhopal

UNIT IV RESPONSIBILITIES AND RIGHTS 9

Collegiality and Loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) - Discrimination

UNIT V GLOBAL ISSUES 9

Multinational Corporations – Business Ethics - Environmental Ethics – Computer Ethics - Role in Technological Development – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Honesty – Moral Leadership – Sample Code of Conduct

TOTAL : 45 PERIODS

TEXT BOOKS

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, New York (2005).
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering Ethics Concepts and Cases", Thompson Learning, (2000).

REFERENCES

1. Charles D Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, (1999).
2. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, (2003)
3. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, (2001)
4. Prof. (Col) P S Bajaj and Dr. Raj Agrawal, "Business Ethics – An Indian Perspective", Biztantra, New Delhi, (2004)
5. David Ermann and Michele S Shauf, "Computers, Ethics and Society", Oxford University Press, (2003)

ML9038 COMPUTER AIDED DESIGN LT P C
3 0 0 3

OBJECTIVES

Study CAD and its application for drafting, modeling and as a basis for FEM analysis

UNIT I INTRODUCTION 6

Product Cycle – Design process – CAD Hardware – Mainframe, Mini Workstation, Micro computer Based systems, Input and Output Devices – Software – Operating System, Geometric Modeling capabilities – Hardware Integration and Networking.

UNIT II COMPUTER GRAPHICS 10

Two dimensional transformations – Transformation of Straight Lines- Rotation – Reflection – Scaling – Combined Transformations – Translations and homogeneous co-ordinates – Three dimensional transformations – Scaling –Rotation – Reflection – Translation – Projections – Orthographic and Isometric Projections – Clipping – Hidden Line and Surface Removal.

UNIT III GEOMETRIC MODEL 10

Geometrical Modeling – wire frame models – entities – surface models- entities- solid models –Entities – Boundary Representation (B-Rep)- Constructive Solid Geometry (CSG) – Sweep and Analytical Solid Modeling.

UNIT IV CAD STANDARDS 7

Graphical Kernel System(GKS), Programmers Hierarchical Interface for Graphics(PHIGS), Initial Graphics Exchange Specification(IGES), Standard for Exchange of product Model Data(STEP), Drawing Exchange Format(DXF), Dimensional Measurement Interface Specification(DMIS) – Introduction to Drafting and Modeling Systems.

UNIT V FINITE ELEMENT ANALYSIS 12

Introduction – procedures – Element types – Nodal approximation – Element matrices, vectors and equations – Global connectivity – Assembly – Boundary conditions – Solutions techniques – Interfaces to CAD – Introduction to packages. Case Studies - Applications.

TOTAL : 45 PERIODS

TEXT BOOK:

1. D.F.Rogers and J.A.Adams," Mathematical Elements in Computer Graphics", McGraw – Hill Book Company, NewYork, 1976.
2. Ibrahim Zeid, " CAD –CAM Theory and Practice", Tata McGraw Hill Publishing Co.Ltd., 1991.

REFERENCES:

1. P.Radhakrishnan and C.P Kothandaraman," Computer Graphics and Design", Dhanpat Rai and Sons, NewDelhi, 1991.
2. E.Dieter George," Engineering Design", McGraw – Hill International Edition, 1991.
3. P.Radhakrishnan and S.Subramanyan," CAD/CAM/CIM", Wiley Eastern Ltd., New Age International Ltd., 1994.
4. Groover and Zimmers," CAD/CAM: Computer Aided Design and Manufacturing", Prentice Hall of India, New Delhi, 1994.
5. V.Ramamurthi," Computer Aided Mechanical Design and Analysis", Tata McGraw Hill Publishing Co Ltd., 1998.

ML9039 POLYMER RHEOLOGY LT P C
3 0 0 3

OBJECTIVE

Students have studied the fundamentals of plastics from the point of structure and properties. In this course the rheological aspects of production should be understood in detail.

UNIT I INTRODUCTION TO POLYMER RHEOLOGY 9

Rheology- Classification of fluid behaviour – Elastic , viscous and viscoelastic – Newtonian and non-newtonian fluids – Pseudo plastic and dilatant fluids – Stress, strain – Rate of strain/shear – Relation between them – Viscosity of Polymer Systems – MFI.

UNIT II PRINCIPLES OF POLYMER RHEOLOGY 9

Rheological systems – Plasticity – Elastic behaviour – Stress strain curves – Viscoelastic behaviour of polymer melts – Bingham plastic fluids – Viscoplastic fluids – Thixotropic & Rheopectic – Viscoelastic fluids – Weissenberg effect – Die swell

UNIT III FACTORS INFLUENCING POLYMER RHEOLOGY 9

Physical factors – Effect of Temperature – Pressure – Shear rate – Shear stress – Shear induced crystallization – Molecular Parameters – Molecular weight – MWD – Concentration – Crosslinking – Crystallinity – Copolymerization – Grafting – Branching-Blending -Fillers – Plasticizers – Ionic Polymers.

UNIT IV RHEOMETRY AND TESTING METHODS 9

Rheological measurements – Capillary viscometer – Rotary rheometer – Cone & Plate (C-P), Plate-Plate (P-P) and concentric cylindrical viscometer – Static and Dynamic Tests – Mechanical models of viscoelastic systems – Maxwell & VOIGT Kelvin – Polymer Viscoelasticity.

UNIT V RHEOLOGY IN PLASTICS AND RUBBER PROCESSING 9

Rheology of two roll mill & calendar – Internal mixer – Extrusion – Rubber extruders – Vented & Co-extrusion – Moulding & Forming operations – Injection, Compression, Blow, Film Blowing, Sheet Extrusion – Melt flow through dies – Die well – Melt fracture.

TOTAL : 45 PERIODS

TEXT BOOK:

1. Gupta, B. K., “Applied Rheology in Polymer Processing”, Asian Books Pvt. Ltd. New Delhi 2005.

REFERENCES:

1. Faith A. Morrison,“ Understanding Rheology”, Oxford University Press, 2001
2. Bird,R.B., Stewart,W.E. and Lightfoot, E. N. (BSL),“ Transport Phenomena”, John Wiley & Sons: New York, 1960.
3. Ferry, J.D., “ Viscoelastic Properties of Polymers”, John Wiley & Sons, Inc. New York, 1980.
4. Bird, R.B., Armstrong, R.C. and Hassager,O., “Dynamics of Polymer Liquids, Volume 1: Fluid Mechanics”, Wiley: New York, 1987.

ML9042 FRACTURE MECHANICS & FAILURE ANALYSIS LT P C
3 0 0 3

OBJECTIVE

After completion of this course, students should have been understood causes of fracture and failure on the basis of fracture mechanics.

UNIT I ELEMENTS OF SOLID MECHANICS 5

The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation - limit analysis.

UNIT II STATIONARY CRACK UNDER STATIC LOADING 10

Two dimensional elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation - plastic zone size – Dugdaale model – J integral and its relation to crack opening displacement.

UNIT III ENERGY BALANCE AND CRACK GROWTH 8

Griffith analysis – Linear Fracture Mechanics-Crack Opening displacement – Dynamic energy balance – crack arrest.

UNIT IV FATIGUE CRACK GROWTH CURVE 10

Empirical Relation describing crack growth by fatigue – Life calculations for a given load amplitude – effects of changing the load spectrum – Effects of Environment.

UNIT V ELEMENTS OF APPLIED FRACTURE MECHANICS 12

Examples of crack-growth Analysis for cyclic loading - leak before break – crack Initiation under large scale yielding – Thickness as a Design parameter – crack instability in Thermal or Residual – stress fields.

TOTAL : 45 PERIODS

TEXT BOOK:

1. Norman E. Dowling," Mechanical Behavior of Materials", 2nd Edition, Prentice-Hall 1999.

REFERENCES:

1. David Broek, "Elementary Engineering Fracture Mechanics", Fifthoff and Noerdhoff International Publisher, 1978.
2. Kare Hellan,"Introduction of Fracture Mechanics", McGraw-Hill Book Company, 1985.
3. Preshant Kumar, "Elements of Fracture Mechanics", Wheeler Publishing, 1999.
4. Suresh, S.," Fatigue of Materials", Cambridge University Press, 2 nd edition, 1998.
5. Ashok Saxena," Nonlinear Fracture Mechanics for Engineers", CRC Press, 1998.
6. Schive, Jaap, "Fatigue of Structures and Materials", Kluwer Academic Publishers, 2001.

ME9032 COMPUTATIONAL FLUID DYNAMICS L T P C
3 0 0 3

AIM

To impart the knowledge of numerical techniques to the solution of fluid dynamics and heat transfer problems.

OBJECTIVES

- To introduce Governing Equations of vicous fluid flows
- To introduce numerical modeling and its role in the field of fluid flow and heat transfer
- To enable the students to understand the various discretization methods, solution procedures and turbulence modeling.
- To create confidence to solve complex problems in the field of fluid flow and heat transfer by using high speed computers.

PREREQUISITE:
Fundamental Knowledge of partial differential equations, Heat Transfer and Fluid Mechanics

UNIT I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 8
Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momemtum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

UNIT II FINITE DIFFERENCE METHOD 9
Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – solution methods for finite difference equations – Elliptic equations – Iterative solution Methods – Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations.

UNIT III FINITE VOLUME METHOD (FVM) FOR DIFFUSION 9
Finite volume formulation for steady state One, Two and Three -dimensional diffusion problems. One dimensional unsteady heat conduction through Explicit, Crank – Nicolson and fully implicit schemes.

UNIT IV FINITE VOLUME METHOD FOR CONVECTION DIFFUSION 10
Steady one-dimensional convection and diffusion – Central, upwind differencing schemes-properties of discretization schemes – Conservativeness, Boundedness, Trasnportiveness, Hybrid, Power-law, QUICK Schemes.

UNIT V CALCULATION FLOW FIELD BY FVM 9
Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants. Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. T. J. Chung, Computational Fluid Dynamics, Cambridge University, Press, 2002.\
2. Versteeg, H. K., and Malalasekera, W., An Introduction to Computational Fluid Dynamics: The finite volume Method, Longman, 1998.
3. Ghoshdastidar, P. S., Computer simulation of flow and heat transfer, Tata McGraw Hill Publishing Company Ltd., 1998.

REFERENCES:

1. Patankar, S.V. Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, 2004.
2. Muralidhar, K., and Sundararajan, T., computationsl Fluid Flow and Heat Transfer, Narosa Publishing House, NewDelhi, 1995.
3. Ghoshdastidar P.S., Heat Transfer, Oxford Unversity Press, 2005.
4. Prodip Niyogi, Chakrabarty .S.K., Laha .M.K. Introduction to Computational Fluid Dynamics, Pearson Education, 2005.
5. Introduction to Computational Fluid Dynamics Anil W. Date Cambridge University Press, 2005.

IE9401 **DESIGN OF EXPERIMENTS** **L T P C**
3 1 0 4

OBJECTIVES

To impart knowledge on statistical tools for industrial experimentation related to selection of product and process parameters in various environments.

UNIT I CONCEPTS AND TERMINOLOGY 5

Review of hypothesis testing – P Value, "t" Vs paired "t" test, simple comparative experiment, planning of experiment – steps. Terminology - factors, levels, variables, Design principles – replication, randomization, blocking, confounding, Analysis of variance, sum of squares, degrees of freedom.

UNIT II SINGLE FACTOR EXPERIMENTS 10

Completely randomized design, Randomized block design, effect of coding the observations, Latin Square design, orthogonal contrasts, comparison of treatment means – Duncan's multiple range test, Newman- Keuel's test, Fisher's LSD test, Tukey's test.

UNIT III FACTORIAL EXPERIMENTS 10

Main and interaction effects, Rules for sum of squares and expected mean square, two and three factor full factorial design, 2k designs with two and three factors, Yate's algorithm, practical applications.

UNIT IV SPECIAL EXPERIMENTAL DESIGNS 10

Blocking and confounding in 2k design, nested design, split – plot design, two level fractional factorial design, fitting regression models, introduction to response surface methods.

UNIT V TAGUCHI TECHNIQUES 10

Introduction, Orthogonal designs, data analysis using ANOVA and response graph, parameter design – noise factors, objective functions (S/N ratios), multi-level factor OA designs, applications.

TOTAL : 60 PERIODS

TEXT BOOK:

1. Douglus C. Montgomery, Design and Analysis of Experiments, John Wiley & Sons, 2005

REFERENCES:

1. Angela M. Dean and Daniel Voss, Design and Analysis of Experiments, Springer texts in Statistics, 2000.
2. Philip J. Ross, Taguchi Techniques for Quality Engineering, Prentice Hall, 1989.