ANNA UNIVERSITY, CHENNAI

AFFILIATED INSTITUTIONS

R - 2013

B.E. MATERIAL SCIENCE AND ENGINEERING

I – VIII SEMESTERS CURRICULUM AND SYLLABUS

SEMESTER I

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	HS6151	Technical English – I	3	1	0	4
2.	MA6151	Mathematics – I	3	1	0	4
3.	PH6151	Engineering Physics – I	3	0	0	3
4.	CY6151	Engineering Chemistry – I	3	0	0	3
5.	GE6151	Computer Programming	3	0	0	3
6.	GE6152	Engineering Graphics	2	0	3	4
PRACTICALS						
7.	GE6161	Computer Practices Laboratory	0	0	3	2
8.	GE6162	Engineering Practices Laboratory	0	0	3	2
9.	GE6163	Physics and Chemistry Laboratory - I	0	0	2	1
		TOTAL	**17**	**2**	**11**	**26**

SEMESTER II

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	HS6251	Technical English – II	3	1	0	4
2.	MA6251	Mathematics – II	3	1	0	4
3.	PH6251	Engineering Physics – II	3	0	0	3
4.	CY6251	Engineering Chemistry – II	3	0	0	3
5.	GE6252	Basic Electrical and Electronics Engineering	4	0	0	4
6.	GE6253	Engineering Mechanics	3	1	0	4
PRACTICALS						
7.	GE6261	Computer Aided Drafting and Modeling Laboratory	0	1	2	2
8.	GE6262	Physics and Chemistry Laboratory - II	0	0	2	1
		TOTAL	**19**	**4**	**4**	**25**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MA6351	Transforms and Partial Differential Equations	3	1	0	4
2.	ML6301	Casting and Machining Processes	3	0	0	3
3.	ML6302	Thermodynamics and Kinetics of Materials	3	1	0	4
4.	CE6306	Strength of Materials	3	1	0	4
5.	ML6303	Materials Structure and Properties	3	0	0	3
6.	ML6304	Processing of Iron and Steel	3	0	0	3
PRACTICAL						
7.	CE6315	Strength of Materials Laboratory	0	0	3	2
8.	ML6311	Microstructure Analysis Laboratory	0	0	3	2
		TOTAL	**18**	**3**	**6**	**25**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	ML6401	Mechanical Behaviour of Materials	3	1	0	4
2.	ME6504	Metrology and Measurements	3	0	0	3
3.	ML6402	Non-Ferrous Metallurgy	3	0	0	3
4.	ML6403	Powder Metallurgy	3	0	0	3
5.	ML6404	Solid State Physics	3	1	0	4
6.	ML6405	Phase Transformations	3	0	0	3
PRACTICAL						
7.	ME6513	Metrology and Measurements Laboratory	0	0	3	2
8.	ME6465	Manufacturing Technology Laboratory	0	0	3	2
9.	ML6412	Foundry and Powder Metallurgy Laboratory	0	0	3	2
		TOTAL	**18**	**2**	**9**	**26**

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	ML6501	Theory and Applications of Metal Forming	3	0	0	3
2.	ML6502	Material Aspects in Design	3	1	0	4
3.	ML6503	Characterization of Materials	3	0	0	3
4.	ML6504	Heat Treatment of Metals and Alloys	3	0	0	3
5.	ML6505	Welding Metallurgy	3	0	0	3
6.	ML6506	Corrosion and Surface Engineering	3	0	0	3
PRACTICAL						
7.	ML6511	Heat Treatment Laboratory	0	0	3	2
8.	ML6512	Metal Forming and Welding Analysis Laboratory	0	0	3	2
9.	ML6513	Presentation Skills and Technical Seminar	0	0	2	1
		TOTAL	**18**	**1**	**8**	**24**

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	ML6601	Polymer Process Engineering	3	0	0	3
2.	ML6602	Creep and Fatigue Behavior of Materials	3	0	0	3
3.	GE6351	Environmental Science and Engineering	3	0	0	3
4.	ML6603	Composite Materials	3	0	0	3
5.	MG6091	Industrial Management	3	0	0	3
6.		Elective – I	3	0	0	3
PRACTICAL						
7.	ML6611	Composite Materials Laboratory	0	0	3	2
8.	GE6674	Communication and Soft Skills - Laboratory Based	0	0	4	2
9.	ML6612	Advanced Materials Characterization Laboratory	0	0	3	2
		TOTAL	**18**	**0**	**10**	**24**

SEMESTER VII

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	GE6757	Total Quality Management	3	0	0	3
2.	ML6701	Computer Applications in Materials Science	3	1	0	4
3.	ML6702	Non Destructive Materials Evaluation	3	0	0	3
4.	ML6703	Nanostructured Materials	3	0	0	3
5.		Elective - II	3	0	0	3
6.		Elective - III	3	0	0	3
PRACTICAL						
7.	MF6711	Computer Aided Simulation and Analysis Laboratory	0	0	3	2
8.	ML6711	Comprehension	0	0	2	1
9.	ML6712	Material Design Project	0	0	4	2
10.	ML6713	Industrial / Field Training	0	0	0	1
		TOTAL	**18**	**1**	**9**	**25**

SEMESTER VIII

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.		Elective IV	3	0	0	3
2.		Elective V	3	0	0	3
PRACTICAL						
3.	ML6811	Project Work	0	0	12	6
		TOTAL	6	**0**	**12**	**12**

TOTAL NUMBER OF CREDITS TO BE EARNED FOR AWARD OF THE DEGREE = 187

LIST OF ELECTIVES FOR MATERIAL SCIENCE AND ENGINEERING
SEMESTER VI

ELECTIVE I

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	ML6001	Modern Manufacturing Process	3	0	0	3
2.	GE6075	Professional Ethics in Engineering	3	0	0	3
3.	ML6002	Bio and Smart Materials	3	0	0	3
4.	ML6003	Principle and Application of Extractive Metallurgy	3	0	0	3

SEMESTER VII

ELECTIVE II

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	ML6004	Metallurgy of Tool Materials and Special Steels	3	0	0	3
2.	ML6005	Laser Processing of Materials	3	0	0	3
3.	ML6006	Ceramics and Refractory Materials	3	0	0	3
4.	ML6007	Automotive Materials	3	0	0	3

ELECTIVE III

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	ML6008	Industrial Tribology	3	0	0	3
2.	ML6009	Cryogenic Treatment of Materials	3	0	0	3
3.	ML6010	Fuel, Furnaces and Refractories	3	0	0	3
4.	ML6011	Nuclear Reactor Materials	3	0	0	3

SEMESTER VIII

ELECTIVE IV

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	ML6012	Fracture Mechanics and Failure Analysis	3	0	0	3
2.	ML6013	Engineering Economics and Cost Estimation	3	0	0	3
3.	ML6014	Finite Element Analysis in Materials Engineering	3	0	0	3
4.	ML6015	Alloy Casting Processes	3	0	0	3

ELECTIVE V

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	ML6016	Energy Storage Devices and Fuel Cells	3	0	0	3
2.	ML6017	Semiconductor Optoelectronic Materials and Devices	3	0	0	3
3.	ML6018	Modeling and Simulation in Materials Engineering	3	0	0	3

HS6151 **TECHNICAL ENGLISH – I** **L T P C**
3 1 0 4

OBJECTIVES:

- To enable learners of Engineering and Technology develop their basic communication skills in English.
- To emphasize specially the development of speaking skills amongst learners of Engineering and Technology.
- To ensure that learners use the electronic media such as internet and supplement the learning materials used in the classroom.
- To inculcate the habit of reading and writing leading to effective and efficient communication.

UNIT I **9+3**

Listening - Introducing learners to GIE - Types of listening - Listening to audio (verbal & sounds); Speaking - Speaking about one's place, important festivals etc. – Introducing oneself, one's family / friend; Reading - Skimming a reading passage – Scanning for specific information - Note-making; Writing - Free writing on any given topic (My favourite place / Hobbies / School life, etc.) - Sentence completion - Autobiographical writing (writing about one's leisure time activities, hometown, etc.); Grammar - Prepositions - Reference words - Wh-questions - Tenses (Simple); Vocabulary - Word formation - Word expansion (root words / etymology); E-materials - Interactive exercises for Grammar & Vocabulary - Reading comprehension exercises - Listening to audio files and answering questions.

UNIT II **9+3**

Listening - Listening and responding to video lectures / talks; Speaking - Describing a simple process (filling a form, etc.) - Asking and answering questions - Telephone skills – Telephone etiquette; Reading – Critical reading - Finding key information in a given text - Sifting facts from opinions; Writing - Biographical writing (place, people) - Process descriptions (general/specific) - Definitions - Recommendations – Instructions; Grammar - Use of imperatives - Subject-verb agreement; Vocabulary - Compound words - Word Association (connotation); E-materials - Interactive exercises for Grammar and Vocabulary - Listening exercises with sample telephone conversations / lectures – Picture-based activities.

UNIT III **9+3**

Listening - Listening to specific task - focused audio tracks; Speaking - Role-play – Simulation - Group interaction - Speaking in formal situations (teachers, officials, foreigners); Reading - Reading and interpreting visual material; Writing - Jumbled sentences - Coherence and cohesion in writing - Channel conversion (flowchart into process) - Types of paragraph (cause and effect / compare and contrast / narrative / analytical) - Informal writing (letter/e-mail/blogs) - Paraphrasing; Grammar - Tenses (Past) - Use of sequence words - Adjectives; Vocabulary - Different forms and uses of words, Cause and effect words; E-materials - Interactive exercises for Grammar and Vocabulary - Excerpts from films related to the theme and follow up exercises - Pictures of flow charts and tables for interpretations.

UNIT IV **9+3**

Listening - Watching videos / documentaries and responding to questions based on them; Speaking - Responding to questions - Different forms of interviews - Speaking at different types of interviews; Reading - Making inference from the reading passage - Predicting the content of a reading passage; Writing - Interpreting visual materials (line graphs, pie charts etc.) - Essay writing – Different types of essays; Grammar - Adverbs – Tenses – future time reference; Vocabulary - Single word substitutes - Use of abbreviations and acronyms; E-materials - Interactive exercises for Grammar and Vocabulary - Sample interviews - film scenes - dialogue writing.

UNIT V **9+3**

Listening - Listening to different accents, Listening to Speeches/Presentations, Listening to broadcast and telecast from Radio and TV; Speaking - Giving impromptu talks, Making presentations on given topics; Reading - Email communication - Reading the attachment files having a poem/joke/proverb - Sending their responses through email; Writing - Creative writing, Poster making; Grammar - Direct and indirect speech; Vocabulary - Lexical items (fixed / semi fixed expressions); E-materials - Interactive exercises for Grammar and Vocabulary - Sending emails with attachment – Audio / video excerpts of different accents - Interpreting posters.

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

Learners should be able to

- speak clearly, confidently, comprehensibly, and communicate with one or many listeners using appropriate communicative strategies.
- write cohesively and coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas logically on a topic.
- read different genres of texts adopting various reading strategies.
- listen/view and comprehend different spoken discourses/excerpts in different accents

TEXTBOOKS:

1. Department of English, Anna University. Mindscapes: English for Technologists and Engineers. Orient Blackswan, Chennai. 2012
2. Dhanavel, S.P. English and Communication Skills for Students of Science and Engineering. Orient Blackswan, Chennai. 2011

REFERENCES:

1. Raman, Meenakshi & Sangeetha Sharma. Technical Communication: Principles and Practice. Oxford University Press, New Delhi. 2011.
2. Regional Institute of English. English for Engineers. Cambridge University Press, New Delhi. 2006.
3. Rizvi, Ashraf. M. Effective Technical Communication. Tata McGraw-Hill, New Delhi. 2005
4. Rutherford, Andrea. J Basic Communication Skills for Technology. Pearson, New Delhi. 2001.
5. Viswamohan, Aysha. English for Technical Communication. Tata McGraw-Hill, New Delhi. 2008.

EXTENSIVE Reading (Not for Examination)

1. Kalam, Abdul. Wings of Fire. Universities Press, Hyderabad. 1999.

WEBSITES:

1. http://www.usingenglish.com
2. http://www.uefap.com

TEACHING METHODS:

- Lectures
- Activities conducted individually, in pairs and in groups like self introduction, peer introduction, group poster making, grammar and vocabulary games, etc.
- Discussions
- Role play activities
- Short presentations
- Listening and viewing activities with follow up activities like discussion, filling up worksheets, writing exercises (using language lab wherever necessary/possible) etc.

EVALUATION PATTERN:

Internal assessment: 20%

3 tests of which two are pen and paper tests and the other is a combination of different modes of assessment like

- Project
- Assignment
- Reviews
- Creative writing
- Poster making, etc.

All the four skills are to be tested with equal weightage given to each.

- ✓ Speaking assessment: Individual speaking activities, Pair work activities like role play, Interview, Group discussions
- ✓ Reading assessment: Reading passages with comprehension questions graded from simple to complex, from direct to inferential
- ✓ Writing assessment: Writing paragraphs, essays etc. Writing should include grammar and vocabulary.
- ✓ Listening/Viewing assessment: Lectures, dialogues, film clippings with questions on verbal as well as audio/visual content.

End Semester Examination: 80%

MA6151	**MATHEMATICS – I**	**L T P C**
		3 1 0 4

OBJECTIVES:

- To develop the use of matrix algebra techniques this is needed by engineers for practical applications.
- To make the student knowledgeable in the area of infinite series and their convergence so that he/ she will be familiar with limitations of using infinite series approximations for solutions arising in mathematical modeling.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To introduce the concepts of improper integrals, Gamma, Beta and Error functions which are needed in engineering applications.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.

UNIT I MATRICES 9+3

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of eigenvalues and eigenvectors – Statement and applications of Cayley-Hamilton Theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II SEQUENCES AND SERIES 9+3

Sequences: Definition and examples – Series: Types and Convergence – Series of positive terms – Tests of convergence: Comparison test, Integral test and D'Alembert's ratio test – Alternating series – Leibnitz's test – Series of positive and negative terms – Absolute and conditional convergence.

UNIT III APPLICATIONS OF DIFFERENTIAL CALCULUS 9+3

Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelopes - Evolute as envelope of normals.

UNIT IV DIFFERENTIAL CALCULUS OF SEVERAL VARIABLES 9+3

Limits and Continuity – Partial derivatives – Total derivative – Differentiation of implicit functions – Jacobian and properties – Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT V MULTIPLE INTEGRALS 9+3

Double integrals in cartesian and polar coordinates – Change of order of integration – Area enclosed by plane curves – Change of variables in double integrals – Area of a curved surface - Triple integrals – Volume of Solids.

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

- This course equips students to have basic knowledge and understanding in one fields of materials, integral and differential calculus.

TEXT BOOKS:

1. Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", Eighth Edition, Laxmi Publications Pvt Ltd., 2011.
2. Grewal. B.S, "Higher Engineering Mathematics", 41 st Edition, Khanna Publications, Delhi, 2011.

REFERENCES:

1. Dass, H.K., and Er. Rajnish Verma," Higher Engineering Mathematics", S. Chand Private Ltd., 2011.
2. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2012.
3. Peter V. O'Neil," Advanced Engineering Mathematics", 7th Edition, Cengage learning, 2012.
4. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 2008.
5. Sivarama Krishna Das P. and Rukmangadachari E., "Engineering Mathematics", Volume I, Second Edition, PEARSON Publishing, 2011.

PH6151 ENGINEERING PHYSICS – I L T P C
3 0 0 3

OBJECTIVES:

- To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

UNIT I CRYSTAL PHYSICS 9

Lattice – Unit cell – Bravais lattice – Lattice planes – Miller indices – d spacing in cubic lattice – Calculation of number of atoms per unit cell – Atomic radius – Coordination number – Packing factor for SC, BCC, FCC and HCP structures – Diamond and graphite structures (qualitative treatment) - Crystal growth techniques –solution, melt (Bridgman and Czochralski) and vapour growth techniques (qualitative)

UNIT II PROPERTIES OF MATTER AND THERMAL PHYSICS 9

Elasticity- Hooke's law - Relationship between three modulii of elasticity (qualitative) – stress -strain diagram – Poisson's ratio –Factors affecting elasticity –Bending moment – Depression of a cantilever –Young's modulus by uniform bending- I-shaped girders

Modes of heat transfer- thermal conductivity- Newton's law of cooling - Linear heat flow – Lee's disc method – Radial heat flow – Rubber tube method – conduction through compound media (series and parallel)

UNIT III QUANTUM PHYSICS 9

Black body radiation – Planck's theory (derivation) – Deduction of Wien's displacement law and Rayleigh – Jeans' Law from Planck's theory – Compton effect. Theory and experimental verification – Properties of Matter waves – G.P Thomson experiment -Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one dimensional box - Electron microscope - Scanning electron microscope - Transmission electron microscope.

UNIT IV ACOUSTICS AND ULTRASONICS 9

Classification of Sound- decibel- Weber–Fechner law – Sabine's formula- derivation using growth and decay method – Absorption Coefficient and its determination –factors affecting acoustics of buildings and their remedies.

Production of ultrasonics by magnetostriction and piezoelectric methods - acoustic grating -Non Destructive Testing – pulse echo system through transmission and reflection modes - A,B and C – scan displays, Medical applications - Sonogram

UNIT V PHOTONICS AND FIBRE OPTICS 9

Spontaneous and stimulated emission- Population inversion -Einstein's A and B coefficients - derivation. Types of lasers – Nd:YAG, CO_2, Semiconductor lasers (homojunction & heterojunction)- Industrial and Medical Applications.

Principle and propagation of light in optical fibres – Numerical aperture and Acceptance angle - Types of optical fibres (material, refractive index, mode) – attenuation, dispersion, bending - Fibre Optical Communication system (Block diagram) - Active and passive fibre sensors- Endoscope.

TOTAL: 45 PERIODS

OUTCOMES:

- The students will have knowledge on the basics of physics related to properties of matter, optics, acoustics etc., and they will apply these fundamental principles to solve practical problems related to materials used for engineering applications.

TEXT BOOKS:

1. Arumugam M. Engineering Physics. Anuradha publishers, 2010
2. Gaur R.K. and Gupta S.L. Engineering Physics. Dhanpat Rai publishers, 2009
3. Mani Naidu S. Engineering Physics, Second Edition, PEARSON Publishing, 2011.

REFERENCES:

1. Searls and Zemansky. University Physics, 2009
2. Mani P. Engineering Physics I. Dhanam Publications, 2011
3. Marikani A. Engineering Physics. PHI Learning Pvt., India, 2009
4. Palanisamy P.K. Engineering Physics. SCITECH Publications, 2011
5. Rajagopal K. Engineering Physics. PHI, New Delhi, 2011
6. Senthilkumar G. Engineering Physics I. VRB Publishers, 2011.

CY6151 ENGINEERING CHEMISTRY - I L T P C
3 0 0 3

OBJECTIVES:

- To make the students conversant with basics of polymer chemistry.
- To make the student acquire sound knowledge of second law of thermodynamics and

second law based derivations of importance in engineering applications in all disciplines.

- To acquaint the student with concepts of important photophysical and photochemical processes and spectroscopy.
- To develop an understanding of the basic concepts of phase rule and its applications to single and two component systems and appreciate the purpose and significance of alloys.
- To acquaint the students with the basics of nano materials, their properties and applications.

UNIT I POLYMER CHEMISTRY 9

Introduction: Classification of polymers – Natural and synthetic; Thermoplastic and Thermosetting. Functionality – Degree of polymerization. Types and mechanism of polymerization: Addition (Free Radical, cationic and anionic); condensation and copolymerization. Properties of polymers: Tg, Tacticity, Molecular weight – weight average, number average and polydispersity index. Techniques of polymerization: Bulk, emulsion, solution and suspension. Preparation, properties and uses of Nylon 6,6, and Epoxy resin.

UNIT II CHEMICAL THERMODYNAMICS 9

Terminology of thermodynamics - Second law: Entropy - entropy change for an ideal gas, reversible and irreversible processes; entropy of phase transitions; Clausius inequality. Free energy and work function: Helmholtz and Gibbs free energy functions (problems); Criteria of spontaneity; Gibbs-Helmholtz equation (problems); Clausius-Clapeyron equation; Maxwell relations – Van't Hoff isotherm and isochore(problems).

UNIT III PHOTOCHEMISTRY AND SPECTROSCOPY 9

Photochemistry: Laws of photochemistry - Grotthuss–Draper law, Stark–Einstein law and Lambert-Beer Law. Quantum efficiency – determination- Photo processes - Internal Conversion, Inter-system crossing, Fluorescence, Phosphorescence, Chemiluminescence and Photo-sensitization. Spectroscopy: Electromagnetic spectrum - Absorption of radiation – Electronic, Vibrational and rotational transitions. UV-visible and IR spectroscopy – principles, instrumentation (Block diagram only).

UNIT IV PHASE RULE AND ALLOYS 9

Phase rule: Introduction, definition of terms with examples, One Component System- water system - Reduced phase rule - Two Component Systems- classification – lead-silver system, zinc-magnesium system. Alloys: Introduction- Definition- Properties of alloys- Significance of alloying, Functions and effect of alloying elements- Ferrous alloys- Nichrome and Stainless steel – heat treatment of steel; Non-ferrous alloys – brass and bronze.

UNIT V NANOCHEMISTRY 9

Basics - distinction between molecules, nanoparticles and bulk materials; size-dependent properties. Nanoparticles: nano cluster, nano rod, nanotube(CNT) and nanowire. Synthesis: precipitation, thermolysis, hydrothermal, solvothermal, electrode position, chemical vapour deposition, laser ablation; Properties and applications

TOTAL :45 PERIODS

OUTCOMES:

- The knowledge gained on polymer chemistry, thermodynamics. spectroscopy, phase rule and nano materials will provide a strong platform to understand the concepts on these subjects for further learning.

TEXT BOOKS:

1. Jain P.C. and Monica Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company (P) Ltd., New Delhi, 2010

2. Kannan P., Ravikrishnan A., “Engineering Chemistry”, Sri Krishna Hi-tech Publishing Company Pvt. Ltd. Chennai, 2009

REFERENCES:

1. Dara S.S, Umare S.S, “Engineering Chemistry”, S. Chand & Company Ltd., New Delhi 2010
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company, Ltd., New Delhi, 2008.
3. Gowariker V.R. , Viswanathan N.V. and JayadevSreedhar, “Polymer Science”, New Age International P (Ltd.,), Chennai, 2006.
4. Ozin G. A. and Arsenault A. C., “Nanochemistry: A Chemical Approach to Nanomaterials”, RSC Publishing, 2005.

GE6151 COMPUTER PROGRAMMING L T P C
3 0 0 3

OBJECTIVES:

The students should be made to:

- Learn the organization of a digital computer.
- Be exposed to the number systems.
- Learn to think logically and write pseudo code or draw flow charts for problems.
- Be exposed to the syntax of C.
- Be familiar with programming in C.
- Learn to use arrays, strings, functions, pointers, structures and unions in C.

UNIT I INTRODUCTION 8

Generation and Classification of Computers- Basic Organization of a Computer –Number System – Binary – Decimal – Conversion – Problems. Need for logical analysis and thinking – Algorithm – Pseudo code – Flow Chart.

UNIT II C PROGRAMMING BASICS 10

Problem formulation – Problem Solving - Introduction to ‘ C’ programming –fundamentals – structure of a ‘C’ program – compilation and linking processes – Constants, Variables – Data Types – Expressions using operators in ‘C’ – Managing Input and Output operations – Decision Making and Branching – Looping statements – solving simple scientific and statistical problems.

UNIT III ARRAYS AND STRINGS 9

Arrays – Initialization – Declaration – One dimensional and Two dimensional arrays. String- String operations – String Arrays. Simple programs- sorting- searching – matrix operations.

UNIT IV FUNCTIONS AND POINTERS 9

Function – definition of function – Declaration of function – Pass by value – Pass by reference – Recursion – Pointers - Definition – Initialization – Pointers arithmetic – Pointers and arrays- Example Problems.

UNIT V STRUCTURES AND UNIONS 9

Introduction – need for structure data type – structure definition – Structure declaration – Structure within a structure - Union - Programs using structures and Unions – Storage classes, Pre-processor directives.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Design C Programs for problems.
- Write and execute C programs for simple applications.

TEXTBOOKS:

1. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2011.
2. Pradip Dey, Manas Ghosh, "Fundamentals of Computing and Programming in C", First Edition, Oxford University Press, 2009
3. Yashavant P. Kanetkar. " Let Us C", BPB Publications, 2011.

REFERENCES:

1. Byron S Gottfried, "Programming with C", Schaum's Outlines, Second Edition, Tata McGraw-Hill, 2006.
2. Dromey R.G., "How to Solve it by Computer", Pearson Education, Fourth Reprint, 2007.
3. Kernighan,B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2006.
4. Rajaram.M. and Uma Maheswari, 'Computer programming with C', pearson 2014.

GE6152 ENGINEERING GRAPHICS L T P C
2 0 3 4

OBJECTIVES:

- To develop in students, graphic skills for communication of concepts, ideas and design of Engineering products.
- To expose them to existing national standards related to technical drawings.

CONCEPTS AND CONVENTIONS (Not for Examination) 1

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I PLANE CURVES AND FREE HAND SKETCHING 5+9

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves, Scales: Construction of Diagonal and Vernier scales.

Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Free hand sketching of multiple views from pictorial views of objects

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACES 5+9

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS 5+9

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method and auxiliary plane method.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 5+9

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Development of lateral surfaces of solids with cut-outs and holes

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 6+9

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions and miscellaneous problems. Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method .

COMPUTER AIDED DRAFTING (Demonstration Only) 3

Introduction to drafting packages and demonstration of their use.

TOTAL : 75 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

- perform free hand sketching of basic geometrical constructions and multiple views of objects.
- do orthographic projection of lines and plane surfaces.
- draw projections and solids and development of surfaces.
- prepare isometric and perspective sections of simple solids.
- demonstrate computer aided drafting.

TEXT BOOK:

1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2010.

REFERENCES:

1. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
2. Luzzader, Warren.J. and Duff,John M., “Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
3. Shah M.B., and Rana B.C., “Engineering Drawing”, Pearson, 2nd Edition, 2009.
4. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2008.
5. Natrajan K.V., “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2009.
6. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.

4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Special points applicable to University Examinations on Engineering Graphics:

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

GE6161 COMPUTER PRACTICES LABORATORY L T P C
0 0 3 2

OBJECTIVES:

The student should be made to:

- Be familiar with the use of Office software.
- Be exposed to presentation and visualization tools.
- Be exposed to problem solving techniques and flow charts.
- Be familiar with programming in C.
- Learn to use Arrays, strings, functions, structures and unions.

LIST OF EXPERIMENTS:

1. Search, generate, manipulate data using MS office/ Open Office
2. Presentation and Visualization – graphs, charts, 2D, 3D
3. Problem formulation, Problem Solving and Flowcharts
4. C Programming using Simple statements and expressions
5. Scientific problem solving using decision making and looping.
6. Simple programming for one dimensional and two dimensional arrays.
7. Solving problems using String functions
8. Programs with user defined functions – Includes Parameter Passing
9. Program using Recursive Function and conversion from given program to flow chart.
10. Program using structures and unions.

TOTAL : 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Apply good programming design methods for program development.
- Design and implement C programs for simple applications.
- Develop recursive programs.

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS:

Standalone desktops with C compiler 30 Nos.

(or)

Server with C compiler supporting 30 terminals or more.

GE6162 ENGINEERING PRACTICES LABORATORY L T P C
0 0 3 2

OBJECTIVES:

- To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

GROUP A (CIVIL & MECHANICAL)

I CIVIL ENGINEERING PRACTICE 9

Buildings:

(a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

Plumbing Works:

(a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.
(b) Study of pipe connections requirements for pumps and turbines.
(c) Preparation of plumbing line sketches for water supply and sewage works.
(d) Hands-on-exercise:

Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.

(e) Demonstration of plumbing requirements of high-rise buildings.

Carpentry using Power Tools only:

(a) Study of the joints in roofs, doors, windows and furniture.
(b) Hands-on-exercise:

Wood work, joints by sawing, planing and cutting.

II MECHANICAL ENGINEERING PRACTICE 13

Welding:

(a) Preparation of arc welding of butt joints, lap joints and tee joints.
(b) Gas welding practice

Basic Machining:

(a) Simple Turning and Taper turning
(b) Drilling Practice

Sheet Metal Work:

(a) Forming & Bending:
(b) Model making – Trays, funnels, etc.
(c) Different type of joints.

Machine assembly practice:

(a) Study of centrifugal pump
(b) Study of air conditioner

Demonstration on:

(a) Smithy operations, upsetting, swaging, setting down and bending. Example – Exercise – Production of hexagonal headed bolt.
(b) Foundry operations like mould preparation for gear and step cone pulley.
(c) Fitting – Exercises – Preparation of square fitting and vee – fitting models.

GROUP B (ELECTRICAL & ELECTRONICS)

III ELECTRICAL ENGINEERING PRACTICE **10**

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring
4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5. Measurement of energy using single phase energy meter.
6. Measurement of resistance to earth of an electrical equipment.

IV ELECTRONICS ENGINEERING PRACTICE **13**

1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.
2. Study of logic gates AND, OR, EOR and NOT.
3. Generation of Clock Signal.
4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

TOTAL: 45 PERIODS

OUTCOMES:

- ability to fabricate carpentry components and pipe connections including plumbing works.
- ability to use welding equipments to join the structures.
- ability to fabricate electrical and electronics circuits.

REFERENCES:

1. Jeyachandran K., Natarajan S. & Balasubramanian S., “A Primer on Engineering Practices Laboratory”, Anuradha Publications, 2007.
2. Jeyapoovan T., Saravanapandian M. & Pranitha S., “Engineering Practices Lab Manual”, Vikas Puplishing House Pvt.Ltd, 2006.
3. Bawa H.S., “Workshop Practice”, Tata McGraw – Hill Publishing Company Limited, 2007.
4. Rajendra Prasad A. & Sarma P.M.M.S., “Workshop Practice”, Sree Sai Publication, 2002.
5. Kannaiah P. & Narayana K.L., “Manual on Workshop Practice”, Scitech Publications, 1999.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

CIVIL

1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings.	15 Sets.
2. Carpentry vice (fitted to work bench)	15 Nos.
3. Standard woodworking tools	15 Sets.
4. Models of industrial trusses, door joints, furniture joints	5 each
5. Power Tools: (a) Rotary Hammer	2 Nos

(b) Demolition Hammer	2 Nos
(c) Circular Saw	2 Nos
(d) Planer	2 Nos
(e) Hand Drilling Machine	2 Nos
(f) Jigsaw	2 Nos

MECHANICAL

1. Arc welding transformer with cables and holders	5 Nos.
2. Welding booth with exhaust facility	5 Nos.
3. Welding accessories like welding shield, chipping hammer, wire brush, etc.	5 Sets.
4. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	2 Nos.
5. Centre lathe	2 Nos.
6. Hearth furnace, anvil and smithy tools	2 Sets.
7. Moulding table, foundry tools	2 Sets.
8. Power Tool: Angle Grinder	2 Nos
9. Study-purpose items: centrifugal pump, air-conditioner	One each.

ELECTRICAL

1. Assorted electrical components for house wiring	15 Sets
2. Electrical measuring instruments	10 Sets
3. Study purpose items: Iron box, fan and regulator, emergency lamp	1 each
4. Megger (250V/500V)	1 No.
5. Power Tools: (a) Range Finder	2 Nos
(b) Digital Live-wire detector	2 Nos

ELECTRONICS

1. Soldering guns	10 Nos.
2. Assorted electronic components for making circuits	50 Nos.
3. Small PCBs	10 Nos.
4. Multimeters	10 Nos.
5. Study purpose items: Telephone, FM radio, low-voltage power supply	

GE6163 PHYSICS AND CHEMISTRY LABORATORY – I

L	T	P	C
0	0	2	1

PHYSICS LABORATORY – I

OBJECTIVES:

- To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics and properties of matter.

LIST OF EXPERIMENTS

(Any FIVE Experiments)

1. (a) Determination of Wavelength, and particle size using Laser
   (b) Determination of acceptance angle in an optical fiber.

2. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer.
3. Determination of wavelength of mercury spectrum – spectrometer grating
4. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
5. Determination of Young's modulus by Non uniform bending method
6. Determination of specific resistance of a given coil of wire – Carey Foster's Bridge

OUTCOMES:

- The hands on exercises undergone by the students will help them to apply physics principles of optics and thermal physics to evaluate engineering properties of materials.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Diode laser, lycopodium powder, glass plate, optical fiber.
2. Ultrasonic interferometer
3. Spectrometer, mercury lamp, grating
4. Lee's Disc experimental set up
5. Traveling microscope, meter scale, knife edge, weights
6. Carey foster's bridge set up
   (vernier Caliper, Screw gauge, reading lens are required for most of the experiments)

CHEMISTRY LABORATORY- I

OBJECTIVES:

- To make the student to acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis.
- To acquaint the students with the determination of molecular weight of a polymer by vacometry.

LIST OF EXPERIMENTS

(Any FIVE Experiments)

1 Determination of DO content of water sample by Winkler's method.
2 Determination of chloride content of water sample by argentometric method.
3 Determination of strength of given hydrochloric acid using pH meter.
4 Determination of strength of acids in a mixture using conductivity meter.
5 Estimation of iron content of the water sample using spectrophotometer.
(1,10- phenanthroline / thiocyanate method).
6 Determination of molecular weight of polyvinylalcohol using Ostwald viscometer.
7 Conductometric titration of strong acid vs strong base.

TOTAL: 30 PERIODS

OUTCOMES:

- The students will be outfitted with hands-on knowledge in the quantitative chemical analysis of water quality related parameters.

REFERENCES:

1. Daniel R. Palleros, "Experimental organic chemistry" John Wiley & Sons, Inc., New York 2001.
2. Furniss B.S. Hannaford A.J, Smith P.W.G and Tatchel A.R., "Vogel's Textbook of practical organic chemistry", LBS Singapore 1994.
3. Jeffery G.H., Bassett J., Mendham J.and Denny vogel's R.C, "Text book of quantitative analysis chemical analysis", ELBS 5th Edn. Longman, Singapore publishers, Singapore, 1996.
4. Kolthoff I.M., Sandell E.B. et al. "Quantitative chemical analysis", Mcmillan, Madras 1980.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Iodine flask - 30 Nos
2. pH meter - 5 Nos
3. Conductivity meter - 5 Nos
4. Spectrophotometer - 5 Nos
5. Ostwald Viscometer - 10 Nos

Common Apparatus : Pipette, Burette, conical flask, percelain tile, dropper (each 30 Nos.)

HS6251 TECHNICAL ENGLISH II L T P C
3 1 0 4

OBJECTIVES:

- To make learners acquire listening and speaking skills in both formal and informal contexts.
- To help them develop their reading skills by familiarizing them with different types of reading strategies.
- To equip them with writing skills needed for academic as well as workplace contexts.
- To make them acquire language skills at their own pace by using e-materials and language lab components.

UNIT I 9+3

Listening - Listening to informal conversations and participating; Speaking - Opening a conversation (greetings, comments on topics like weather) - Turn taking - Closing a conversation (excuses, general wish, positive comment, thanks); Reading - Developing analytical skills, Deductive and inductive reasoning - Extensive reading; Writing - Effective use of SMS for sending short notes and messages - Using 'emoticons' as symbols in email messages; Grammar - Regular and irregular verbs - Active and passive voice; Vocabulary - Homonyms (e.g. 'can') - Homophones (e.g. 'some', 'sum'); E-materials - Interactive exercise on Grammar and vocabulary – blogging; Language Lab - Listening to different types of conversation and answering questions.

UNIT II 9+3

Listening - Listening to situation based dialogues; Speaking - Conversation practice in real life situations, asking for directions (using polite expressions), giving directions (using imperative sentences), Purchasing goods from a shop, Discussing various aspects of a film (they have already seen) or a book (they have already read); Reading - Reading a short story or an article from newspaper, Critical reading, Comprehension skills; Writing - Writing a review / summary of a story / article, Personal letter (Inviting your friend to a function, congratulating someone for his / her success, thanking one's friends / relatives); Grammar - modal verbs, Purpose expressions; Vocabulary - Phrasal verbs and their meanings, Using phrasal verbs in sentences; E-materials - Interactive exercises on Grammar and vocabulary, Extensive reading activity (reading stories / novels), Posting reviews in blogs - Language Lab - Dialogues (Fill up exercises), Recording students' dialogues.

UNIT III 9+3

Listening - Listening to the conversation - Understanding the structure of conversations; Speaking - Conversation skills with a sense of stress, intonation, pronunciation and meaning - Seeking information – expressing feelings (affection, anger, regret, etc.); Reading - Speed reading – reading passages with time limit - Skimming; Writing - Minutes of meeting – format and practice in the preparation of minutes - Writing summary after reading articles from journals - Format for journal articles – elements of technical articles (abstract, introduction, methodology, results, discussion, conclusion, appendices, references) - Writing strategies; Grammar - Conditional clauses - Cause and effect expressions; Vocabulary - Words used as nouns and verbs without any change in the spelling (e.g. 'rock', 'train', 'ring'); E-materials - Interactive exercise on Grammar and vocabulary -

Speed Reading practice exercises; Language Lab - Intonation practice using EFLU and RIE materials – Attending a meeting and writing minutes.

UNIT IV **9+3**

Listening - Listening to a telephone conversation, Viewing model interviews (face-to-face, telephonic and video conferencing); Speaking - Role play practice in telephone skills - listening and responding, -asking questions, -note taking – passing on messages, Role play and mock interview for grasping interview skills; Reading - Reading the job advertisements and the profile of the company concerned – scanning; Writing - Applying for a job – cover letter - résumé preparation – vision, mission and goals of the candidate; Grammar - Numerical expressions - Connectives (discourse markers); Vocabulary - Idioms and their meanings – using idioms in sentences; E-materials - Interactive exercises on Grammar and Vocabulary - Different forms of résumés- Filling up a résumé / cover letter; Language Lab - Telephonic interview – recording the responses - e-résumé writing.

UNIT V **9+3**

Listening - Viewing a model group discussion and reviewing the performance of each participant - Identifying the characteristics of a good listener; Speaking - Group discussion skills – initiating the discussion – exchanging suggestions and proposals – expressing dissent/agreement – assertiveness in expressing opinions – mind mapping technique; Reading - Note making skills – making notes from books, or any form of written materials - Intensive reading; Writing – Checklist - Types of reports – Feasibility / Project report – report format – recommendations / suggestions – interpretation of data (using charts for effective presentation); Grammar - Use of clauses; Vocabulary – Collocation; E-materials - Interactive grammar and vocabulary exercises - Sample GD - Pictures for discussion, Interactive grammar and vocabulary exercises; Language Lab - Different models of group discussion.

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

Learners should be able to

- speak convincingly, express their opinions clearly, initiate a discussion, negotiate, argue using appropriate communicative strategies.
- write effectively and persuasively and produce different types of writing such as narration, description, exposition and argument as well as creative, critical, analytical and evaluative writing.
- read different genres of texts, infer implied meanings and critically analyse and evaluate them for ideas as well as for method of presentation.
- listen/view and comprehend different spoken excerpts critically and infer unspoken and implied meanings.

TEXTBOOKS:

1. Department of English, Anna University. Mindscapes: English for Technologists and Engineers. Orient Blackswan, Chennai. 2012
2. Dhanavel, S.P. English and Communication Skills for Students of Science and Engineering. Orient Blackswan, Chennai. 2011

REFERENCES:

1. Anderson, Paul V. Technical Communication: A Reader-Centered Approach. Cengage. New Delhi. 2008
2. Muralikrishna, & Sunita Mishra. Communication Skills for Engineers. Pearson, New Delhi. 2011
3. Riordan, Daniel. G. Technical Communication. Cengage Learning, New Delhi. 2005
4. Sharma, Sangeetha & Binod Mishra. Communication Skills for Engineers and Scientists. PHI Learning, New Delhi. 2009
5. Smith-Worthington, Darlene & Sue Jefferson. Technical Writing for Success. Cengage, Mason USA. 2007

EXTENSIVE Reading (Not for Examination)

1. Khera, Shiv. You can Win. Macmillan, Delhi. 1998.

Websites

1. http://www.englishclub.com
2. http://owl.english.purdue.edu

TEACHING METHODS:

- Lectures
- Activities conducted individually, in pairs and in groups like individual writing and presentations, group discussions, interviews, reporting, etc
- Long presentations using visual aids
- Listening and viewing activities with follow up activities like discussions, filling up worksheets, writing exercises (using language lab wherever necessary/possible) etc
- Projects like group reports, mock interviews etc using a combination of two or more of the language skills

EVALUATION PATTERN:

Internal assessment: 20%

3 tests of which two are pen and paper tests and the other is a combination of different modes of assessment like

- Project
- Assignment
- Report
- Creative writing, etc.

All the four skills are to be tested with equal weightage given to each.

- ✓ Speaking assessment: Individual presentations, Group discussions
- ✓ Reading assessment: Reading passages with comprehension questions graded following Bloom's taxonomy
- ✓ Writing assessment: Writing essays, CVs, reports etc. Writing should include grammar and vocabulary.
- ✓ Listening/Viewing assessment: Lectures, dialogues, film clippings with questions on verbal as well as audio/visual content graded following Bloom's taxonomy.

End Semester Examination: 80%

MA6251	**MATHEMATICS – II**	**L T P C**
		3 1 0 4

OBJECTIVES:

- To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems.
- To acquaint the student with the concepts of vector calculus needed for problems in all engineering disciplines.
- To develop an understanding of the standard techniques of complex variable theory so as to enable the student to apply them with confidence, in application areas such as heat conduction, elasticity, fluid dynamics and flow the of electric current.

- To make the student appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.

UNIT I VECTOR CALCULUS 9+3

Gradient, divergence and curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelopipeds.

UNIT II ORDINARY DIFFERENTIAL EQUATIONS 9+3

Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients.

UNIT III LAPLACE TRANSFORM 9+3

Laplace transform – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Transforms of unit step function and impulse functions – Transform of periodic functions. Inverse Laplace transform -Statement of Convolution theorem – Initial and final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

UNIT IV ANALYTIC FUNCTIONS 9+3

Functions of a complex variable – Analytic functions: Necessary conditions – Cauchy-Riemann equations and sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function – Harmonic conjugate – Construction of analytic functions – Conformal mapping: $w = z+k$, kz, $1/z$, z^2, e^z and bilinear transformation.

UNIT V COMPLEX INTEGRATION 9+3

Complex integration – Statement and applications of Cauchy's integral theorem and Cauchy's integral formula – Taylor's and Laurent's series expansions – Singular points – Residues – Cauchy's residue theorem – Evaluation of real definite integrals as contour integrals around unit circle and semi-circle (excluding poles on the real axis).

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

- The subject helps the students to develop the fundamentals and basic concepts in vector calculus, ODE, Laplace transform and complex functions. Students will be able to solve problems related to engineering applications by using these techniques.

TEXT BOOKS:

1. Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", Eighth Edition, Laxmi Publications Pvt Ltd.,2011.
2. Grewal. B.S, "Higher Engineering Mathematics", 41st Edition, Khanna Publications, Delhi, 2011.

REFERENCES:

1. Dass, H.K., and Er. Rajnish Verma," Higher Engineering Mathematics", S. Chand Private Ltd., 2011
2. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2012.
3. Peter V. O'Neil," Advanced Engineering Mathematics", 7th Edition, Cengage learning, 2012.
4. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 2008.
5. Sivarama Krishna Das P. and Rukmangadachari E., "Engineering Mathematics" Volume II, Second Edition, PEARSON Publishing, 2011.

PH6251 ENGINEERING PHYSICS – II L T P C
3 0 0 3

OBJECTIVES:

- To enrich the understanding of various types of materials and their applications in engineering and technology.

UNIT I CONDUCTING MATERIALS 9

Conductors – classical free electron theory of metals – Electrical and thermal conductivity – Wiedemann – Franz law – Lorentz number – Draw backs of classical theory – Quantum theory – Fermi distribution function – Effect of temperature on Fermi Function – Density of energy states – carrier concentration in metals.

UNIT II SEMICONDUCTING MATERIALS 9

Intrinsic semiconductor – carrier concentration derivation – Fermi level – Variation of Fermi level with temperature – electrical conductivity – band gap determination – compound semiconductors -direct and indirect band gap- derivation of carrier concentration in n-type and p-type semiconductor – variation of Fermi level with temperature and impurity concentration –– Hall effect –Determination of Hall coefficient – Applications.

UNIT III MAGNETIC AND SUPERCONDUCTING MATERIALS 9

Origin of magnetic moment – Bohr magneton – comparison of Dia, Para and Ferro magnetism – Domain theory – Hysteresis – soft and hard magnetic materials – antiferromagnetic materials – Ferrites and its applications

Superconductivity: properties – Type I and Type II superconductors – BCS theory of superconductivity(Qualitative) - High T_c superconductors – Applications of superconductors – SQUID, cryotron, magnetic levitation.

UNIT IV DIELECTRIC MATERIALS 9

Electrical susceptibility – dielectric constant – electronic, ionic, orientational and space charge polarization – frequency and temperature dependence of polarisation – internal field – Claussius – Mosotti relation (derivation) – dielectric loss – dielectric breakdown – uses of dielectric materials (capacitor and transformer) – ferroelectricity and applications.

UNIT V ADVANCED ENGINEERING MATERIALS 9

Metallic glasses: preparation, properties and applications. Shape memory alloys (SMA): Characteristics, properties of NiTi alloy, application, Nanomaterials– Preparation -pulsed laser deposition – chemical vapour deposition – Applications – NLO materials –Birefringence- optical Kerr effect – Classification of Biomaterials and its applications

TOTAL: 45 PERIODS

OUTCOMES:

- The students will have the knowledge on physics of materials and that knowledge will be used by them in different engineering and technology applications.

TEXT BOOKS:

1. Arumugam M., Materials Science. Anuradha publishers, 2010
2. Pillai S.O., Solid State Physics. New Age International(P) Ltd., publishers, 2009

REFERENCES:

1. Palanisamy P.K. Materials Science. SCITECH Publishers, 2011
2. Senthilkumar G. Engineering Physics II. VRB Publishers, 2011
3. Mani P. Engineering Physics II. Dhanam Publications, 2011
4. Marikani A. Engineering Physics. PHI Learning Pvt., India, 2009

CY6251 ENGINEERING CHEMISTRY - II L T P C
3 0 0 3

OBJECTIVES:

- To make the students conversant with boiler feed water requirements, related problems and water treatment techniques.
- Principles of electrochemical reactions, redox reactions in corrosion of materials and methods for corrosion prevention and protection of materials.
- Principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.
- Preparation, properties and applications of engineering materials.
- Types of fuels, calorific value calculations, manufacture of solid, liquid and gaseous fuels.

UNIT I WATER TECHNOLOGY 9

Introduction to boiler feed water-requirements-formation of deposits in steam boilers and heat exchangers- disadvantages (wastage of fuels, decrease in efficiency, boiler explosion) prevention of scale formation -softening of hard water -external treatment zeolite and demineralization - internal treatment- boiler compounds (phosphate, calgon, carbonate, colloidal) - caustic embrittlement -boiler corrosion-priming and foaming- desalination of brackish water –reverse osmosis.

UNIT II ELECTROCHEMISTRY AND CORROSION 9

Electrochemical cell - redox reaction, electrode potential- origin of electrode potential- oxidation potential- reduction potential, measurement and applications - electrochemical series and its significance - Nernst equation (derivation and problems). Corrosion- causes- factors- types- chemical, electrochemical corrosion (galvanic, differential aeration), corrosion control - material selection and design aspects - electrochemical protection – sacrificial anode method and impressed current cathodic method. Paints- constituents and function. Electroplating of Copper and electroless plating of nickel.

UNIT III ENERGY SOURCES 9

Introduction- nuclear energy- nuclear fission- controlled nuclear fission- nuclear fusion- differences between nuclear fission and fusion- nuclear chain reactions- nuclear reactor power generator- classification of nuclear reactor- light water reactor- breeder reactor- solar energy conversion- solar cells- wind energy. Batteries and fuel cells:Types of batteries- alkaline battery- lead storage battery- nickel-cadmium battery- lithium battery- fuel cell H_2 -O_2 fuel cell- applications.

UNIT IV ENGINEERING MATERIALS 9

Abrasives: definition, classification or types, grinding wheel, abrasive paper and cloth. Refractories: definition, characteristics, classification, properties – refractoriness and RUL, dimensional stability, thermal spalling, thermal expansion, porosity; Manufacture of alumina, magnesite and silicon carbide, Portland cement- manufacture and properties - setting and hardening of cement, special cement- waterproof and white cement–properties and uses. Glass - manufacture, types, properties and uses.

UNIT V FUELS AND COMBUSTION 9

Fuel: Introduction- classification of fuels- calorific value- higher and lower calorific values- coal- analysis of coal (proximate and ultimate)- carbonization- manufacture of metallurgical coke (Otto Hoffmann method) - petroleum- manufacture of synthetic petrol (Bergius process)- knocking- octane number - diesel oil- cetane number - natural gas- compressed natural gas(CNG)- liquefied petroleum gases(LPG)- producer gas- water gas. Power alcohol and bio diesel. Combustion of fuels: introduction- theoretical calculation of calorific value- calculation of stoichiometry of fuel and air ratio- ignition temperature- explosive range - flue gas analysis (ORSAT Method).

TOTAL: 45 PERIODS

OUTCOMES:

- The knowledge gained on engineering materials, fuels, energy sources and water treatment techniques will facilitate better understanding of engineering processes and applications for further learning.

TEXT BOOKS:

1. Vairam S, Kalyani P and SubaRamesh.,"Engineering Chemistry"., Wiley India PvtLtd.,New Delhi., 2011
2. DaraS.S,UmareS.S."Engineering Chemistry", S. Chand & Company Ltd., New Delhi , 2010

REFERENCES:

1 Kannan P. and Ravikrishnan A., "Engineering Chemistry", Sri Krishna Hi-tech Publishing Company Pvt. Ltd. Chennai, 2009

2. AshimaSrivastava and Janhavi N N., "Concepts of Engineering Chemistry", ACME Learning Private Limited., New Delhi., 2010.
3. RenuBapna and Renu Gupta., "Engineering Chemistry", Macmillan India Publisher Ltd., 2010.

4 Pahari A and Chauhan B., "Engineering Chemistry"., Firewall Media., New Delhi., 2010

GE6252 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING L T P C
4 0 0 4

OBJECTIVES:

- To explain the basic theorems used in Electrical circuits and the different components and function of electrical machines.
- To explain the fundamentals of semiconductor and applications.
- To explain the principles of digital electronics
- To impart knowledge of communication.

UNIT I ELECTRICAL CIRCUITS & MEASURMENTS 12

Ohm's Law – Kirchoff's Laws – Steady State Solution of DC Circuits – Introduction to AC Circuits – Waveforms and RMS Value – Power and Power factor – Single Phase and Three Phase Balanced Circuits.

Operating Principles of Moving Coil and Moving Iron Instruments (Ammeters and Voltmeters), Dynamometer type Watt meters and Energy meters.

UNIT II ELECTRICAL MECHANICS 12

Construction, Principle of Operation, Basic Equations and Applications of DC Generators, DC Motors, Single Phase Transformer, single phase induction Motor.

UNIT III SEMICONDUCTOR DEVICES AND APPLICATIONS 12

Characteristics of PN Junction Diode – Zener Effect – Zener Diode and its Characteristics – Half wave and Full wave Rectifiers – Voltage Regulation.

Bipolar Junction Transistor – CB, CE, CC Configurations and Characteristics – Elementary Treatment of Small Signal Amplifier.

UNIT IV DIGITAL ELECTRONICS 12

Binary Number System – Logic Gates – Boolean Algebra – Half and Full Adders – Flip-Flops – Registers and Counters – A/D and D/A Conversion (single concepts)

UNIT V FUNDAMENTALS OF COMMUNICATION ENGINEERING 12

Types of Signals: Analog and Digital Signals – Modulation and Demodulation: Principles of Amplitude and Frequency Modulations.

Communication Systems: Radio, TV, Fax, Microwave, Satellite and Optical Fibre (Block Diagram Approach only).

TOTAL: 60 PERIODS

OUTCOMES:

- Ability to identify the electrical components explain the characteristics of electrical machines.
- Ability to identify electronics components and use of them to design circuits.

TEXT BOOKS:

1. Mittle N., "Basic Electrical Engineering", Tata McGraw Hill Edition, New Delhi, 1990.
2. Sedha R.S., "Applied Electronics", S. Chand & Co., 2006.

REFERENCES:

1. Muthusubramanian R, Salivahanan S and Muraleedharan K A, "Basic Electrical, Electronics and Computer Engineering", Tata McGraw Hill, Second Edition, 2006.
2. Nagsarkar T K and Sukhija M S, "Basics of Electrical Engineering", Oxford press 2005.
3. Mehta V K, "Principles of Electronics", S.Chand & Company Ltd, 1994.
4. Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, 2002.
5. Premkumar N, "Basic Electrical Engineering", Anuradha Publishers, 2003.

GE6253 ENGINEERING MECHANICS L T P C
3 1 0 4

OBJECTIVES:

- To develop capacity to predict the effect of force and motion in the course of carrying out the design functions of engineering.

UNIT I BASICS AND STATICS OF PARTICLES 12

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces –– Vectorial representation of forces – Vector operations of forces -additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility .

UNIT II EQUILIBRIUM OF RIGID BODIES 12

Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions

UNIT III PROPERTIES OF SURFACES AND SOLIDS 12

Centroids and centre of mass– Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, - Angle section, Hollow section by using standard formula – Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem –Principal moments of inertia of plane areas –

Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.

UNIT IV DYNAMICS OF PARTICLES 12

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

UNIT V FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS 12

Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction – wedge friction-. Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

TOTAL : 60 PERIODS

OUTCOMES:

- Ability to explain the differential principles applies to solve engineering problems dealing with force, displacement, velocity and acceleration.
- Ability to analyse the forces in any structures.
- Ability to solve rigid body subjected to dynamic forces.

TEXT BOOKS:

1. Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing company, New Delhi 2004.
2. Vela Murali, "Engineering Mechanics", Oxford University Press 2010.

REFERENCES:

1. Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th Edition, Pearson Education 2010.
2. Irving H. Shames and Krishna Mohana Rao. G., "Engineering Mechanics – Statics and Dynamics", 4th Edition, Pearson Education 2006.
3. Meriam J.L. and Kraige L.G., " Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2", Third Edition, John Wiley & Sons,1993.
4. Rajasekaran S and Sankarasubramanian G., "Engineering Mechanics Statics and Dynamics", 3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.
5. Bhavikatti, S.S and Rajashekarappa, K.G., "Engineering Mechanics", New Age International (P) Limited Publishers, 1998.
6. Kumar, K.L., "Engineering Mechanics", 3rd Revised Edition, Tata McGraw-Hill Publishing company, New Delhi 2008.

GE6261 COMPUTER AIDED DRAFTING AND MODELING LABORATORY L T P C
0 1 2 2

OBJECTIVES:

- To develop skill to use software to create 2D and 3D models.

LIST OF EXERCISES USING SOFTWARE CAPABLE OF DRAFTING AND MODELING

1. Study of capabilities of software for Drafting and Modeling – Coordinate systems (absolute, relative, polar, etc.) – Creation of simple figures like polygon and general multi-line figures.
2. Drawing of a Title Block with necessary text and projection symbol.

3. Drawing of curves like parabola, spiral, involute using Bspline or cubic spline.
4. Drawing of front view and top view of simple solids like prism, pyramid, cylinder, cone, etc, and dimensioning.
5. Drawing front view, top view and side view of objects from the given pictorial views (eg. V-block, Base of a mixie, Simple stool, Objects with hole and curves).
6. Drawing of a plan of residential building (Two bed rooms, kitchen, hall, etc.)
7. Drawing of a simple steel truss.
8. Drawing sectional views of prism, pyramid, cylinder, cone, etc,
9. Drawing isometric projection of simple objects.
10. Creation of 3-D models of simple objects and obtaining 2-D multi-view drawings from 3-D model.

Note: Plotting of drawings must be made for each exercise and attached to the records written by students.

TOTAL: 45 PERIODS

OUTCOMES:

- ability to use the software packers for drafting and modeling
- ability to create 2D and 3D models of Engineering Components

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

Sl.No	Description of Equipment	Quantity
1.	Pentium IV computer or better hardware, with suitable graphics facility	30 No.
2.	Licensed software for Drafting and Modeling.	30 Licenses
3.	Laser Printer or Plotter to print / plot drawings	2 No.

GE6262 PHYSICS AND CHEMISTRY LABORATORY – II

L	T	P	C
0	0	2	1

PHYSICS LABORATORY – II

OBJECTIVES:

- To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics and properties of matter.

LIST OF EXPERIMENTS
(Any FIVE Experiments)

1. Determination of Young's modulus by uniform bending method
2. Determination of band gap of a semiconductor
3. Determination of Coefficient of viscosity of a liquid –Poiseuille's method
4. Determination of Dispersive power of a prism - Spectrometer
5. Determination of thickness of a thin wire – Air wedge method
6. Determination of Rigidity modulus – Torsion pendulum

OUTCOMES:

- The students will have the ability to test materials by using their knowledge of applied physics principles in optics and properties of matter.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Traveling microscope, meter scale, Knife edge, weights
2. Band gap experimental set up
3. Burette, Capillary tube, rubber tube, stop clock, beaker and weighing balance
4. spectrometer, prism, sodium vapour lamp.
5. Air-wedge experimental set up.
6. Torsion pendulum set up.
   (vernier Caliper, Screw gauge, reading lens are required for most of the experiments)

CHEMISTRY LABORATORY - II

OBJECTIVES:

- To make the student acquire practical skills in the wet chemical and instrumental methods for quantitative estimation of hardness, alkalinity, metal ion content, corrosion in metals and cement analysis.

LIST OF EXPERIMENTS
(Any FIVE Experiments)

1 Determination of alkalinity in water sample
2 Determination of total, temporary & permanent hardness of water by EDTA method
3 Estimation of copper content of the given solution by EDTA method
4 Estimation of iron content of the given solution using potentiometer
5 Estimation of sodium present in water using flame photometer
6 Corrosion experiment – weight loss method
7 Conductometric precipitation titration using $BaCl_2$ and Na_2SO_4
8 Determination of CaO in Cement.

TOTAL: 30 PERIODS

OUTCOMES:

- The students will be conversant with hands-on knowledge in the quantitative chemical analysis of water quality related parameters, corrosion measurement and cement analysis.

REFERENCES:

1. Daniel R. Palleros, “Experimental organic chemistry” John Wiley & Sons, Inc., New York, 2001.
2. Furniss B.S. Hannaford A.J, Smith P.W.G and Tatchel A.R., “Vogel’s Textbook of practical organic chemistry, LBS Singapore ,1994.
3. Jeffery G.H, Bassett J., Mendham J. and Denny R.C., “Vogel’s Text book of quantitative analysis chemical analysis”, ELBS 5th Edn. Longman, Singapore publishers, Singapore, 1996.
4. Kolthoff I.M. and Sandell E.B. et al. Quantitative chemical analysis, McMillan, Madras 1980

- **Laboratory classes on alternate weeks for Physics and Chemistry.**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1.	Potentiometer	-	5 Nos
2.	Flame photo meter	-	5 Nos
3.	Weighing Balance	-	5 Nos
4.	Conductivity meter	-	5 Nos

Common Apparatus : Pipette, Burette, conical flask, percelain tile, dropper (30 Nos each)

MA6351 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS L T P C
3 1 0 4

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.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9+3

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

UNIT II FOURIER SERIES 9+3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Complex form of Fourier Series – Parseval's identify – Harmonic Analysis.

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9+3

Classification of PDE – Method of separation of variables - Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two-dimensional equation of heat conduction (excluding insulated edges).

UNIT IV FOURIER TRANSFORMS 9+3

Fourier integral theorem (without proof) – Fourier transform pair – Fourier Sine and Fourier Cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT V Z -TRANSFORMS AND DIFFERENCE EQUATIONS 9+3

Z-transforms - Elementary properties – Inverse Z-transform (using partial fraction and residues) – Convolution theorem -Formation of difference equations – Solution of difference equations using Z-transform.

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

- The understanding of the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.

TEXT BOOKS:

1. Grewal, B.S, "Higher Engineering Mathematic", 42th Edition, Khanna publishers, Delhi, (2012).
2. Veerarajan, T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.

REFERENCES:

1. Bali.N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, Laxmi Publications(P) Ltd. (2007).
2. Ramana.B.V., "Higher Engineering Mathematics", Tata Mc-Graw Hill Publishing Company limited, New Delhi, (2008).
3. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.

4. Erwin Kreyszig, “Advanced Engineering Mathematics”, 8th edition, Wiley India (2007).
5. Ray Wylie. C and Barrett.L.C, "Advanced Engineering Mathematics" Tata McGraw Hill Education Pvt Ltd, Sixth Edition, New Delhi, 2012.
6. Datta.K.B." Mathematical Methods of Science and Engineering", Cengage Learning India Pvt Ltd, Delhi, (2013).

ML6301 CASTING AND MACHINING PROCESSES L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge on the various foundry practices being carried out In the Industry.

UNIT I PATTERN AND DIE MAKING 9

Introduction to foundry process flow, Patterns – types, functions, allowances, Selection of pattern materials, colour codes, core boxes, - considerations in Core box manufacturing, Die materials, Die design and manufacturing techniques Computer applications in Pattern and Die making

UNIT II CASTING DESIGN 9

Solidification of pure metals and alloys –shrinkage in cast metals – Design of Sprue, runner, gates – problems in design and manufacture of thin and unequal Sections, d esigning for directional solidification, Riser design-Chvorinov’s rule, Caines, Modulus , Naval Research Laboratory methods, feeding distances – Calculations and number of Risers required, chills and feeding aids –Exothermic And Insulating sleeves Design problems of L, T, V, X and Y junctions, Computer Applications in casting design—Software for casting design.

UNIT III MOULDING AND CASTING PRACTICES 10

Sand for foundry applications – types, properties, tests. Moulding and Cores and Ingredients, Moulding and Core sand preparations, testing. Various Moulding Practices – Green Sand, CO_2 process, No Bake, Shell, Investment Casting, Permanent Moulding – Gravity, Low Pressure,High Pressure Die casting processes, Ceramic, Plaster of Paris, Centrifugal, Squeeze, Electro Magnetic and Lost Foam processes.

UNIT IV MELTING AND POURING PRACTICES 9

Principles of melting practice – Fluxing, Degasification, Modification, Deoxidation and Inoculation, Types of furnaces –Crucibles, Cupola, Oil fired furnaces, Electric furnaces – Arc and Induction types, Melting practices of Cast Iron, SG Iron, Carbon Steels, High alloy and Stainless steels, Aluminium and Copper alloys, Melt Quality control in all above processes.

UNIT V MACHINING 9

Metal cutting- chip formation, types of chips, principles of cutting –Tool Wear and failure. Principles of Turning, Drilling, Tapping, Milling, Planing, Shaping and Broaching operations

TOTAL : 45 PERIODS

OUTCOMES:

- Ability to understand and perform basic casting processes.
- Ability to design casting and select suitable casting process for different materials.
- Ability to perform basic maching operations in the cast components.

TEXT BOOKS:

1. R.W.Heine, R.Loper, P.C.Rosenthal, “Principles of Metal Casting”, 2nd Edition Tata-McGraw Hill.
2. P.L. Jain, “Principles of Foundry Technology”, Tata-McGraw Hill, 2003.

REFERENCES:
1. R.K.Jain, S.C.Gupta, “Production Technology”, Khanna publishers, New Delhi.
2. AFS Foundry Sand Handbook, American Foundrymen’s Society, Desplaines, 1963.
3. AFS Pattern Maker’s Manual-American Foundrymen’s Society, Desplaines, 1960.
4. ASM Casting Design Handbook, American Society of Metals, Metals Park, 1962.
5. Chvorinov N, Geisserei, “Theory of Solidification of castings”, , Vol.27, 1940, pp 177-225.
6. N.N. Zorev, “Metal Cutting mechanics”, Pergamon Press, Oxford, 1965.

ML 6302 THERMODYNAMICS AND KINETICS OF MATERIALS L T P C
3 1 0 4

OBJECTIVES:
- To introduce the basic knowledge of thermodynamics required for understanding various alloy systems, phase transformations and interpreting properties

UNIT I FUNDAMENTAL CONCEPTS 6

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

UNIT II INTERNAL ENERGY AND ENTROPY 9

First law of Thermodynamics: Relation between Heat and work, Internal energy, Enthalpy. The Second law of thermodynamics: Spontaneous process, Degree of measure of reversibility and irreversibility, Maximum work, criteria of equilibrium. Combined statement of first and second laws on thermodynamics. Statistical interpretation of entropy: Concept of microstate, most probable microstate, Thermal equilibrium, Boltzman equation

UNIT III AUXILARY FUNCTIONS AND THERMODYNAMIC POTENTIALS 10

Auxiliary functions: Helmholtz, Gibbs free energy, Maxwell’s equation, Gibbs-Helmholtz equations. 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. Zeroth law of thermodynamics and its applications. Thermodynamic potentials: Fugacity, Activity and Equilibrium constant. Clausius - Clayperon equation. Le Chatelier’s principle, Vant Hoff’s equation.

UNIT IV THERMODYNAMICS OF SOLUTIONS 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.

UNIT V THERMODYNAMICS OF REACTIONS 10

Thermodynamics of electrochemical cells, solid electrolytes. Basic - Pourbaix diagrams. Thermodynamics of Surfaces: Adsorption isotherms, Effect of surface energy on pressure and phase transformation temperature. Thermodynamics of Defects in solids: Point defects, vacancies and interstitials in solid metals.

TOTAL: 45 PERIODS

OUTCOMES:

- A fundamental understanding of the first and second laws of thermodynamics and their application to a wide range of system.
- The student should be able to use thermodynamics on solid state equilibrium as well as on equilibrium between solids and gasses

TEXT BOOKS:

1. David R Gaskell, “Introduction to the Thermodynamics of materials”, Taylor and Francis, Fifth edition, 2008.
2. Boris.S.Bokstein, Mikhail I. Mendelev, David J. Srolovitz, "Thermodynamics and Kinetics in Materials science", Oxford University Press 2005.

REFERENCES:

1. Prasad, Krishna Kant, Ray, H. S. and Abraham, K. P., “Chemical and Metallurgical Thermodynamics”, New Age International, 2006
2. Upadhyaya, G. S. and Dube, R. K., “Problems in Metallurgical Thermodynamics and Kinetics”, Pergamon Press, London, 1977.
3. Thomas Engel, Philip Reid, 'Thermodynamics, Statistical Thermodynamics and Kinetics", Pearson Education (LPE) 2007.
4. Ahindra Ghosh, T'extbook of Materials and Metallurgical Thermodynamics", Prentice hall of India, 2003.
5. Peter Atkins, Julio de Paula, Physical Chemistry Volume 1: Thermodynamics and Kinetics, W. H. Freeman & Company, 2010
6. DeHoff R T, "Thermodynamics in Materials Science", McGrawhill, Newyork 1993.
7. J J Moore, “Chemical Metallurgy”, Butterworth-Heinemann Ltd, 1990.
8. David V Ragone, “Thermodynamics of Materials - Volume-1”, John Wiley & Sons, Inc. 1995.
9. Darken LS and Gurry R W ,”Physical Chemistry of Metals”, McGraw Hill, 1987.
10. Swalin R A, “Thermodynamics of solids”, John Wiley Sons Inc, third edition, 1966.

CE6306 STRENGTH OF MATERIALS L T P C
3 1 0 4

OBJECTIVES:

To understand the stresses developed in bars, compounds bars, beams, shafts, cylinders and spheres.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains –Stresses on inclined planes – principal stresses and principal planes – Mohr’s circle of stress.

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9

Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending– bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution.

UNIT III TORSION 9

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs.

UNIT IV DEFLECTION OF BEAMS 9

Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams - Conjugate beam and strain energy – Maxwell's reciprocal theorems.

UNIT V THIN CYLINDERS, SPHERES AND THICK CYLINDERS 9

Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure –Deformation in spherical shells – Lame's theorem.

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to apply mathematical knowledge to calculate the deformation behavior of simple structures.
- Critically analyse problem and solve the problems related to mechanical elements and analyse the deformation behavior for different types of loads.

TEXT BOOKS:

1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2007
2. Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2007

REFERENCES:

1. Egor. P.Popov "Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2001
2. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2007.
3. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2007
4. Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing 'co. Ltd., New Delhi, 2005.

ML6303 MATERIALS STRUCTURE AND PROPERTIES L T P C
3 0 0 3

OBJECTIVES:

- 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, elastomers and composites.

UNIT I STRUCTURE OF SOLIDS 10

Overview of Crystal Structure – Solid Solutions-Hume Rothery Rules-Crystal Imperfections- Point Defects- Line Defects-Surface Defects-Bulk Defects-Critical nucleus size and Critical Free energy-Mechanism of Crystallisation- Nucleation-Homogeneous and Heterogenous Nucleation- Growth - Single crystal -Polycrystalline Materials - Basic principles of solidification of metals and alloys. Growth of crystals- Planar growth – dendritic growth – Solidification time - Cooling curves - Non-crystalline solids- Glass Transition Temperature.

UNIT II PHASE DIAGRAMS 10

Phase Rule –Unary System- Binary Phase diagrams- Isomorphous systems-Congruent phase diagrams - Free energy Composition curves- Construction -Microstructural changes during cooling- Tie Line- Lever Rule- Eutectic , Peritectic, Eutectoid and Peritectoid reactions- Typical Phase diagrams – Cu-Zn System – Pb-Sn system- Ag-Pt system-Iron-Iron carbide Equilibrium Diagram

UNIT III FERROUS AND NON FERROUS MATERIALS 9

Classification of steels and cast iron –Microstructure– Effect of alloying elements on steel- Ferrous alloys and their applications - Factors affecting conductivity of a metal – Electrical Resistivity in alloys – Thermal conductivity of metals and alloys - High Resistivity alloys –Some important Titanium alloys, Nickel alloys, Copper alloys, Magnesium alloys and Aluminium alloys.

UNIT IV ENGINEERING CERAMICS 8

Types - Crystal Structures - Silicate Ceramics - Glasses – Glass Ceramics – Advanced ceramics- Functional properties and applications of ceramic materials –SiC, Al_2O_3, Si_3N_4– Super hard materials - Tungsten carbide and Boron nitrides – Graphene. – Applications to bio engineering

UNIT V COMMODITY AND ENGINEERING POLYMERS 8

Classification of polymer – Mechanisms of polymerisation – Copolymers – Examples- Defects in polymers- Thermoplastics - Thermosets (PP, PS, PVC, PMMA, PET,PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE, Polymers – Urea and Phenol formaldehydes)– Engineering plastics - Advanced Polymeric materials -Liquid crystal polymers - Conductive polymers – High Performance fibres– Photonic polymers- -Elastomers- Applications.

TOTAL: 45 PERIODS

OUTCOMES:

- Recognise basic nomenclature, basic microstructure, associate terms with the appropriate structure / phenomena and be able to differentiate between related structure / phenomena.
- Perform simple calculations to qualify materials properties and microstructural characteristics.
- Recognise the effect of composition and microstructure on material properties.
- Ability to perform phase equilibrium calculation and construct phase diagram.
- Select suitable ferrous and non-ferrous materials for Engineering application.

TEXT BOOKS:

1. William D. Callister, Jr., “Materials Science and Engineering an Introduction”, Second 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”, 5thEdition, 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, “Structure and Properties of Engineering Alloys”, Mc-Graw-Hill Inc., U.S.A, 2nd edition, 1993.
6. Kingery, W. D., Bowen H. K. and Uhlmann, D. R., “Introduction to Ceramics”, 2nd Edition, John Wiley & Sons, New York, 1976.

ML6304 PROCESSING OF IRON AND STEEL L T P C
3 0 0 3

OBJECTIVES:

- 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 9

Iron ore classification, Indian iron ores, limestone and coking coal deposits, problems associated with Indian raw materials, Iron ore beneficiation and agglomeration, Briquetting, sintering, Nodulising and pelletizing, testing of burden materials, burden distribution on blast furnace performance.

UNIT II PRINCIPLES AND PROCESSES OF IRON MAKING 9

Blast furnace parts, construction and design aspects, ancillary equipment for charging, preheating the blast, hot blast stoves, gas cleaning, Blast furnace operation, irregularities and remedies, Blast furnace instrumentation and control of furnace 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, Ellingham diagram, material and heat balance- Sponge Iron making.

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 Theories, slag-functions, composition, properties and theories, raw materials for steel making and plant layout.

UNIT IV STEEL MAKING PROCESSES 10

Open Hearth process- constructional features, process types, operation, modified processes, Duplexing, pre-treatment of hot metal. Bessemer processes, Side Blown Converter, 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-Electric Arc and Induction furnace-constructional features. Steel Classifications and Standards- National and International.- Alloy Designation.

UNIT V STEEL LADLE METALLURGY 8

Production practice for plain carbon steels, low alloy – stainless, tool and special steels, modern developments. Secondary steel making processes, continuous steel casting process – Deoxidation and teeming practice. Principle, methods and their comparison, Killed, Rimmed and Capped steels, Degassing practices, ingot production, ingot defects and remedies. Recent trends in steel making technology.

TOTAL: 45 PERIODS

OUTCOMES

- Explain operation of burden
- Explain the operation of different furnaces and processing of iron
- Performs Physical chemical calculations for steel making
- Use of different protocols for steel making
- Use of Ladle metallurgy for alloy steel processing

TEXTBOOKS:

1. Tupkary, R. H., "Modern Iron Making", 4th edition, Khanna Publishers, New Delhi.
2. Tupkary, R. H., "Modern Steel Making", 4th Edition, Khanna Publications, New Delhi.

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,
4. 1964.
5. "Making, Shaping and Treating of Steel", US Steel Corporation, 11th edition, 1994.
6. Ahindra Ghosh and Amit chatterjee, "Iron Making and Steel Making – Theory and Practice", Prentice Hall of India Private Ltd., New Delhi 2008.

CE6315 STRENGTH OF MATERIALS LABORATORY L T P C
0 0 3 2

OBJECTIVES

To supplement the theoretical knowledge gained in Mechanics of Solids with practical testing for determining the strength of materials under externally applied loads. This would enable the student to have a clear understanding of the design for strength and stiffness

LIST OF EXPERIMENTS

1. Tension test on a mild steel rod
2. Double shear test on Mild steel and Aluminium rods
3. Torsion test on mild steel rod
4. Impact test on metal specimen
5. Hardness test on metals - Brinnell and Rockwell Hardness Number
6. Deflection test on beams
7. Compression test on helical springs
8. Strain Measurement using Rosette strain gauge
9. Effect of hardening- Improvement in hardness and impact resistance of steels.
10. Tempering- Improvement Mechanical properties Comparison

(i) Unhardened specimen
(ii) Quenched Specimen and
(iii) Quenched and tempered specimen.

11. Microscopic Examination of

(i) Hardened samples and
(ii) Hardened and tempered samples.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to perform different destructive testing
- Ability to characteristic materials

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Universal Tensile Testing machine with double 1 shear attachment – 40 Ton Capacity	1
2	Torsion Testing Machine (60 NM Capacity)	1
3	Impact Testing Machine (300 J Capacity)	1
4	Brinell Hardness Testing Machine	1
5	Rockwell Hardness Testing Machine	1
6	Spring Testing Machine for tensile and compressive loads (2500 N)	1

7	Metallurgical Microscopes	3
8	Muffle Furnace (800 C)	1

ML6311 MICROSTRUCTURE ANALYSIS LABORATORY L T P C
0 0 3 2

OBJECTIVES:

- To have knowledge on the microstructures of some common types of metals and alloys and the grain size analysis of the given microstructure.

LIST OF EXPERIMENTS

1. Study of metallurgical microscope and sample preparation.
2. Quantitative Metallography – Grain Size, Nodule count, Amount of Phases.
3. Macro etching - cast, forged and welded components.
4. Microscopic examination of cast irons - Gray, White, Malleable and Nodular types
5. Microscopic examination of Plain carbon steels (low carbon, medium carbon, high carbon steels).
6. Microscopic examination of Austenitic Stainless steels and High Speed Steels.
7. Microscopic examination of banded structure in steels and welded joints.
8. Microscopic examination of Copper alloys
9. Microscopic examination of Aluminium alloys
10. Microscopic examination of Titanium alloys
11. Colour mettalography

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to analyse the microstructure and perform grain size, Phase, Porosity calculate from different ferrous and non-ferrous alloys.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl. No.	Description of Equipment	Quantity
1.	Mounting Press	2
2.	Belt Grinder	2
3.	polishing table with row of flat slant metal pieces to fix emery sheets	6
4.	Disc polishing equipment	6
5.	Abrasive Cutter	2
6.	Metallographic Microscope with image analyzer	2

ML6401 MECHANICAL BEHAVIOUR OF MATERIALS L T P C
3 1 0 4

OBJECTIVES

- 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

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 .

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES

- Students will demonstrate and understanding of the mechanical properties and behaviour of materials.
- In the concept of linear elastic fracture mechanics and estimate the effects of cracks in material and structure.
- Students will demonstrate the ability to identify engineering problem in using plastic deformation, fatigue, fracture and creep
- Assues and describe the mechanism loading to failure when provided with a failure example.

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. Honey combe 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.

ME6504 METROLOGY AND MEASUREMENTS L T P C
3 0 0 3

OBJETCTIVES:

- 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

OUTCOMES:

The Students can understand different measurement technologies and use of them in Industrial Components

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.

ML6402 NON-FERROUS METALLURGY L T P C
3 0 0 3

OBJECTIVES:

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

UNIT I COPPER AND COPPER ALLOYS 10

Methods of Production of Copper, Properties and applications of metallic copper. Major alloys of copper and designation- Brasses. Phase diagram of industrially relevant portion. Different compositions, characteristics and uses. Bronzes: Tin bronze. Composition, properties and uses. Other bronzes like Cu-Al, Cu-Si, Cu-Mn and Cu-Be alloys. Cu-Ni alloys. Typical microstructure of copper alloys.

UNIT II ALUMINIUM AND ITS ALLOYS 9

Methods of Production of Aluminium- Properties of metallic aluminium. Alloys of aluminium and designation, classification. Wrought and cast alloys. Heat treatable and nonheat treatable alloys. Age hardening of Al-Cu alloy. Al-Mg-Si, Al-Zn-Mg and Al-Li alloys. Typical microstructure of aluminium alloys. Applications of Al alloys in Automobile an Aircraft industries.

UNIT III MAGNESIUM AND TITANIUM ALLOYS 9

Methods of Production of Magnesium- properties and uses. Magnesium alloys and designation. Methods of Production of Titanium- unique characteristics of the metal- alpha, alpha+beta and beta titanium alloys- major types. Titanium aluminides – their properties and uses. Typical microstructure of magnesium and titanium alloys- Applications of Ti alloys in Aircraft, Chemical and Medical industries.

UNIT IV NICKEL AND ZINC ALLOYS 9

Methods of Production of Nickel-Properties and uses of nickel. Nickel alloys and designation – their properties and uses. Nickel aluminides. Methods of Production of Zinc-Use of zinc in corrosion protection of ferrous materials. Zinc alloys – properties and uses. Typical microstructure of nickel and zinc alloys.

UNIT V LEAD, TIN AND PRECIOUS METALS 8

Methods of Production of Lead and Tin-Major characteristics and applications of lead and tin and their alloys and designation. Low melting nature of solder alloys. Gold, silver and platinum – nobility of these metals. Engineering properties and applications of these metals and their alloys. Typical microstructure of solder alloys

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, the students can able to

- Classify types of materials based on nonferrous metals.
- Describe preparation and heat treatment and processing of nonferrous metals.
- Enumerate (or) select suitable application of alloys of non-ferrous metals.

TEXT BOOKS:

1. Sidney H. Avner, “Introduction to Physical Metallurgy”, Tata McGraw-Hill, 2nd Edition,1997.
2. K.G.Budinski and M.K.Budinski, “Engineering Materials-- Properties and Selection”, PHI Learning Pvt. Ltd., New Delhi, 2009.

REFERENCES:

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

4. Balram Gupta,"Aerospace Materials", Vol. 1, 2 and 3, S. Chand and Co., New Delhi, 1996.
5. Ahindra Ghosh, Hem Shanker Ray, "Principles of Extractive Metallurgy", New Age International, Reprint 2001.

ML6403 POWDER METALLURGY L T P C
3 0 0 3

OBJECTIVES:

- 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 POWDER MANUFACTURE AND CONDITIONING 12

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, Self-propagating high-temperature synthesis (SHS), sol-gel synthesis- Nano powder production methods.

UNIT II CHARACTERISTICS AND TESTING OF METAL POWDERS 8

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 III POWDER COMPACTION 7

Pressure less 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-batch and continuous-sintering atmosphere, Finishing operations – sizing, coining, repressing and heat treatment, special sintering processes- microwave sintering, Spark plasma sintering, Field assisted sintering, Reactive sintering, sintering of nanostructured materials.

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

OUTCOMES:

- Upon completion of this course, the students can able to apply the student will have knowledge about powder metallurgical material and their fabrication processes.

TEXT BOOKS:

1. P.C.Angelo and R.Subramanian., “Powder Metallurgy: Science, Technology and Application” Prentice Hall, 2008
2. Anish Upadhya and G S Upadhaya, “Powder Metallurgy: Science, Technology and Materials, Universities Press, 2011

REFERENCES:

1. Sinha A. K., “Powder Metallurgy”, Dhanpat Rai & Sons. New Delhi, 1982
2. R.M. German, “Powder Metallurgy and Particulate Materials Processing”, Metal Powder Industries Federation, Princeton, NJ, 2005.
3. ASM Handbook. Vol. 7, “Powder Metallurgy”, Metals Park, Ohio, USA, 1990.
4. Animesh Bose., “Advances in Particulate Materials”, Butterworth - Heinemann. New Delhi, 1995.
5. Kempton. H Roll., “Powder Metallurgy”, Metallurgical Society of AMlE, 1988.
6. Ramakrishnan. P., “Powder Metallurgy-Opportunities for Engineering Industries”, Oxford and IBH Publishing Co., Pvt. Ltd, New Delhi, 1987.
7. Erhard Klar., “Powder Metallurgy Applications, Advantages and Limitations”, American Society for Metals, Ohio, 1983.
8. Sands. R. L. and Shakespeare. C. R. “Powder Metallurgy”, George Newes Ltd. London, 1966

ML6404 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 12

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.

UNITII BAND THEORY OF SOLIDS AND SEMICONDUCTOR PHYSICS 12

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, , 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 12

Macroscopic description of the static dielectric constant. The electronic and ionic polarizabilities of molecules, orientational polarization, Measurement of the dielectric constant of a solid. Theinternal

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 12

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 12

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).

TOTAL: 60 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to use semiconductor materials for the application.

TEXT BOOKS:

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

REFERENCES:

1. Charles Kittel.," Introduction to Solid State Physics", John Wiley, 8th edition, 2005.
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

ML6405 PHASE TRANSFORMATIONS 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 super cooling - Extension to heterogeneous nucleation - Nucleation rate and growth rate - overall transformation rate. Concept of Activation energy - Arrhenius equation - Johnson Mehl - Avrami equation. Pearlitic transformations- spinodal decomposition

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 rerystallisation.

TOTAL : 45 PERIODS

OUTCOMES

The course seeks to develop and understanding of the thermodynamic during force for the phase transformation and the role that chemical during forces strain energy and interfacial energy play in powdering or modifying these during forces .

- Ability to calculate single component and multi component phase diagram from thermodynamic data or solution models.
- An appreciation of the importance and energy characteristic of surface and interfaces and their impact on equilibrium microstructures and capacity drives process.
- Ability of solve problems involving steady state and non steady state diffusion of varying degrees of complexity and to understanding the spatio temporal sealing behavior of solution to such diffusion problems.

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”, 1st Edition, CRC, 2003.
4. Anil Sinha, “Physical Metallurgy Handbook”, 1st Edition, McGraw-Hill Professional; 2002.
5. William F. Hosford, “Physical Metallurgy, Materials Engineering Series”, Vol. 26, Taylor & Francis CRC Press, 2005.

ME6513 METROLOGY AND MEASUREMENTS LABORATORY L T P C

0 0 3 2

OBJECTIVES

- To familiar with different measurement equipments and use of this industry for quality inspection

LIST OF EXPERIMENTS

1. Tool Maker's Microscope
2. Comparator
3. Sine Bar
4. Gear Tooth Vernier Caliper
5. Floating gauge Micrometer
6. Co ordinate Measuring Machine
7. Surface Finish Measuring Equipment
8. Vernier Height Gauge
9. Bore diameter measurement using telescope gauge
10. Bore diameter measurement using micrometer
11. Force Measurement
12. Torque Measurement
13. Temperature measurement
14. Autocollimator

TOTAL: 45 PERIODS

OUTCOMES

- Ability to handle different measurement tools and perform measurements in quality impulsion

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Micrometer	5
2	Vernier Caliper	5
3	Vernier Height Gauge	2
4	Vernier depth Gauge	2
5	Slip Gauge Set	1
6	Gear Tooth Vernier	1
7	Sine Bar	1
8	Floating Carriage Micrometer	1
9	Profile Projector / Tool Makers Microscope	1
10	Parallel/counter flow heat exchanger apparatus	1
11	Mechanical / Electrical / Pneumatic Comparator	1
12	Autocollimator	1
13	Temperature Measuring Setup	1
14	Force Measuring Setup	1
15	Torque Measuring Setup	1
16	Coordinate measuring machine	1
17	Surface finish measuring equipment	1
18	Bore gauge	1
19	Telescope gauge	1

ME 6465 MANUFACTURING TECHNOLOGY LABORATORY L T P C
0 0 3 2

OBJECTIVES:

- Demonstration and study of the VARIOUS machines. The Main emphasis will be on a complete understanding of the machine capabilities and processes.

LIST OF EXPERIMENTS

UNIT I LATHE PRACTICE
a. Plain Turning
b. Taper Turning
c. Thread Cutting
d. Estimation of machining time for the above turning processes.

UNIT II DRILLING PRACTICE
a. Drilling
b. Tapping
c. Reaming.

UNIT III MILLING
a. Surface Milling.
b. Gear Cutting.
c. Contour Milling.

UNIT IV PLANNING AND SHAPING
a. Cutting Key Ways.
b. Dove tail machining.

TOTAL: 45 PERIODS

OUTCOMES:
- Ability to use different machine tools to manufacturing gears.
- Ability to use different machine tools for finishing operations
- Ability to manufacture tools using cutter grinder
- Develop CNC part programming

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. No.	NAME OF THE EQUIPMENT	Qty.
1	Lathe	15 Nos.
2	Drilling Machine	1 No.
3	Milling Machine	2 Nos.
4	Planning Machine	1 No
5	Shaping Machine	2 Nos.

ML6412 FOUNDRY AND POWDER METALLURGY LABORATORY L T P C
0 0 3 2

FOUNDRY PRACTICES

OBJECTIVES:
- To make students learn about melting of metals, casting of metals and various sand testing methods.

LIST OF EXPERIMENTS
1. Determination of Average Sand grain Fineness
2. Determination of Moisture content in Sand
3. Determination of Permeability of Green Sand
4. Estimation of Active clay content in Sand

5. Loss on Ignition Test for Green moulding Sand
6. Determination of Green Compression and Shear Strength
7. Determination of Dry Compression Strength
8. Determination of Scratch Hardness.
9. Determination of Compatibility
10. Metal Casting by Green sand and full mould process

OUTCOMES:

- Ability to characteristic the raw materials used in Foundary
- Ability to perform Foundary practices
- Ability to casting powder
- Ability to perform powder compaction and sintering

POWDER METALLURGY

OBJECTIVES

- This laboratory course offers practical knowledge of powder metallurgy: powder synthesis, compaction and sintering.

LIST OF EXPERIMENTS

1. Powder Production by wet chemical synthesis
2. Powder size reduction by Ball Milling
3. Sieve Analysis Particle size distribution
4. Measurement of Apparent and Tap Density of Powders
5. Measurement of Flow Rate of Powders
6. Determination of optimum compaction pressure.
7. Density determination of sintered product.
8. Fracture Toughness determination of sintered product.
9. Preparation of porous ceramic product.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to produce and characterize the powders.
- Ability to prepare powder metallurgical compare and perform density and fracture toughness.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl. No.	Description of Equipment	Quantity
1.	Sieve shaker with set of sieves	1
2.	Infrared Moisture balance	2
3.	Permeability meter	1
4.	AFS sand rammer, base block, base permeability tube, tube filler accessory.	1
5.	Clay washer	1
6.	Muffle furnace	1
7.	Universal strength testing machine (Hydraulic)	1
8.	Scratch hardness tester	1
9	Compactablity specimen tube, Compactablity scale, Knife	1
10	Moulding box with patterns	1
11	Sand mixer	1
12	Digital top balance	1

ML6501 THEORY AND APPLICATIONS OF METAL FORMING **L T P C**
3 0 0 3

OBJECTIVES:

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

UNIT I STRESS - STRAIN TENSOR **9**

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, Slip, twinning, Forming load calculations, Strain Rate Tensor.

UNIT II FUNDAMENTALS OF METAL FORMING **9**

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

UNIT III FORGING AND ROLLING **9**

Forging-Hot, Cold and Warm Forging – types of presses and hammers. Classification, Open die forging and Closed die forging, die design, forging in plane strain, calculation of forging loads, use of software for analysis - 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 **9**

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 road, wires and tubes.

UNIT V SHEET METAL FORMING AND OTHER PROCESSES **9**

Forming methods – Shearing, Fine and Adiabatic blanking, bending, stretch forming, deep drawing, defects in formed part, sheet metal formability, forming limit diagram. High velocity forming, Comparison with conventional forming, Explosive forming, Electro hydraulic, Electro Magnetic forming, Dynapark and petroforge forming.

TOTAL : 45 PERIODS

OUTCOMES:

- Ability to make use of mechanical and thermodynamics principle of plastic deformation to form the components using different techniques.

TEXT BOOKS:

1. Dieter. G. E., “Mechanical Metallurgy”, Mc Graw – Hill Co., SI Edition, 1995.
2. Surender Kumar, “Technology of Metal Forming Processes”, PHI, New Delhi, 2008.

REFERENCES:

1. Kurt Lange, “Handbook of Metal Forming”, Society of Manufacturing Engineers, Michigan, USA, 1998.
2. Nagpal G. R., “Metal Forming Processes”, Khanna Pub., New Delhi, 2000
3. Avitzur, “Metal Forming – Process and Analysis”, Tata McGraw – Hill Co., New Delhi, 1977.
4. Shiro Kobayshi, Altan. T, "Metal Forming and Finite Element Method", Oxford University Press, 1987.
5. Dr.Sadhu Singh, “Theory of plasticity and Metal Forming Processes”, Khanna Publishers, 2005.
6. William F. Hosford and Robert M. Caddell, “Metal Forming Mechanics and Metallurgy”, Cambridge Press,2011.

ML6502 **MATERIAL ASPECTS IN DESIGN** **L T P C**
3 1 0 4

OBJECTIVES

- 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

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

- Ability to use different design criteria and failure criteria for safe design of components.

TEXT BOOKS:

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

REFERENCE:

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

ML6503 **CHARACTERIZATION OF MATERIALS** **L T P C**
3 0 0 3

OBJECTIVES:

- 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 and transmission electron microscopy as well as surface analysis.

UNIT I METALLOGRAPHIC TECHNIQUES 8

Macro examination - applications, metallurgical microscope - principle, construction and working, metallographic specimen preparation, optic properties - magnification, numerical aperture, resolving power, depth of focus, depth of field, different light sources lenses aberrations and their remedial measures, various illumination techniques-bright field , dark field, phase-contrast polarized light illuminations, interference microscopy, high temperature microscopy; quantitative metallography – Image analysis

UNIT II X-RAY DIFFRACTION TECHNIQUES 10

Crystallography basics, reciprocal lattice, X-ray generation, absorption edges, 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. Diffractometer – General feature and optics, proportional, Scintillating and Geiger counters.

UNIT III ANALYSIS OF X-RAY DIFFRACTION 9

Line broadening, particle size, crystallite size, Precise parameter measurement, Phase identification, phase quantification, Phase diagram determination X-ray diffraction application in the determination of crystal structure, lattice parameter, 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, Selected Area Electron Diffraction, electron-specimen interactions, Construction, modes of operation and application of Scanning electron microscope, Electron probe micro analysis, basics of Field ion microscopy (FIB), Scanning Tunneling Microscope (STM) and Atomic Force Microscope(AFM).

UNIT V CHEMICAL AND ADVANCED THERMAL ANALYSIS 9

Surface chemical composition- Mass spectroscopy and X-ray emission spectroscopy (Principle and limitations) - Energy Dispersive Spectroscopy- Wave Dispersive Spectroscopy- Quadrapole mass spectrometer. Electron spectroscopy for chemical analysis (ESCA), Ultraviolet Photo Electron Spectroscopy (UPS), X ray Photoelectron Spectroscopy (XPS), Auger Electron Spectroscopy (AES), Electron Energy Analysers, Secondary ion mass spectrometry - Applications. Unit meshes of five types of surface nets - diffraction from diperiodic structures using electron, Low Energy Electron Diffraction (LEED), Reflection High Energy Electron Diffraction (RHEED)-TGA

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to perform analysis of X ray diffraction and electon microscope images and the chemical and thermal analysis datas.

TEXT BOOKS:

1. Cullity, B. D.," Elements of X-ray diffraction", 3rd Edition, Addison-Wesley Company Inc., New York, 2000
2. Phillips V A, "Modern Metallographic Techniques and their Applications", Wiley Eastern,1971.

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. Whan R E (Ed), ASM Handbook, Volume 10, Materials Characterisation", Nineth Edition,

ASM international, USA, 1986.
5. Haines, P.J.," Principles of Thermal Analysis and Calorimetry", Royal Society of Chemistry (RSC), Cambridge, 2002.
6. D. A. Skoog, F. James Leary and T. A. Nieman, "Principles of Instrumental Analysis", Fifth Edition, Saunders Publishing Co., 1998

ML6504 HEAT TREATMENT OF METALS AND ALLOYS L T P C
3 0 0 3

OBJECTIVES:

The course covers the fundamental aspects of the theory and practice of heat treatment of metals and alloys. It provides a comprehensive understanding of the various transformation reactions associated with the changes in microstructure and property that occur due to controlled heat treatment.

UNIT I TRANSFORMATIONS IN STEELS 10

Allotropic changes in Iron, Iron-Iron carbide 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 – Time-Temperature- Transformation curves (TTT-diagrams), continuous cooling transformations – CCT-diagrams - effect of alloying additions on TTT diagrams, mechanism and kinetics of pearlitic, bainitic and martensitic transformations – precipitation hardening

UNIT II HEAT TREATMENT PROCESSES 9

Annealing- Types, Normalising, Hardening & Quenching –Mechanisms-hardenability studies – Jominy end-quench test, Grossman's experiments, tempering – Hollomon & Jaffe tempering correlations, tempering – tempered brittleness – effects of alloying elements on tempering, austempering and martempering, precipitation hardening, thermomechanical treatment, intercritical heat treatment, polymer quenching, sub-zero treatment – cryogenic quenching, patenting

UNIT III CASE HARDENING 9

Introduction, carburisation – principle – carbon potential – mechanism – application of Fick's law – depth of carburisation and its control – methods of carburising – heat treatment after carburising– structure, properties and defects in carburising, nitriding – mechanism – retained austenite – Remedy- effect of microstructure – nitriding methods, ion-nitriding and nitro-carburising, boronising, chromising, cyaniding and carbonitriding, induction and flame hardening, Laser and Electron beam hardening and welding – principles – methods – operating variables, measurement of case depth

UNIT IV FURNACES, ATMOSPHERE AND PROCESS CONTROL 8

Various heating atmosphere used for heat treatment, temperature and atmosphere control – carburising atmosphere and carbon potential measurement, Temperature Measurement Control devices – Nitriding gas atmospheres, quenching media and their characteristics, Stages of Quenching, Various Heat Treatment furnaces- Roller and Mesh type continuous furnaces- fluidised bed furnaces, cryo-chamber, cryo-treatment of steels, sealed quenched furnace, plasma equipment- Elements of Process control systems-PLC ,PID controllers and continuous monitoring systems.

UNIT V HEAT TREATMENT OF SPECIFIC ALLOYS 9

Heat treatment of special purpose steels – tool steels, high speed steels, maraging steels, SLA steels and die steels, heat treatment of cast irons – gray cast irons, white cast irons and S.G.irons, austempering of S.G.Iron, heat treatment of non-ferrous alloys – aluminium alloys, copper alloys, nickel alloys and titanium alloys, defects in heat treated parts – causes and remedies.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to select and perform heat treatment for different ferrous and non-ferrous alloy.
- ability to identify the microstructure and analyse different phase after heat treatment.

TEXT BOOKS:

1. Sydney H. Avner, “Introduction to Physical Metallurgy”, Tata McGraw Hill, New Delhi,1997.
2. Rajan, T. V., Sharma, C. P., Ashok Sharma., “Heat Treatment Principles And Techniques” Prentice-Hall of India Pvt. Ltd., New Delhi, 2002

REFERENCES:

1. Vijendra Singh, “Heat Treatment of Metals”, Second Edition, Standard Publishers Distributors New Delhi, 2009.
2. Prabhudev. K. H. “Handbook of Heat Treatment of Steels”, Tata McGraw-Hill Publishing Co., New Delhi, 1988.
3. Novikov, “Theory of Heat Treatment of Metals”, MIR Publishers, Moscow, 1978.
4. ASM Hand book “Heat Treating”, Vol.4., ASM International, 1999.

ML6505 WELDING METALLURGY L T P C

3 0 0 3

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

OUTCOMES:

- Ability to select and design Welding Materials, differential processes and inspection techniques based on the materials and application and complexity of the component
- An ability to develop inspection procedure for the Weld ability

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.

ML6506 CORROSION AND SURFACE ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- 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 to 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-Hydrogen embrittlement - Remedial Measures.

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 OF INDUSTRIAL COMPONENTS 8

Corrosion in fossil fuel power plants, Automotive industry, Chemical processing industries, corrosion in petroleum production operations and refining, Corrosion of pipelines.- wear of industrial components

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 **9**

Organic, Inorganic and Metallic coatings, electro and Electroless plating and Anodising - Cathodic protection, 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

OUTCOMES

- Ability to control the factors affects the metal corrosion.
- Ability to measure the corrosion rate.
- Ability to prevent corrosion by coatings and inhibitors, etc.

TEXT BOOKS:

1. Fontana and Greene. “Corrosion Engineering”. McGraw Hill Book Co. New York. USA1986.
2. Kenneth G Budinski. “Surface Engineering for Wear Resistance”. Prentice Hall Inc.. Engelwood Cliff., New Jersey. USA 1988

REFERENCES:

1. Denny A. Jones,”Principles and Prevention of Corrosion” 2nd Edition, Prentice Hall of India,1996.
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
5. Raj Narayan. “An Introduction to Metallic Corrosion and its prevention”, Oxford & 1BH, New Delhi,1983.

ML6511 HEAT TREATMENT LABORATORY **L T P C**
0 0 3 2

OBJECTIVES:

- This laboratory course offers practical knowledge of heat treatment applicable to Ferrous as well as Non-Ferrous materials and studies micro structural changes and hardness evaluation.

LIST OF EXPERIMENTS

1. Annealing and normalising of hardened steels
2. Spheroidisation annealing of high carbon steels
3. Effect of quenching media on hardening of steel
4. Effect of tempering temperature and time on tempering of steel
5. Effect of carbon percentage on the hardness of steel
6. Carburizing of steel
7. Case hardness depth measurements
8. Austempering treatment
9. Hardenability test – Jominy End Quench Test
10. Heat treatment of cast iron
11. Heat treatment of Stainless Steels and High speed steels

12. Heat treatment of non-ferrous alloys
13. Estimation of Ferrite

TOTAL: 45 PERIODS

OUTCOMES:

Ability to perform different heat treatment operation and characterise the microstructure.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl. No.	Description of Equipment	Quantity
1.	Heat treatment furnace	1
2.	Joining end Quench test apparatus	1
3.	Hardness testing machine	1
4.	Optical microscope with usage analyser	1

ML6512 METAL FORMING AND WELDING ANALYSIS LABORATORY L T P C
0 0 3 2

OBJECTIVES:

To acquire knowledge on basic metal forming processes by experimental study and analysis

METAL FORMING:

1. Formability of sheet metal by Ericsson cupping test
2. Thickness reduction in sheet metal rolling
3. Deep drawing for simple cup shape
4. Diameter reduction in wire drawing
5. Extrusion of cylindrical component
6. Non destructive test of metal formed components

WELDING ENGINEERING:

1. Weldability test – Bend test
2. Weld decay test
3. Macro etching analysis of welded component
4. Micro hardness analysis of welded components
5. Micro structural analysis of welded components
6. Non destructive test of welded components

TOTAL : 45 PERIODS

OUTCOMES:

- Ability to perform metal forming and welding
- Ability to evaluate the properties of processed component.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl. No.	Description of Equipment	Quantity
1.	Ericson Cup test machine	1
2.	Three roll mill	1
3.	Hydraulic press 60T	1
4.	Extrusion die – cold	1
5.	Die penetration test	1

6.	Ultrasonic flaw detector	1
7.	UTM	1
8.	Vicker Hardness tester	1
9.	Image analyser	1

ML6513 PRESENTATION SKILLS AND TECHNICAL SEMINAR L T P C
0 0 2 1

OBJECTIVES:

- To encourage the students to study advanced engineering developments
- To prepare and present technical reports.
- To encourage the students to use various teaching aids such as over head projectors, power point presentation and demonstrative models.

METHOD OF EVALUATION :

During the seminar session each student is expected to prepare and present a topic on engineering/ technology, for a duration of about 8 to 10 minutes. In a session of three periods per week, 15 students are expected to present the seminar. Each student is expected to present atleast twice during the semester and the student is evaluated based on that. At the end of the semester, he / she can submit a report on his / her topic of seminar and marks are given based on the report. A Faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also. Evaluation is 100% internal.

TOTAL : 30 PERIODS

OUTCOMES:

- Ability to review, prepare and present technological developments
- Ability to face the placement interviews

ML6601 POLYMER PROCESS ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- The subject exposes students to the basics of polymer, polymerisation, condensation, their properties and overview of manufacturing.

UNIT I POLYMERIZATION 9

Fundamentals of polymers – monomers – functionality - Classification – characterization –. Types of Polymerization: cationic polymerization – anionic polymerization – coordination polymerization – free radical polymerization. Copolymerization concepts - Simple condensation reactions – Extension of condensation reactions to polymer synthesis – functional group reactivity. Polycondensation – kinetics of polycondensation - Carother's equation – Linear polymers by polycondensation – Interfacial polymerization – crosslinked polymers by condensation – gel point.

UNIT II MOLECULAR WEIGHTS OF POLYMERS 9

Number average and weight average molecular weights – Degree of polymerization – molecular weight distribution – Polydispersity – Molecular weight determination- Different methods – Gel Permeation Chromatography

UNIT III TRANSITIONS IN POLYMERS 9

First and second order transitions – Glass transition, Tg – multiple transitions in polymers – experimental study – significance of transition temperatures. Crystallinity in polymers – effect of crystallization – factors affecting crystallization, crystal nucleation and growth – Relationship between Tg and Tm – Structure–Property relationship.

UNIT IV SOLUTION PROPERTIES OF POLYMERS 9

Size and shape of the macromolecules – Solubility parameter – polymer/solvent interaction parameter – temperature – size and molecular weight. Solution properties of polymers. Importance of Rheology – Newtonian and Non-Newtonian flow behaviour – Polymer melts Rheology.

UNIT V POLYMER PROCESSING 9

Overview of Features of Single screw extruder –Tubular blown film process - Coextrusion.- Injection Moulding systems – Compression & Transfer Moulding - Blow Moulding – Rotational Moulding – Thermoforming – Vacuum forming -Calendering process – Fiber Spinning process –Structural Foam Moulding – Sandwich Moulding.Processing for Thermosets- Reaction Injection Moulding & Reinforced Reaction Injection Moulding.

TOTAL: 45 PERIODS

OUTCOMES:

- Use of techniques for polymer processing.
- Ability to develop structure – property relationship in polymer.

TEXT BOOKS:

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

REFERENCES:

1. Billmayer Jr. and Fred. W., “Textbook of Polymer Science”, WileyTappers, 1965.
2. David, J. W., “Polymer Science and Engineering”, Prentice Hall,1971.
3. Schmidt, A. K. and Marlies, G. A., “High Polymers - Theory and Practice”, McGraw Hill,1948.
4. McKelvey, J. M., “Polymer Processing”, John Wiley, 1962.
5. Rodriguez, F., Cohen.C., Oberic.K and Arches, L.A., Principles of Polymer Systems, 5th Edition, Taylor and Francis, 2003.
6. Crawford R.J, "Plastics Engineering" 3rd Edition, Pergamon Press, London 1987

ML6602 CREEP AND FATIGUE BEHAVIOUR OF MATERIALS L T P C
3 0 0 3

OBJECTIVES:

- The useful life of components is 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 - LM parameter-– Extrapolation procedure for creep rupture data – materials for elevated temperature rules.

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-factors affecting fatigue-size, temp, surface condition-microstructure-soderburg and goodman equation

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-paris equation-fatigue life prediction

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: 45 PERIODS

OUTCOMES:

- Identify the fracture due to creep and fatigue
- Use of suitable mathematical equation to predict ability the crack growth rate
- Ability to perform failure analysis

TEXT BOOKS:

1. Richard. W. Hertzberg," Deformation and Fracture Mechanism of Engineering Materials", 4th Edition, John Willey and Sons, 1996.
2. Anderson, T. L., " Fracture Mechanics: Fundamentals and Applications", 2nd Edition, CRC Press, 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 Edition, Pergamon Press, 1984.
4. Frost & Ashby, "Deformation - Mechanism Maps", 1st Edition, Pergamon Press, 1982.
5. Suresh, S.," Fatigue of Materials", 2nd Edition, Cambridge University Press, 1998.
6. Cadek, J.," Creep in Metallic Materials", Elsevier, 1988.
7. Ashok Saxena," Nonlinear Fracture Mechanics for Engineers", CRC Press, 1998.

GE6351 ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C

3 0 0 3

OBJECTIVES:

To the study of nature and the facts about environment.

- To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth's interior and surface.

- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 12

Definition, scope and importance of Risk and hazards; Chemical hazards, Physical hazards, Biological hazards in the environment – concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers-Oxygen cycle and Nitrogen cycle – energy flow in the ecosystem – ecological succession processes – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds
Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION 10

Definition – causes, effects and control measures of: (a) Air pollution (Atmospheric chemistry- Chemical composition of the atmosphere; Chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, oxygen and ozone chemistry;- Mitigation procedures- Control of particulate and gaseous emission, Control of SO_2, NO_X, CO and HC) (b) Water pollution : Physical and chemical properties of terrestrial and marine water and their environmental significance; Water quality parameters – physical, chemical and biological; absorption of heavy metals - Water treatment processes. (c) Soil pollution - soil waste management: causes, effects and control measures of municipal solid wastes – (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards–role of an individual in prevention of pollution – pollution case studies –
Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and overutilization of surface and ground water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Energy Conversion processes – Biogas – production and uses, anaerobic digestion; case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Introduction to Environmental Biochemistry: Proteins –Biochemical degradation of pollutants, Bioconversion of pollutants.
Field study of local area to document environmental assets – river/forest/grassland/hill/mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – 12 Principles of green chemistry- nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production act – Air act – Water act – Wildlife protection act – Forest conservation act – The Biomedical Waste (Management and Handling) Rules; 1998 and amendments- scheme of

labeling of environmentally friendly products (Ecomark). enforcement machinery involved in environmental legislation- central and state pollution control boards- disaster management: floods, earthquake, cyclone and landslides.
Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare –Environmental impact analysis (EIA)- -GIS-remote sensing-role of information technology in environment and human health – Case studies.

TOTAL : 45 PERIODS

OUTCOMES:

Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.

- Public awareness of environmental is at infant stage.
- Ignorance and incomplete knowledge has lead to misconceptions
- Development and improvement in std. of living has lead to serious environmental disasters

TEXT BOOKS :

1. Gilbert M.Masters, "Introduction to Environmental Engineering and Science", 2nd Edition, Pearson Education 2004.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2006.

REFERENCES :

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia',Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, "Environmental Law", Prentice Hall of India Pvt Ltd, New Delhi, 2007.
4. Rajagopalan, R, "Environmental Studies-From Crisis to Cure", Oxford University Press (2005)

ML6603 COMPOSITE MATERIALS L T P C
3 0 0 3

OBJECTIVES:

- 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. The Motive is to make the students to understand different processing methods, issues, properties and testing methods of different composite materials

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. Fiber production techniques for glass, carbon and ceramic fibers

UNIT II POLYMER MATRIX COMPOSITES 12

Polymer 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 (GFRP). Laminates- Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates.-applications of PMC in aerospace, automotive industries

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, a spray process, Liquid infiltration In-situ reactions-Interface-measurement of interface properties- applications of MMC in aerospace, automotive industries

UNIT IV CERAMIC MATRIX COMPOSITES AND SPECIAL 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 (CIPing) – Hot isostatic pressing (HIPing). applications of CMC in aerospace, automotive industries- 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- Processing of Ceramic Matrix composites.

UNIT V MECHANICS OF COMPOSITES 7

Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Definition of stress and Moment Resultants. Strain Displacement relations.

Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

TOTAL: 45 PERIODS

OUTCOMES:

- Use of different material to design composites
- Use of different techniques to process different types of composites and know the limitations of each process
- Use of Mathematical techniques to predict the macroscopic properties of different Laminates

TEXT BOOKS:

1. Mathews F. L. and Rawlings R. D., "Composite Materials: Engineering and Science", 1st Edition, Chapman and Hall, London, England, 1994.
2. Chawla K. K., "Composite materials", Second Edition, Springer – Verlag, 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.
5. ASM Hand Book, " Composites", Vol.21, ASM International, 2001.

MG6091 INDUSTRIAL MANAGEMENT L T P C
3 0 0 3

OBJECTIVES :

- To provide an opportunity to learn basic management concepts essential for business..

UNIT I INTRODUCTION 9

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 –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 – Information technology in management – Decisions support system – Business Process Re-engineering (BPR) – Enterprises Resource Planning (ERP) – Supply Chain Management (SCM) – Activity Based Management (ABM).

TOTAL : 45 PERIODS

OUTCOMES :

- Students gain knowledge on the basic management principles to become management(s) professional.

TEXTBOOKS

1. Herald Knottz and Heinz Weihrich, "Essentials of Management", Tata McGraw Hill Education Pvt. Ltd., 2010.
2. Stephen P. Robbins, "Organization Behaviour", 13 Edition, Pearson Education Inc., 2010.

REFERENCES:

1. Ties, AF, Stoner and R.Edward Freeman, 'Management' Prentice Hall of India Pvt. Ltd. New Delhi 110 011, 1992
2. Joseph J, Massie, 'Essentials of Management' Prentice Hall of India Pvt. Ltd. 1985.
3. P.C. Tripathi & P.N. Reddy, 'Principles of Management', TataMcGraw Hill, 2006

ML6611 COMPOSITE MATERIALS LABORATORY L T P C
0 0 3 2

OBJECTIVES:

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

LIST OF EXPERIMENTS:

1. Preparation of Continuous Fiber reinforced Polymer Composites
2. Preparation of Dis-Continuous Fiber reinforced Polymer Composites
3. Study of Tensile strength and young's modulus of FRP composites
4. Study of Flexural strength of FRP composites
5. Study of Hardness of FRP composites
6. Study of drop weight impact testing
7. Preparation of Al-SiC composites by stir casting method
8. Study of microstructure, hardness and density of Al-SiC composite
9. Study of Tensile strength of Al-SiC composites
10. Environmental Testing (Humidity and temperature)

TOTAL : 45 PERIODS

OUTCOMES:

Ability to prepare and characterise different components materials.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl. No.	Description of Equipment	Quantity
1.	Tensile testing machine	1
2.	Hardness testing machine (Knoop, Brinell)	1
3.	Drop weight impact tester	1
4.	Stir casting set up	1
5.	Optical microscope	1
6.	Humidifier	1
7.	Hot testile testing machine	1
8.	Weighting balance	1
9.	Flexural testing machine	**1**

GE6674 COMMUNICATION AND SOFT SKILLS - LABORATORY BASED L T P C
0 0 4 2

OBJECTIVES:

- To enable learners to develop their communicative competence.
- To facilitate them to hone their soft skills.
- To equip them with employability skills to enhance their prospect of placements.

UNIT I LISTENING AND SPEAKING SKILLS 12

Conversational skills (formal and informal) – group discussion and interview skills – making presentations.

Listening to lectures, discussions, talk shows, news programmes, dialogues from TV/radio/Ted talk/Podcast – watching videos on interesting events on Youtube.

UNIT II READING AND WRITING SKILLS 12

Reading different genres of tests ranging from newspapers to philosophical treatises – reading strategies such as graphic organizers, summarizing and interpretation.

Writing job applications – cover letter – resume – emails – letters – memos – reports – blogs – writing for publications.

UNIT III ENGLISH FOR NATIONAL AND INTERNATIONAL EXAMINATIONS AND PLACEMENTS 12

International English Language Testing System (IELTS) – Test of English as a Foreign Language (TOEFL) – Graduate Record Examination (GRE) – Civil Service (Language related) – Verbal ability.

UNIT IV SOFT SKILLS (1) 12

Motivation – self image – goal setting – managing changes – time management – stress management – leadership traits – team work – career and life planning.

UNIT V SOFT SKILLS (2) 12

Multiple intelligences – emotional intelligence – spiritual quotient (ethics) – intercultural communication – creative and critical thinking – learning styles and strategies.

TOTAL: 60 PERIODS

Teaching Methods:

1. To be totally learner-centric with minimum teacher intervention as the course revolves around practice.
2. Suitable audio/video samples from Podcast/YouTube to be used for illustrative purposes.
3. Portfolio approach for writing to be followed. Learners are to be encouraged to blog, tweet, text and email employing appropriate language.
4. GD/Interview/Role Play/Debate could be conducted off the laboratory (in a regular classroom) but learners are to be exposed to telephonic interview and video conferencing.
5. Learners are to be assigned to read/write/listen/view materials outside the classroom as well for graining proficiency and better participation in the class.

Lab Infrastructure:

S. No.	Description of Equipment (minimum configuration)	Qty Required
1	**Server**	1 No.
	• PIV System	
	• 1 GB RAM / 40 GB HDD	
	• OS: Win 2000 server	
	• Audio card with headphones	
	• JRE 1.3	

2	**Client Systems** • PIII System • 256 or 512 MB RAM / 40 GB HDD • OS: Win 2000 • Audio card with headphones • JRE 1.3	60 Nos.

3	Handicam	1 No.
4	Television 46”	1 No.
5	Collar mike	1 No.
6	Cordless mike	1 No.
7	Audio Mixer	1 No.
8	DVD recorder/player	1 No.
9	LCD Projector with MP3/CD/DVD provision for Audio/video facility	1 No.

Evaluation:

Internal: 20 marks

Record maintenance: Students should write a report on a regular basis on the activities conducted, focusing on the details such as the description of the activity, ideas emerged, learning outcomes and so on. At the end of the semester records can be evaluated out of 20 marks.

External: 80 marks

Online Test	- 35 marks
Interview	- 15 marks
Presentation	- 15 marks
Group Discussion	- 15 marks

Note on Internal and External Evaluation:

1. Interview – mock interview can be conducted on one-on-one basis.
2. Speaking – example for role play:
   a. Marketing engineer convincing a customer to buy his product.
   b. Telephonic conversation- fixing an official appointment / placing an order / enquiring and so on.
3. Presentation – should be extempore on simple topics.
4. Discussion – topics of different kinds; general topics, case studies and abstract concept.

OUTCOMES:

At the end of the course, learners should be able to

- Take international examination such as IELTS and TOEFL
- Make presentations and Participate in Group Discussions.
- Successfully answer questions in interviews**.**

REFERENCES:

1. Business English Certificate Materials, Cambridge University Press.
2. Graded Examinations in Spoken English and Spoken English for Work downloadable materials from Trinity College, London.
3. International English Language Testing System Practice Tests, Cambridge University Press.
4. Interactive Multimedia Programs on Managing Time and Stress.

5. Personality Development (CD-ROM), Times Multimedia, Mumbai.
6. Robert M Sherfield and et al. “Developing Soft Skills” 4th edition, New Delhi: Pearson Education, 2009.

WEB SOURCES:

http://www.slideshare.net/rohitjsh/presentation-on-group-discussion
http://www.washington.edu/doit/TeamN/present_tips.html
http://www.oxforddictionaries.com/words/writing-job-applications
http://www.kent.ac.uk/careers/cv/coveringletters.htm
http://www.mindtools.com/pages/article/newCDV_34.htm

ML6612 ADVANCED MATERIALS CHARACTERIZATION LABORATORY **L T P C 0 0 3 2**

OBJECTIVES:

- 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

OUTCOMES

Ability to characteristic the material using advanced characterization tools.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl. No.	Description of Equipment	Quantity
1.	Metallographic Microscope with image analyzer	10
2.	X-ray Diffractometer (XRD)	1
3.	Scanning Electron Microscope (SEM)	1
4.	Transmission Electron Microscope (TEM)	1

Note:

1. SEM, XRD, TEM equipments and related hardware are not mandatory. Only the data, graphs, images taken from these equipments are needed for conducting this laboratory. Demonstration of equipments may be done by visit to Research & Development centres or educational institutes.

GE6757 TOTAL QUALITY MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- To facilitate the understanding of Quality Management principles and process.

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Costs of quality.

UNIT II TQM PRINCIPLES 9

Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS AND 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 AND TECHNIQUES II 9

Control Charts - Process Capability - Concepts of Six Sigma - Quality Function Development (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000 - ISO 9001-2008 Quality System - Elements, Documentation, Quality Auditing - QS 9000 - ISO 14000 - Concepts, Requirements and Benefits - TQM Implementation in manufacturing and service sectors..

TOTAL: 45 PERIODS

OUTCOMES:

- The student would be able to apply the tools and techniques of quality management to manufacturing and services processes.

TEXTBOOK:

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

REFERENCES:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
3. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.

ML6701 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 Eigen value Problems – Schrödinger's equation – Full and Partial Diagonalisation - Sturm Sequence.

UNIT V SELECTED APPLICATIONS IN MATERIALS SCIENCE 9

Modeling and property prediction.

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

- Ability to use computational techniques the Materials Engineering
- Use of mathematical equation to predict the properties of materials

TEXT BOOKS:

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, World Scientific Pub Co Inc, 1997
2. Wilkinson J H," The Algebraic Eigenvalue Problem", Clarendon Press Oxford, 1964.
3. Chandra. S.,"Computer Applications in Physics: with Fortran, Basic and C", 2nd Edition, Narosa Publications, 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

ML6702 NON DESTRUCTIVE MATERIALS EVALUATION L T P C
3 0 0 3

OBJECTIVES:

- To study and understand the various Nondestructive Evaluation and Testing methods, theory and their industrial applications.

UNIT I INTRODUCTION TO NDT 7

NDT Versus Mechanical testing, Need for Nondestructive testing Relative merits and limitations, Various physical characteristics of materials and their applications in NDT., Visual inspection – Unaided and aided- Standards

UNIT II SURFACE NDE METHODS 8

Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

UNIT III THERMOGRAPHY AND EDDY CURRENT TESTING (ET) 10

Thermography- Principles, Contact and non contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications.

Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement , Applications, advantages, Limitations, Interpretation/Evaluation.

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

Ultrasonic Testing-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. Acoustic Emission Technique –Principle, AE parameters, Applications.

UNIT V RADIOGRAPHY (RT) 10

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography- Gamma ray Radiography, Safety in X- ray and gamma ray radiography.

TOTAL: 45 PERIODS

OUTCOMES:

- Identify suitable Non destructive technique to inspect industrial component
- Ability to use the different technique and know its applications and limitations

TEXT BOOKS:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2009.
2. Ravi Prakash, “Non-Destructive Testing Techniques”, 1st Revised Edition, New Age International Publishers, 2010

REFERENCES:

1. ASM Metals Handbook,”Non-Destructive Evaluation and Quality Control”, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.

2. Paul E Mix, “Introduction to nondestructive testing: a training guide”, 2nd Edition, Wiley, New Jersey, 2005
3. Charles, J. Hellier,“ Handbook of nondestructive evaluation”, McGraw Hill, New York 2001.
4. 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.

ML6703 NANOSTRUCTURED MATERIALS L T P C
3 0 0 3

OBJECTIVES:

- To motivate the students to understand the evolution of nanomaterials in the scientific era and make them to understand different processing methods, properties of nanomaterials for the future engineering applications

UNIT I INTRODUCTION TO NANOMATERIALS 7

Amorphous, Crystalline, microcrystalline, quasicrystalline and nanocrystalline materials- historical development of nanomaterials – Nanomaterials classification (Gleiter’s Classification) – properly changes done to size effects, Hall – petch, inverse Hall- petch effects - polymeric nanostructures

UNIT II ZERO DIMENSIONAL NANOMATERIALS 10

Nanoparticles – Properties – Processing – Liquid state processing - Sol-gel process, wet chemical synthesis – Vapour state processing – PVD, CVD, Aerosol processing, solid state processing – mechanical, mechanochemical synthesis – Application of nanoparticle. Quantum Dots – Quantum confinement – Pauli’s Exclusion Principle – Processing – Optical lithography – MOCVD – Droplet epitaxy - Applications.

UNIT III ONE DIMENSIONAL NANOMATERIALS 10

Carbon nanotubes – Old and new forms of carbon – Structure of CNT and classification – Processing – Solid carbon based production techniques – Gaseous carbon based production technique - growth mechanisms – Applications.Nanowire – processing – Laser ablation – Oxide assisted growth – carbo thermal reactions – Thermal evaporation – Temperature based synthesis – Electro spinning – Vapour–Solid growth (VS growth) - vapour – liquid – solid growth (VLS technique) – Applications.

UNIT IV SUPER HARD COATINGS AND BULK NANOSTRUCTURED MATERIALS 9

Superhard coating – types – characteristics – thermal stability – case studies $nc-TiN/a-Si_3N_4$ coating) – Applications. Bulk nanostructure formation – Equal Channel Angular pressing (ECAP) – High Pressure Torsion(HPT), Accumulative roll bending – Reciprocating extrusion - compression, cyclic close die forging – Repetitive corrugation and straightening – Grain refinement mechanisms.

UNIT V CHARACTERIZATION OF NANOMATERIALS 9

Nano indentation – Types of nanoindenter – Force actuation-Displacement measurement- factors affecting nanoindentation- Atomic Force Microscope (AFM) – Scanning Tunneling Microscope (STM) – Electrostatic Force Mode (EFM) – Magnetic Force Mode (MFM) – Scanning Electron Microscope (SEM) – Transmission Electron Microscope (TEM).

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to design nanostructure using Building blocks of Nanotechnology
- Ability to use OD, 1D, 2D nano building block to process bulk nano structures
- Use of difficult characterization techniques to study the Fundamental properties.

TEXT BOOKS:

1. Carl C. Koch (ed.), "Nanostructured Materials", Processing, Properties and Potential Applications, Noyes Publications, Norwich, New York, U.S.A.
2. Bhusan, Bharat (Ed), "Springer Handbook of Nanotechnology", 2nd Edition, 2007.

REFERENCES:

1. Mark Ratner and Daniel Ratner, "Nano Technology", Pearson Education, New Delhi, 2003.
2. Charles P. Poole Jr., Frank J. Ownes, 'Introduction to Nanotechnology", Wiley Interscience, 2003.
3. G. Wilde, "Nanostructured Materials', Elsevier, 2008.
4. Bamberg, D., Grundman, M. and Ledentsov, N.N., "Quantum Dot Heterostructures", Wiley, 1999.
5. G Timp (ed), "Nanotechnology", AIP press/Springer, 1999.
6. K.A. Padmanabhan and S. Balasivanandha Prabu, 'On the Origins of Conflict in the Experimental Results Concerning the Mechanical Properties of Ultra-Fine Grained and Nanostructured Materials: Effects of Processing Routes and Experimental Conditions', Adv.Mech.Properties and Deform. Mechanism of Bulk Nanostr.Mat, Trans Tech Publication,UK, ISBN-13::978-3-03785-105-0, pp.3-54,

MF6711 COMPUTER AIDED SIMULATION AND ANALYSIS LABORATORY

L	T	P	C
0	0	3	2

OBJECTIVES:

- To give exposure to software tools needed to analyze engineering problems.
- To expose the students to different applications of simulation and analysis tools.

LIST OF EXPERIMENTS:

A. SIMULATION

1. MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables
2. Use of Matlab to solve simple problems in vibration
3. Mechanism Simulation using software

B. ANALYSIS

1. Force and Stress analysis using link elements in Trusses, cables etc.
2. Stress and deflection analysis in beams with different support conditions.
3. Stress analysis of flat plates and simple shells.
4. Stress analysis of axi – symmetric components.
5. Thermal stress and heat transfer analysis of plates.
6. Thermal stress analysis of cylindrical shells.
7. Vibration analysis of spring-mass systems.
8. Model analysis of Beams.
9. Harmonic, transient and spectrum analysis of simple systems.

TOTAL: 45 PERIODS

OUTCOME

- To train the students to make use of software for simulation and analysis for various applications in the field of manufacturing engineering.

TEXT BOOKS:

1. The Mathworks, Inc, "The student Edition of Matlab", student Edition, The MATLAB curriculum series, 1997

2. Rudra Pratap, “Getting started with MATLAB”, 1st Edition, Oxford University Press, 2010

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl. No.	Description of Equipment	Quantity
1.	Computer work station	30
2.	Color Desk Jet Printer	01
3.	Software Suitable analysis software	30 licencses
4.	C / MATLAB	5 licencses

ML6711 **COMPREHENSION** **L T P C**
0 0 2 1

OBJECTIVES:

- To encourage the students to comprehend the knowledge acquired from the first Semester to Sixth Semester of B.E Degree Course through periodic exercise.

METHOD OF EVALUATION:

The students will be assessed 100% internally through weekly test with objective type questions on all the subject related topics

TOTAL : 30 PERIODS

OUTCOMES:

- ability to understand and comprehend any given problem related to mechanical engineering field.

ML6712 **MATERIAL DESIGN PROJECT** **L T P C**
0 0 4 2

OBJECTIVES

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

OUTCOMES:

Ability to present the microstructure and provide Processing – Structure- Property correlation for the materials.

ML6713 **INDUSTRIAL/ FIELD TRAINING** **L T P C**
0 0 0 1

OBJECTIVES:

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.

OUTCOMES

Ability to present the Industrial activities and know about process/product/magnet techniques under in the Industries.

ML6811 **PROJECT WORK** **L T P C**
0 0 12 6

OBJECTIVES:

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voce examination.

The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. 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 based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 180 PERIODS

OUTCOMES:

- On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

ML6001 **MODERN MANUFACTURING PROCESS** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand material removal by using various forms of energy and machining new materials and complex parts with high accuracy by using non-traditional machining.

UNIT I INTRODUCTION 7

Need of Non-Traditional Machining Processes – Classification Based on Energy, Mechanism, source of energy, transfer media and process - Process selection-Based on Physical Parameters, shapes to be machined, process capability and economics – Overview of all processes.

UNIT II MECHANICAL PROCESS 10

Ultrasonic Machining: Principle- Transducer types – Concentrators - Abrasive Slurry - Process Parameters – Tool Feed Mechanism – Advantages and Limitations – Applications. Abrasive Jet Machining: Process- Principle – Process Variables – Material Removal Rate - Advantages and Limitations – Applications. Water Jet Machining: Principle – Process Variables - Advantages and Limitations – Practical Applications – Abrasive water jet machining process.

UNIT III ELECTRICAL DISCHARGE MACHINING 10

Electrical Discharge Machining: Mechanism of metal removal – Dielectric Fluid – Flushing methods - Electrode Materials - Spark Erosion Generators – Electrode Feed System – Material Removal Rate – Process Parameters – Tool Electrode Design – Tool wear Characteristics of Spark Eroded Surfaces- Advantages and Limitations – Practical Applications. Electrical Discharge Wire Cut and Grinding: Principle – Wire Feed System - Advantages and Limitations
– Practical Applications

UNIT IV CHEMICAL AND ELECTRO CHEMICAL MACHINING 10

Chemical Machining: fundamentals, Principle –classification and selection of Etchant -chemical milling, Engraving, Blanking - Advantages and limitations – Applications. Electro Chemical Machining: Electro-chemistry of the process-Electrolytes - Electrolyte and their Properties – Material Removal Rate – Tool Material – Tool Feed System – Design For Electrolyte Flow – Process Variables - Advantages and Limitations – Applications - Electro Chemical Grinding: Honing, cutting off, Deburring and turning.

UNIT V HIGH ENERGY MACHINING PROCESS 8

Electron Beam Machining: Principle –Generation and control of electron beam-Advantages and Limitations – Applications. Laser Beam Machining: Principle –Solid and Gas Laser Application – Thermal Features of LBM - Advantages and Limitations – Applications. Ion Beam Machining: Equipment – process characteristics - Advantages and Limitations – Applications. Plasma Arc Machining: Principle –Gas mixture– Types of Torches – Process Parameters - Advantages and Limitations – Applications. Ion Beam Machining – Principle – MRR – advantages, limitation, applications.

TOTAL : 45 PERIODS

OUTCOMES:

- Describe the modern manufacturing process with respect to productivity economic
- Explain the trends in development of manufacturing process selection of suitable process for metal cutting and non-traditional manufacturing.

TEXT BOOKS:

1. P.C Pandey And H.S. Shan, “Modern Machining Process”, Tata Mc Graw – Hill Publishing Company Limited, New Delhi, 2007
2. V.K. Jain, “Advanced Machining Process”, Allied Publishers Pvt Limited 2007

REFERENCES:

1. Amithaba Bhattacharyya, “New Technology”, The Institution Of Engineers, India
2. HMT Bangalore, "Production Technology”, Tata Mc Graw–Hill Publishing Company Limited, New Delhi, 2006.
3. Hassan El – Hofy “Advanced machining Processes” MC Graw-Hill, 2005.

GE6075 PROFESSIONAL ETHICS IN ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To enable the students to create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I HUMAN VALUES 10

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II ENGINEERING ETHICS9

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination

UNIT V GLOBAL ISSUES 8

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of the course, the student should be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society

TEXTBOOKS:

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

REFERENCES:

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009
3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, "Fundametals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001
5. Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd.,New Delhi 2013.\
6. World Community Service Centre, ' Value Education', Vethathiri publications, Erode, 2011

Web sources:
1. www.onlineethics.org
2. www.nspe.org
3. www.globalethics.org

ML6002 BIO AND SMART MATERIALS L T P C
3 0 0 3

OBJECTIVES:
- To study applications of materials in biomedical engineering and special materials for actuators, sensors, etc.

UNIT I INTRODUCTION 9
Intelligent / Smart materials – Functional materials – Polyfunctional materials – Structural materials, Electrical materials, bio-compatible materials. – 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 – in vitro and in vivo evaluation of biomaterials.

UNIT II ELECTRO-RHEOLOGICAL AND PIEZOELECTRIC MATERIALS 9
The principal ingredients of smart materials –microsensors- hybrid smart materials - an algorithm for synthesizing 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 – Basics, Principles and instrumentation and application of Magnetorheological fluids
– Piezoelectric materials: polymers and ceramics, mechanism, properties and application. Introduction to electro-restrictive and magneto-restrictive materials

UNIT III SHAPE MEMORY MATERIALS 9
Nickel – Titanium alloy (Nitinol) – Materials characteristics of Nitinol – martensitic transformations – austenitic transformations – thermoelastic martensitic transformations– classification of SMA alloys- mechanism of magnetic SMA – applications of SMA – continuum applications of SMA fasteners – 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 – Shape memory polymers– mechanism of shape memory-Primary moulding – secondary moulding – types and applications.

UNIT IV ORTHOPAEDIC AND DENTAL MATERIALS 9
Bone and teeth composition, formation and properties – bioresorbable, bioinert, bioactive materials - temporary fixation devices – joint replacement – biomaterials used in bone and joint replacement metals and alloys- Fillings and restoration materials – Materials for oral and maxillofacial surgery – dental cements and dental amalgams – dental adhesives- bone tissue engineering.

UNIT V APPLICATIONS OF BIO MATERIALS FOR CARDIOVASCULAR OPTHALMOLOGY AND SKIN REGENERATION 9
Blood clotting – blood theology– approaches to thrombo resistance materials development – blood vessels – The heart – aorta and valves – geometry of blood circulation – cardiac pacemakers – blood substitutes – extracorporeal blood circulation devices.The lungs – vascular implants: vascular graft, cardiac valve prostheses, card– Biomaterials in opthalmology –skin grafts -connective tissue

grafts – tissue adhesives – drug delivery methods and materials.

TOTAL: 45 PERIODS

OUTCOMES:

- Use of Bio materials for cardiovascular Opthalmology and Skin Regeneration
- Use of Bio materials for Dental & Bone application
- Use of shape memory alloys in engineering application
- Explain the characteristics of Bio and smart materials
- Use of smart materials as sensors, actuators.

TEXTBOOKS:

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. Duerig,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. Mohsen Shahinpoor and Hans-Jo¨rg Schneider "Intelligent Materials", RSC Publishing, 2008
4. Mel Schwartz (Ed), Encyclopaedia of Smart Materials" Volume –I and II, John Wiley & Sons, Inc.2002
5. Buddy D. Ratner (Editor), Allan S. Hoffman (Editor), Frederick J. Schoen (Editor), Jack E. Lemons, "Biomaterials Science: An Introduction to Materials in Medicine", 2nd Edition, Academic Presswww.ethics.org , 2004

ML6003 PRINCIPLE AND APPLICATION OF EXTRACTIVE METALLURGY L T P C
3 0 0 3

OBJECTIVES:

- To provide a broad idea about various resources of metals, different extraction procedures and feasibility predictions for metallurgical reactions.

UNIT I PYROMETALLURGY 10

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

UNIT II HYDRO METALLURGY 10

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

UNIT III ELECTROMETALLURGYAND REFINING 8

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

UNIT IV EXTRACTION AND REFINING OF METAL ORES 10

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

UNIT V EXTRACTION OF PRECIOUS METALS 7

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

TOTAL : 45 PERIODS

OUTCOMES:

Explain different stages in Electro metallurgy

- Use the principles of pyro, Hydo and Electro for extraction
- Explain the steps of Metal ores.

TEXT BOOKS:

1. Ray. H.S., Sridhar R., Abraham. K P., "Extraction of Non Ferrous Metals", Affiliated East – West Press Pvt. Ltd. New Delhi, 1990.
2. Terkel Rosenquist, "Principles of Extractive Metallurgy", 2nd Edition, McGraw-Hill International Book Co. London, 1983.

REFERENCES:

1. Ray. H S., and Ghosh A., "Principles of Non-ferrous Extractive Metallurgy", Prentice Hall of India, New Delhi, 1994.
2. Pehlke.R.D., "Unit Processes in Extractive Metallurgy", American Elsevier Publishing Co., New York, USA, 1993.
3. Venkatachalam.S., "Hydrometallurgy", Narosa Publishing House, New Delhi. 1998.

ML6004 METALLURGY OF TOOL MATERIALS AND SPECIAL STEELS L T P C
3 0 0 3

OBJECTIVES

- 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 VS PECIAL STEELS 7

Composition, microstructure, properties and applications of special steels- microalloyed steels-TRIP steels-HSLA steel etc

TOTAL : 45 PERIODS

OUTCOMES:

- Use of different steels for tool application
- Perform different Heat treatment on them to improve their properties
- Select the suitable

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

ML6005 LASER PROCESSING OF MATERIALS L T P C
3 0 0 3

OBJECTIVES:

- To impart the knowledge about the principles of industrial lasers such as laser generation, mode selection, beam mechanisms, modifications and characteristics, types of lasers etc. Also to introduce the concepts of laser processing of materials which includes background of laser systems, process parameters, material considerations and specific applications.

UNIT I PRINCIPLES OF INDUSTRIAL LASERS 9

Principle of laser generation, optical resonators, laser modes- mode selection, line- broadening mechanisms, laser beam modifications and types of industrials lasers.

UNIT II THERMAL PROCESS- HEAT AND FLUID FLOW 9

Heat flow in the work piece: thick plate with point heat source, thin plate with line heat source, peak temperature and cooling rates

Fluid flow in molten pool: continuity equation, navier-stokes equation and surface tension effects.

UNIT III LASER METALLURGY 9

Process microstructure- fusion zone, zone of partial melting, haz, discontinuities- porosity, cracking, lack of fusion, incomplete penetration and undercut.

UNIT IV LASER WELDING AND SURFACE MODIFICATIONS 10

Process mechanisms (Key hole and Plasmas) – operating characteristics – process variations – imperfections- industrial applications –recent developments Laser surface heat treatment, Laser

surface melting- Glazing, Laser direct Metal deposition– Laser surface alloying, Laser surface cladding and Hard coatings, Laser physical vapour deposition and Laser shock peening.

UNIT V LASER MACHINING 8

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.

TOTAL: 45 PERIODS

OUTCOMES:

- Discuss the Laser principles and use of it in processing of Engineering materials.
- Use of it for Welding and surface modification of different Engineering materials.
- Perform Machining using Laser.

TEXT BOOKS:

1. Elijah kannatey-Asibu, Jr., "Principles of Laser Materials Processing", John Wiley & Sons, 2009
2. Jacques Perrière, Eric Millon, Eric Fogarassy, "Recent advances in laser processing of Materials" Elsevier, 2006.

REFERENCES:

1. John C. Ion, "Laser Processing of Engineering Materials", Elsevier Butter Worth-Heinemann, Burlington, 2005.
2. Steen W. M.,"Laser Materials Processing", 3rd Edition, Springer Verlag, U.K., 2003.
3. ykalin, Ugloo A.,Kokona A.,"Laser and Electron Beam Material Processing", Hand Book, MIR Publishers, 1987
4. Narendra B. Dahotre, Sandip P. Harimkar, "Laser Fabrication and Machining of Materials" Springer,2008
5. Duley W. W.," Laser Processing and Analysis of Materials"; Plenum Press, New York, 1983.

ML6006 CERAMICS AND REFRACTORY MATERIALS L T P C
3 0 0 3

OBJECTIVES:

- To import knowledge on raw materials for ceramic, natural ceramic and engineering ceramic
- To study the characteristics and processing application of glass, refractories and engineering ceramics
- To introduce advanced ceramics and their applications.

UNIT I FUNDAMENTALS 9

Ceramic crystal structures. Phase diagram Al_2O_3-SiO2.Ceramic raw materials, Silicate and non silicate ceramics. Composition, properties, Mineralogy, Phase analysis.

UNIT II GLASS 9

Introduction, classification, preparation-raw materials, mixing, charging, melting, processing. Manufacture of glass products- flat ware, hollow ware. Cullets, optical glass, optical fibers

UNIT III REFRACTORIES 9

Importance and requirements, classification-fire clay, alumino silicate, silica, magnesite, forsterite, dolomite, chromite, chrome magnesite, zirconia, carbon and graphite-refractory failures.

UNIT IV CERAMICS 9

Ceramic fabrication processes-slip forming process, plastic forming process, dry forming process, drying and finishing, firing.

UNIT V ADVANCED CERAMICS 9

Oxides, carbides, nitrides, borides, silicides, sialon carbon fibres and Carbon composites. Applications in structural, electrical and bioceramics. Ceramic coatings (thermal barriers), nuclear(cermets), process(filter, catalyst).

TOTAL:45 PERIODS

OUTCOMES:

- Discuss different Engineering ceramics and use of these different application.

TEXT BOOKS:

1.W.D.Kingery, H.K.Bowen and D.R. Uhlmann, "Introduction to Ceramics", 2nd Edition, by John Wiley and Sons, New York,1976
2 Nandi D.N.Handbook on Refractories Tata Mc Graw –Hill publishing Co New Delhi 1991
3.James S.Reed, "Principles of Ceramic processing" John Wiley and Sons NY 1988

REFERENCES:

1. Singer, F and Singer, S.S, "Industrial Ceramics", Oxford & IBH Publishing Co., 1991
2. W.Ryan, "Properties of Ceramic Raw Materials", 2nd Edition, Pergamon Press, 1978
3. David W. Richerson, "Modern Ceramic Engineering", 3rd Edition, Taylor & Francis, 2005.
4.Tooley F.V, "Handbook of Glass Manufacture", Vol I&II, Ogden Publishing Co., NY, 1960.

ML6007 AUTOMOTIVE MATERIALS L T P C
3 0 0 3

OBJECTIVES:

- Knowledge on properties of engineering materials
- To select suitable materials for design
- Materials selection criteria for engine and transmission systems
- Different materials used for automotive structures.
- Different electronic materials for automotive applications

UNIT I ENGINEERING MATERIALS AND THEIR PROPERTIES 9

Classes of engineering materials - the evolution of engineering materials, Definition of materials properties, Displaying material properties using materials selection charts, Forces for change in materials selection and design, Materials and the environment-selection of materials for automotive, aerospace, marine and defence applications.

UNIT II BASIS OF MATERIAL SELECTION 9

Selection strategy, Attribute limits and Material indices, structural index Selection procedure: Design process - types of design, design requirements, Function, Material attributes, Shape and Manufacturing processes - Materials processing and design processes and their influence on design, Process attributes, Systematic process selection, Process selection diagrams, Process cost, Energy consumption for production, Material costs, Availability, Recyclability, Environmental consideration. Computer aided selection.

UNIT III MATERIALS FOR ENGINES AND TRANSMISSION SYSTEMS 9

Materials selection for IC engines: Piston, piston rings, cylinder, Engine block, Connecting rod, Crank shaft, Fly wheels, Gear box, Gears, Splines, Clutches.

UNIT IV MATERIALS FOR AUTOMOTIVE STRUCTURES 9

Materials selection for bearings,leaf springs,chasis & frames, Bumper, shock absorbers, wind screens, panels, brake shoes, Disc, wheels, differentials , damping and antifriction fluids, Tyres and tubes.

UNIT V ELECTRONIC MATERIALS FOR AUTOMOTIVE APPLICATIONS 9

Materials for electronic devices meant for engine control, ABS, Steering, Suspension, Sensors, anti-collision, Anti-fog, Head lamps.

TOTAL: 45 PERIODS

OUTCOMES:

- Discuss different materials used for Automotive component manufacturing .
- Select proper material for Automobile applications

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, Butterworths, 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. M F Ashby, “Materials Selection in Mechanical Design”, Third Edition, Butterworth-Heineman, New York, 2005.
4. ASM Handbook. “Materials Selection and Design”, Vol. 20- ASM Metals Park Ohio.USA, 1997.
5. Cantor, “Automotive Engineering: Lightweight, Functional, and Novel Materials”, Taylor & Francis Group, London, 2006

ML6008 INDUSTRIAL TRIBOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To introduce and expose students to the field and fundamentals in tribology and its applications.

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

OUTCOMES:

- Ability to design friction, wear and Lubrication
- Ability to identify different types of sliding & rolling friction, Wear and related theories
- Ability to distinguish among the different Lubricant regime.
- Select materials for bearing.

TEXT BOOK:

1. A. Harnoy. “Bearing Design in Machinery “Marcel Dekker Inc, New York, 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 Educational Books 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.

ML6009 CRYOGENIC TREATMENT OF MATERIALS L T P C
3 0 0 3

OBJECTIVES:

- 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- Satellite communication, Surveillance Imaging, Military applications, Impact of regenerative materials on cooler performance, Impact of material 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,Hardness Precautions during cryogenic treatment.

UNIT IV MATERIALS ENGINEERING 9

Desirable qualities for materials used in cryogenic applications, History and applications of metallic / non-metallic materials, Understanding properties and fabrication processes of superconducting Nb3Sn wires, High temperature superconductors. Characterization of cryogenically processed materials.

UNIT V APPLICATIONS 9

Cryogenic processing of materials for Space applications, Superconductivity, Medical applications, Food Preservation-Individual Quick Freezing, Tool Industry, Automobiles etc.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to perform cryogenic treatment of materials
- Ability to select materials for cryogenic treatment
- Discuss the properties and application after cryogenic treatment of materials

TEXT BOOK:

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

REFERENCES:

1. William E. Bryson, “Cryogenics”, HanserGardner 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

ML6010 FUELS, FURNACES AND REFRACTORIES L T P C
3 0 0 3

OBJECTIVES

- Knowledge on different source of fuel
- Knowledge about different types of furnaces
- Different types of refractories used for furnaces application
- Knowledge on issues in environment

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 12

Bricks, Monolithic and castables. Manufacturing and properties of refractories. Refractories for iron and steel industry-Coke oven, blast furnace, LD converter, continuous casting, EAF and functional refractories. Refractories for Cement and non ferrous metallurgical industries.

UNIT V ADVANCED ISSUES 6

Energy and environment, environmental optimization, Recycling of thermal energy. Emissions control.

TOTAL:45 PERIODS

OUTCOMES

- Use of different fuels for energy generation system
- Use of refractories in furnance
- Ability to disscuss the issures in environmental.

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 publishing Co New Delhi 1991

REFERENCES

1. Chester, J.H. "Refractories, Production and Properties", Iron and Steel Institute, London, 1973.
2. Robert E.Fisher, "Advances in Refractory Technology", Ceramic Transaction, Vol.4, 1990, American Ceramic Society, Westerville,Ohio, USA.
3. Suryanarayana A.V.K, "Fuels, Furnaces, Refractories and Pyrometry", BS Publications, 2005.
4. Robert D.Reed, "Furnace Operation", Gulf Publishing Co., Paris, 1991.
5. Shaha A.K, "Combustion Engineering and Fuel Technology", Oxford & IBH Publishing Co., New Delhi, 1974.
6. Daniel Rhodes, Kilns: Design, "Construction and Operation", Chilton Book Co., Pennsylvania, 1974
7. Samir Sarkar, "Fuels and Combustion", 2nd Edition, Orient Longman, Bombay, 1990

ML6011 NUCLEAR REACTOR MATERIALS L T P C

3 0 0 3

OBJECTIVES:

- Import knowledge about different nuclear materials
- Identify the materials for nuclear reactor and fuel
- Knowledge about nuclear waste and prevention techniques
- Know about irradiation effects in nuclear fuels.

UNIT I FUNDAMENTALS OF NUCLEAR ENGINEERING 9

Atomic structure, atomic number, mass number, isotopes, nuclear energy and nuclear forces, binding energy, nuclear stability, radioactivity, nuclear reactions, nuclear fissions, nuclear fusion

UNIT II NUCLEAR REACTORS 12

Types of reactors-ordinary water moderated reactors, heavy water cooled and moderated reactors-design, construction and control of nuclear reactors-moderators-coolants-reflectors and structural materials, nuclear power stations in india, comparison of nuclear power plants with thermal power plants

UNIT III FUELS 9

Ores and beneficiation – Uranium and thorium ores, availability in India, solvent extraction and ore beneficiation. fuels of different types – metallic, alloy and dispersion fuels for research reactors, ceramic (oxide, carbide and nitride) fuels for thermal power reactor and fast reactors. Fabrication of oxide, mixed-oxide and mixed-carbide fuel for power reactors. Fabrication, characterization and property evaluation of advanced fuel type, processes encountered in fabrication, fuel property evaluation – thermal and physical properties

UNIT IV NUCLEAR WASTE AND RADIATION PROTECTION 6

Introduction-unit of nuclear radiation-Types of waste –disposal –ICRP recommendations-radiation hazards and prevention –radiation dose units

UNIT V IRRADIATION EFFECTS IN NUCLEAR FUELS: 9

Irradiation Examination of Fuels, Irradiation behaviour of metallic uranium – irradiation growth, thermal cycling, swelling, adjusted uranium, blistering in uranium rods. Irradiation effects in ceramic oxide and mixed oxide fuels, definition and units of burnup, main causes of fuel element failure in power reactors and remedies to avoid failures. Behaviour of fuel under off normal and accident condition, criteria for fuel failure during LOCA: oxidation, deformation, stored energy

TOTAL: 45 PERIODS

OUTCOMES:

- Use of the Fuel in Nuclear reactor
- Ability to discuss the Nucleator radiation and the controlling methods.
- Ability to examine the fuels.

TEXT BOOKS:

1. L.C. Merrite, "Basic principles of Nuclear science and Reactors" Wiley Eastern 1977.
2. P.K.Nag, "Power Plant Engineering" Tata Mcgraw Hill, 2007
3. Arora and Domkundwar, "Power plant Engineering", Dhanpati Rai &Co
4. Combined power plants by J.H.Horlocks by Pergamon press
5. Benedict M and Pigter T.A. "Nuclear Chemical Engineering" Mcgraw Hill 1981

REFERENCES:

1. Frost, "Nuclear Fuel Elements: Design Fabrication and Performance", PERGAMON publications, 1982.
2. Olander D R., "Fundamental Aspects of Nuclear Reactor Fuel Elements" NTIS publication, 1976.
3. Kaufman A R, John Wiley, "Nuclear Reactor Fuel Elements, Metallurgy and Fabrication", 1962
4. Gupta C K "Materials in Nuclear Applications" vol.1, CRC publications, 1989.

ML6012 FRACTURE MECHANICS AND FAILURE ANALYSIS L T P C
3 0 0 3

OBJECTIVES:

- To introduce the basic concept of fracture mechanics and failure analysis
- Import knowledge on mechanics of fracture during static and dynamic loading
- Understanding the failure mechanism of creep rupture.
- Understand the mechanism of wear and corrosion and knowledge on prevention

UNIT I BASIC CONCEPTS IN FRACTURE MECHANICS 9

The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation, Brittle fracture: Griffiths theory, Ductile fracture, Probabilistic aspects of fracture mechanics - Microstructure

UNIT II MECHANICS OF FRACTURE- STATIC LOADING 9

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. Strain energy release and stress intensity factor. Evaluation of fracture Toughness of different materials: size effect & control.

UNIT III FAILURE ANALYSIS OF FATIGUE FRACTURE 9

Fundamental sources of failures- Deficiency in design, Empirical Relation describing crack growth by fatigue – Life calculations for a given load amplitude – effects of changing the load spectrum – Effects of Environment. Micro-structural analysis of fatigue failures, some case studies in analysis of fatigue failures.

UNIT IV FAILURE ANALYSIS OF CREEP RUPTURE 9

Fracture at elevated temperature: Time dependent mechanical behavior, stress rupture, Micro Structural changes during creep, Mechanism of creep deformation and Creep deformation maps, Prediction of time to rupture, Creep-fatigue interaction. Some case studies in analysis of creep failures.

UNIT V FAILURE ANALYSIS OF CORROSION AND WEAR 9

Types of corrosion, Corrosion stress, corrosion cracking, Analysis of corrosion failure. Procedure for analysis of stress corrosion cracking. Effect of Environment. Analysis of corrosion characteristics of metals and alloys in different environment. Types of wear, Role of friction, Interaction of corrosion and wear. Analysis of wear failure.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to design structure to prevent failure from the internal defect that unit within the structure
- Ability to design structure to prevent fatigue and creep
- Ability to define different deformation and related theories
- Ability to analyse the corrosion and wear failure and system methods to prevent corrosion and wear.

TEXT BOOKS:

1. Hertz berg R W, "Deformation and fracture mechanics of Engineering Materials" Second Edition John Wiley sons inc, New York 1983.
2. Knott. J.F, "Fundamentals of Fracture Mechanics" Butterworth London, 1973.

REFERENCES:

1. Evalds H L and RJH Warnhil, ”Fracture Mechanics”, Edward Arnold Ltd, Baltimore,1984.
2. Campbel J E, Underwood J H, and Gerberich W W., “Applications of Fracture Mechanics for the selection of Materials “, American Society for Metals, Metals Park Ohio, 1982.
3. Fracture Mechanics Metals Handbook, ninth edition, vol. 8 437-491, American Society of Metals Metal Park ohio, 1985
4. Kare Hellan,“Introduction of Fracture Mechanics”, McGraw-Hill Book Company, 1985.
5. Prashant Kumar, “Elements of Fracture Mechanics”, Wheeler Publishing, 1999.

ML6013 ENGINEERING ECONOMICS AND COST ESTIMATION L T P C
3 0 0 3

OBJECTIVES:

- Import and train the student to cost estimation of component
- To provide knowledge about value engineering
- To know about the cash slow in Industry.
- To solve problem on depreciation.

UNIT I INTRODUCTION TO ECONOMICS 8

Introduction to economics – Flow in an economy – Law of supply and demand – Concept of engineering economics – Engineering efficiency – Economic efficiency – Scope of engineering economics – Element of costs – Marginal cost – Marginal revenue – Sunk cost – Opportunity cost – Break-even analysis – V ratio – Elementary economic analysis – Material selection for product design selection for a product – Process planning.

UNIT II VALUE ENGINEERING 10

Make or buy decision – Value engineering – Function – Aims – Value engineering procedure – Interest formulae and their applications –Time value of money – Single payment compound amount factor – Single payment present worth factor – Equal payment series sinking fund factor – Equal payment series payment Present worth factor – Equal payment series capital recovery factor – Uniform gradient series annual equivalent factor – Effective interest rate –
Examples all methods.

UNIT III CASH FLOW 9

Methods of comparison of alternatives – Present worth method (Revenue dominated cash flow diagram) – Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram) – Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram) – Rate of return method – Examples all methods.

UNIT IV REPLACEMENT AND MAINTENANCE ANALYSIS 9

Replacement and maintenance analysis – Types of maintenance – Types of replacement problem – Determination of economic life of an asset – Replacement of an asset with a new asset – Capital recovery with return and concept of challenger and defender – Simple probabilistic model for items which fail completely.

UNIT V DEPRECIATION 9

Depreciation- Introduction – Straight line method of depreciation – Declining balance method of depreciation – Sum of the years digits method of depreciation – Sinking fund method of depreciation/annuity method of depreciation – Service output method of depreciation – Evaluation of public alternatives – Introduction – Examples – Inflation adjusted decisions – Procedure to adjust inflation – Examples on comparison of alternatives and determination of economic life of asset.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to perfom cost analysis
- Ability to demonstrate the effects of depreciation, on price

TEXT BOOKS

1. Panneer Selvam, R., “Engineering Economics”, Prentice Hall of India Ltd, 2001.
2. Smith, G.W., “Engineering Economy”, Lowa State Press, 1973.

REFERENCES

1. Park, C.S., “Contemporary Engineering Economics”, Prentice Hall of India, 2002.
2. Newman, D.G. and Lavelle, J.P., “Engineering Economics and Analysis”, Engineering Press, 2002.
3. Degarmo, E.P., Sullivan, W.G. and Canada, J.R, “Engineering Economy”, Macmillan, 1984.
4. Grant, E.L., Ireson, W.G. and Leavenworth, R.S., “Principles of Engineering Economy”, Ronald Press, 1976.

ML6014 FINITE ELEMENT ANALYSIS IN MATERIALS ENGINEERING L T P C
3 0 0 3

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.

TOTAL : 45 PERIODS

OUTCOMES:

- Given a Structural engineering problem, ability to conduct structural analysis using FEA
- Use of mathematical techniques to solve Engineering problem using FEA.

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.

ML6015 ALLOY CASTING PROCESSES L T P C
3 0 0 3

OBJECTIVES:

- 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

OUTCOMES:

- Ability to design casting process for alloys, such as Magnesium and Aluminum, Steel, Zinc, copper and its alloy.
- Ability to perform die life calculation, productivity

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.

ML6016 ENERGY STORAGE DEVICES AND FUEL CELLS L T P C
3 0 0 3

OBJECTIVES:

- Traditional use of fuels for storage Load management, Space conditioning, Transportation, Utility system, Variable energy sources, Role of different energy forms, Energy quality, Energy efficiency, Energy and power densities.
- Ability to converse about the working of a typical fuel cell, its types and to elaborate on its thermodynamics and kinetics. Able to analyze the cost effectiveness and eco-friendliness of Fuel Cells

UNIT I ENERGY DEMANDS AND ENERGY SOURCES 7

World energy consumption. Energy in developing countries. Firewood crises. Indian energy sources. Non-conventional renewable energy sources. Potential of renewable energy sources. Solar energy types. Wind energy. Wave, tidal and OTEC. Super-conductors in power system.

UNITII NEED OF ENERGY STORAGE; DIFFERENT MODES OF ENERGY STORAG 9

Potential energy: Pumped hydro storage; KE and Compressed gas system: Flywheel storage, compressed air energy storage; Electrical and magnetic energy storage: Capacitors, electromagnets; Chemical Energy storage: Thermo-chemical, photo-chemical, bio-chemical, electro-chemical, fossil fuels and synthetic fuels. Hydrogen for energy storage. Solar Ponds for energy storage

UNIT III ELECTROCHEMICAL ENERGY STORAGE SYSTEMS 10

Batteries: Primary, Secondary batteries; difference between primary and secondary batteries, chemistries of primary batteries such as Zinc-Carbon, Alkaline and secondary batteries such as Lead acid, Nickel Cadmium, Metal hydrides, lithium ion, lithium phosphate and high temperature batteries-sodium-sulphur. Advantages, disadvantages, limitations and application each above mentioned batteries

UNIT IV MAGNETIC AND ELECTRIC ENERGY STORAGE SYSTEMS 9

Superconducting Magnet Energy Storage(SMES) systems; Capacitor and Batteries: Comparison and application; Super capacitor: Electrochemical Double Layer Capacitor (EDLC), principle of working, structure, performance and application, role of activated carbon and carbon nano-tube.

UNIT V FUEL CELL BASICS 10

Fuel cell definition, Difference between batteries and fuel cells, fuel cell history, components of fuel cells, principle of working of fuel cells, Fuel cell thermodynamics and its efficiency, Electrochemical kinetics, Butler-Volmer equation. Types of fuel cellsand its chemistries - AFC, PAFC, PEMFC,MCFC and SOFC – merits and demerits. Fuel cells- global research development trends and application of PEMFC in automobile industry and application SOFC in stationery. Current issues in PEMFC, Direct methanol fuel cells (DMFC) - Electrochemical kinetics methanol oxidation, Hydrogen – production and storage methods for fuel cells.

TOTAL: 45 PERIODS

OUTCOMES:

- Explain and use different modes of energy storage
- Design and use of fuel cell for energy storage
- Perform calculation regarding energy efficiency

REFERENCES

1. Johannes Jensen Bent Squrensen, “Fundamentals of Energy Storage”, John Wiley, NY , 1984.
2. IEE Energy Series’ “Electro-chemical Power Sources”.
3. P.D.Dunn, “Renewable Energies”. First Edition, Peter Peregrinus Ltd, London, United Kingdom , 1986
4. S Srinivasan, “Fuel Cells: From Fundamentals to Applications”, Springer 2006
5. O’Hayre, SW Cha, W Colella and FB Prinz, “Fuel Cell Fundamentals”, Wiley, 2005
6. Xianguo Li, “Principles of Fuel Cells”, Taylor and Francis, 2005
7. J Larminie and A Dicks, “Fuel Cell Systems Explained", 2nd Edition, Wiley,2003

ML6017 SEMICONDUCTOR OPTOELECTRONIC MATERIALS AND DEVICES L T P C

3 0 0 3

OBJECTIVES:

- Impact Knowledge on semiconductor materials, mechanisms and processing techniques
- Develop knowledge on optoelectronic devices
- Explain the basics of semiconductor understanding of fundamentals of optoelectronics
- Explain the Quantum effects and relevant properties due to their effect
- Explain and use of different processing techniques
- Explain and design optoelectronic devices.

UNIT I BASICS OF SEMICONDUCTOR 9

Energy bands and Charge carriers in Semiconductors: direct and indirect semiconductors (HUMO and LUMO), the E-k diagram, Density of states, Occupation probability, Fermi level and quasi Fermi levels, p-n junctions, Schottky junction and Ohmic contacts.

UNIT II FUNDAMENTS OF OPTOELECTRONICS 9

Elements Of Light - Wave nature of light, Polarization, Interference, Diffraction, Light Source. Excess carriers in Semiconductors: optical absorption; photo, electro and cathode – luminescence. Relevence of III-V and IV-VI material-system in optoelectronic devices. Lasers - Laser Emission, Absorption, Radiation, Population Inversion, Optical Feedback, Threshold condition, Laser Modes, Classes of Lasers.

UNIT III QUANTUM EFFECT 9

Quantum confinement, Engineering classifications of nanostructures (1D, 2D, 3D confinement) - nano particles- quantum dots, nanowires-ultra-thin films ultilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, optical, Magnetic and Thermal properties. Semiconducting Hetrostructures.

UNIT IV ADVANCED PROCESSING TECHNIQUES 9

Optoelectronic materials fabrication - Mechanical Milling, Colloidal routes, Selfassembly, CVD, MOCVD, Sputtering, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE and Lithography. Processing Environment - clean room technology: specifications and design, air and water purity, requirements for particular processes.

UNIT V MODERN OPTOELECTRONIC DEVICES 9

Optoelectronic Integrated Circuits: Introduction, hybrid and Monolithic Integration, Application of Opto Electronic Integrated Circuits, Integrated transmitters and Receivers, Guided wave devices. Quantum dot, quantum well lasers, LED, Photovoltaic, Photo-transisters, opto-electronic switches.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to relate impacts of semiconductor material properties into the optical properties of semiconductor devices.
- Ability to relate impacts of semiconductor material properties into the fabrication of semiconductor optoelectronic devices.

REFERENCES

1. Pallab Bhattacharya “Semiconductor Opto Electronic Devices”, Prentice Hall of India Pvt., Ltd., New Delhi, 2006.
2. Jasprit Singh, “Opto Electronics – As Introduction to materials and devices”, McGraw-Hill International Edition, 1998.
3. Timp. G, "Nanotechnology", AIP press/Springer, 1999.

ML6018 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 EQUATIONS IN FUNCTIONAL MATERIALS 9

Thermoelectric and electromagnetic properties of solids, Constitutive equations in electromagnetism, Maxwell's equation – microscopic and macroscopic approach, Constitutive equations for thermoelectric materials, Thermo-elastic conductors, Magnetizable conductors and Super conductivity

UNIT III CONSTITUTIVE EQUATIONS IN STRUCTURAL MATERIALS 9

Basic concepts from continuum mechanics, Stress tensor, Strain tensor, Strain rate tensor, Equation in conductivity and motion. Constitutive equations for ideal elastic material: Gauchy's method and Grees's Method. Constitutive equations for plasticity: Ideal plastic material and work hardenable plastic material.

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

OUTCOMES:

Upon completion of this course, the students can able to

- Apply numerical techniques to a variety of materials process including solidification, heat treatment, grain from the recovery stabilization
- Able to evaluate the capabilities and limitation of commercial software.

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 l., "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", 5th Edition, Vol. 1, Butterworth Heineman, 2000.