NATIONAL INSTITUTE OF TECHNOLOGY ANDHRA PRADESH

SCHEME OF INSTRUCTION AND SYLLABI
FOR B.TECH PROGRAM

Effective from 2015-16

DEPARTMENT OF METALLURGICAL & MATERIALS ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY ANDHRA PRADESH

VISION

Towards a Global Knowledge Hub, striving continuously in pursuit of excellence in Education, Research, Entrepreneurship and Technological services to the society

MISSION

- Imparting total quality education to develop innovative, entrepreneurial and ethical future professionals fit for globally competitive environment.
- Allowing stake holders to share our reservoir of experience in education and knowledge for mutual enrichment in the field of technical education.
- Fostering product oriented research for establishing a self-sustaining and wealth creating centre to serve the societal needs.

DEPARTMENT OF METALLURGICAL & MATERIALS ENGINEERING

VISION

Attain global recognition in research and training to meet challenging needs of Metallurgical and Materials Engineering with ethical and moral responsibility towards society.

MISSION

- Provide outstanding technical education for analysis, design and operation of metallurgical and materials systems.
- Keep abreast with rapid strides of technology and improve academic standards through innovative teaching and learning processes.
- Engage in quality research in metallurgical, materials and allied engineering areas.
- Develop academic linkages with leading industries for mutual benefit.

GRADUATE ATTRIBUTES

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These attributes are generic and are common to all engineering programs. These Graduate Attributes are identified by National Board of Accreditation.

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/Development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

DEPARTMENT OF METALLURGICAL & MATERIALS ENGINEERING
B.TECH IN METALLURGICAL AND MATERIALS ENGINEERING
PROGRAM EDUCATIONAL OBJECTIVES

PEO1	Apply knowledge of basic sciences and metallurgical engineering to extract & refine metals and to manufacture products.
PEO2	Design, characterize and evaluate material systems for metallurgical and materials applications.
PEO3	Work effectively as individuals and as team members in multidisciplinary projects.
PEO4	Pursue life-long learning to enhance knowledge base and skills for professional growth.

Mapping of Mission statements with program educational objectives

Mission Statement	PEO1	PEO2	PEO3	PEO4
Provide outstanding technical education for analysis, design and operation of metallurgical and materials systems.	✓	✓		
Keep abreast with rapid strides of technology and improve academic standards through innovative teaching and learning processes.		✓	✓	
Engage in quality research in metallurgical, materials and allied engineering areas.	✓	✓	✓	
Develop academic linkages with leading industries for mutual benefit.				✓

Mapping of program educational objectives with graduate attributes

PEO	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
PEO1	✓	✓	✓	✓	✓	✓					✓	
PEO2	✓	✓	✓	✓		✓	✓					
PEO3						✓	✓	✓	✓	✓	✓	
PEO4		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓

PROGRAM OUTCOMES: At the end of the program the student will be able to:

PO1	Design processes for concentrating ores and minerals.
PO2	Select processes for extraction of ferrous and non-ferrous metals.
PO3	Assess performance of metallurgical processes.
PO4	Identify processes to produce products as per specifications.
PO5	Produce defect free products using metal forming and metal joining processes.
PO6	Design thermo-mechanical treatment processes to modify the properties of metals and alloys for specific engineering applications.
PO7	Analyze processes for protecting materials from mechanical and environmental degradation
PO8	Design material systems, components, processes for specific applications considering environmental sustainability.
PO9	Apply modern science, engineering and project management principles to address the specific needs of metallurgical industries.
PO10	Function in multi-disciplinary teams using tools and environment to achieve project objectives.
PO11	Practice professional ethics for improved moral and human values.
PO12	Engage in lifelong learning for professional advancement.

Mapping of program outcomes with program educational objectives

PO	PEO1	PEO2	PEO3	PEO4
1	3	1	1	
2	3	1	1	
3	3	3	1	1
4	2	3		
5	3	3		
6	2	2		
7	2	2		
8	1	2		
9	2	3	2	
10	1	2	3	3
11	1	1	3	3
12	1	1	2	3

<u>CURRICULAR COMPONENTS</u>

DEGREE REQUIREMENTS FOR B. TECH IN METALLURGICAL AND MATERIALS ENGINEERING

Category of Courses	**Credits Offered**	**Min. credits to be earned**
Basic Science Core (BSC)	30	30
Engineering Science Core (ESC)	35	35
Humanities and Social Science Core(HSC)	07	07
Program Core Courses (PCC)	88	88
Departmental Elective Courses (DEC)	21	18
Open Elective Courses (OPC)	06	06
Program major Project (PRC)	06	06
EAA: Games and Sports (MDC)	0	0
Total	**193**	190

SCHEME OF INSTRUCTION

B.Tech. (Metallurgical and Materials Engineering) Course Structure

B. Tech. I - Year I – Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	MA101	Mathematics – I	4	0	0	4	BSC
2	HS101 ME102	English for Communication (or) Engineering Graphics	3 2	0 0	2 3	4 4	HSC ESC
3	PH101 CY101	Physics (or) Chemistry	4 4	0 0	0 0	4 4	BSC BSC
4	EC101 EE101	Basic Electronics Engineering (or) Basic Electrical Engineering	3 3	0 0	0 0	3 3	ESC ESC
5	CE102 ME101	Environmental Science and Engineering (or) Basic Mechanical Engineering	3 3	0 0	0 0	3 3	ESC ESC
6	CS101 CE101	Prob. Solving and Computer Programming (or)Engineering Mechanics	4 4	0 0	0 0	4 4	ESC ESC
7	PH102 CY102	Physics Lab (or) Chemistry Lab	0 0	0 0	3 3	2 2	BSC BSC
8	CS102 ME103	Prob. Solving and Computer Programming Lab(or) Workshop Practice	0 0	0 0	3 3	2 2	ESC ESC
9	EA101	EAA: Games and Sports	0	0	3	0	MDC
		TOTAL	**21**	**0**	**11**	**26**	
			20	**0**	**12**	**26**	

B.Tech. I - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	MA151	Mathematics – II	4	0	0	4	BSC
2	ME102 HS101	Engineering Graphics (or) English for Communication	2 3	0 0	3 2	4 4	ESC HSC
3	CY101 PH101	Chemistry (or) Physics	4 4	0 0	0 0	4 4	BSC BSC
4	EE101 EC101	Basic Electrical Engineering (or) Basic Electronics Engineering	3 3	0 0	0 0	3 3	ESC ESC
5	ME101 CE102	Basic Mechanical Engineering (or) Environmental Science and Engineering	3 3	0 0	0 0	3 3	ESC ESC
6	CE101 CS101	Engineering Mechanics (or) Problem Solving and Computer Programming	4 4	0 0	0 0	4 4	ESC ESC
7	CY102 PH102	Chemistry Lab (or) Physics Lab	0 0	0 0	3 3	2 2	BSC BSC
8	ME103 CS102	Workshop practice (or) Problem Solving and Computer Prog. Lab	0 0	0 0	3 3	2 2	ESC ESC
9	EA151	EAA: Games and Sports	0	0	3	0	MDC
	Total		**20**	**0**	**12**	**26**	
			21	**0**	**11**	**26**	

II - Year I - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	MA201	Mathematics III	4	0	0	4	BSC
2	MM201	Physical Metallurgy and Materials Engineering	3	1	0	4	PCC
3	MM202	Mineral Processing	3	1	0	4	PCC
4	MM203	Metallurgical Thermodynamics and Kinetics	3	1	0	4	PCC
5	MM204	Transport Phenomena	3	1	0	4	PCC
6	MM205	Mineral Processing Laboratory	0	0	3	2	PCC
7	CY202	Instrumental Methods of Metallurgical and Materials Analysis Laboratory	0	0	3	2	BSC
8	EE235	Basic Electrical Engineering Laboratory	0	0	3	2	ESC
		TOTAL	**16**	**4**	**9**	**26**	

II - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	MA251	Mathematics IV	4	0	0	4	BSC
2	MM251	Phase Transformations and Heat Treatment	3	1	0	4	PCC
3	MM252	Unit Processes in Extractive Metallurgy	3	1	0	4	PCC
4	MM253	Computer Applications in Materials Engineering	3	0	0	3	PCC
5	PH285	Electronic and Magnetic Materials	3	0	0	3	PCC
6	MM254	Unit Processes in Extractive Metallurgy Laboratory	0	0	3	2	PCC
7	MM255	Physical Metallurgy and Heat Treatment Laboratory	0	0	3	2	PCC
8	EC289	Basic Electronics Laboratory	0	0	3	2	ESC
		TOTAL	**16**	**2**	**9**	**24**	

III - Year I – Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat.
1	SM335	Engineering Economics and Accountancy	3	0	0	3	HSC
2	MM301	Ferrous Production Technology	3	1	0	4	PCC
3	MM302	Mechanical Behaviour of Materials	3	1	0	4	PCC
4	MM303	Powder Metallurgy	3	1	0	4	PCC
5		Elective I	3	0	0	3	DEC
6		Elective II	3	0	0	3	DEC
7	MM304	Mechanical Behaviour of Materials Laboratory	0	0	3	2	PCC
8	MM305	Powder Metallurgy Laboratory	0	0	3	2	PCC
		TOTAL	**18**	**3**	**6**	**25**	

III - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat.
1	ME385	Welding Technology	3	0	0	3	PCC
2	MM351	Foundry Technology and Non-Destructive Testing	3	1	0	4	PCC
3	MM352	Electrometallurgy and Corrosion	3	1	0	4	PCC
4		Elective III	3	0	0	3	DEC
5		Elective IV	3	0	0	3	DEC
6		Open Elective I	3	0	0	3	OPC
7	MM353	Foundry Technology and Non-Destructive Testing Laboratory	0	0	3	2	PCC
8	MM354	Electrometallurgy and Corrosion Laboratory	0	0	3	2	PCC
		TOTAL	**18**	**2**	**6**	**24**	

IV - Year I - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat.
1	MM401	X-Ray Diffraction and Electron Microscopy	3	1	0	4	PCC
2	MM402	Mechanical Working of Materials	3	0	0	3	PCC
3	MM403	Non Ferrous Extractive Metallurgy	4	0	0	4	PCC
4		Elective V	3	0	0	3	DEC
5		Open Elective II	3	0	0	3	OPC
6	MM404	X-Ray Diffraction and Electron Microscopy Laboratory	0	0	3	2	PCC
7	MM405	Mechanical Working of Materials Laboratory	0	0	3	2	PCC
8	MM449	Project Work-Part A	0	0	3	2	PRC
		TOTAL	**16**	**1**	**9**	**23**	

IV - Year II– Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat.
1	ME435	Industrial Management	3	0	0	3	PCC
2	MM451	Characterization Techniques	3	0	0	3	PCC
3		Elective VI	3	0	0	3	DEC
3		Elective VII	3	0	0	3	DEC
4	MM452	Characterization Techniques Laboratory	0	0	3	2	PCC
5	MM491	Seminar	0	0	3	1	PCC
7	MM499	Project Work – Part B	0	0	6	4	PRC
		TOTAL	**12**	**0**	**9**	**19**	

List of Electives

III Year I Semester

MM311 Computational Materials Engineering
MM312 Refractory and Rare Metal Extraction
MM313 Fuels, Refractories and Furnaces
MM314 Ceramics, Polymers and Composites
MM315 Polymer Technology
MM316 Composite Technology

III Year II Semester

MM361 Creep, Fatigue and Fracture
MM362 Fracture Mechanics and Failure Analysis
MM363 High Temperature Materials
MM364 Advanced Ferrous Production Technology
MM365 Alternate Route of Iron Production
MM366 Secondary Steel Making

IV Year I Semester

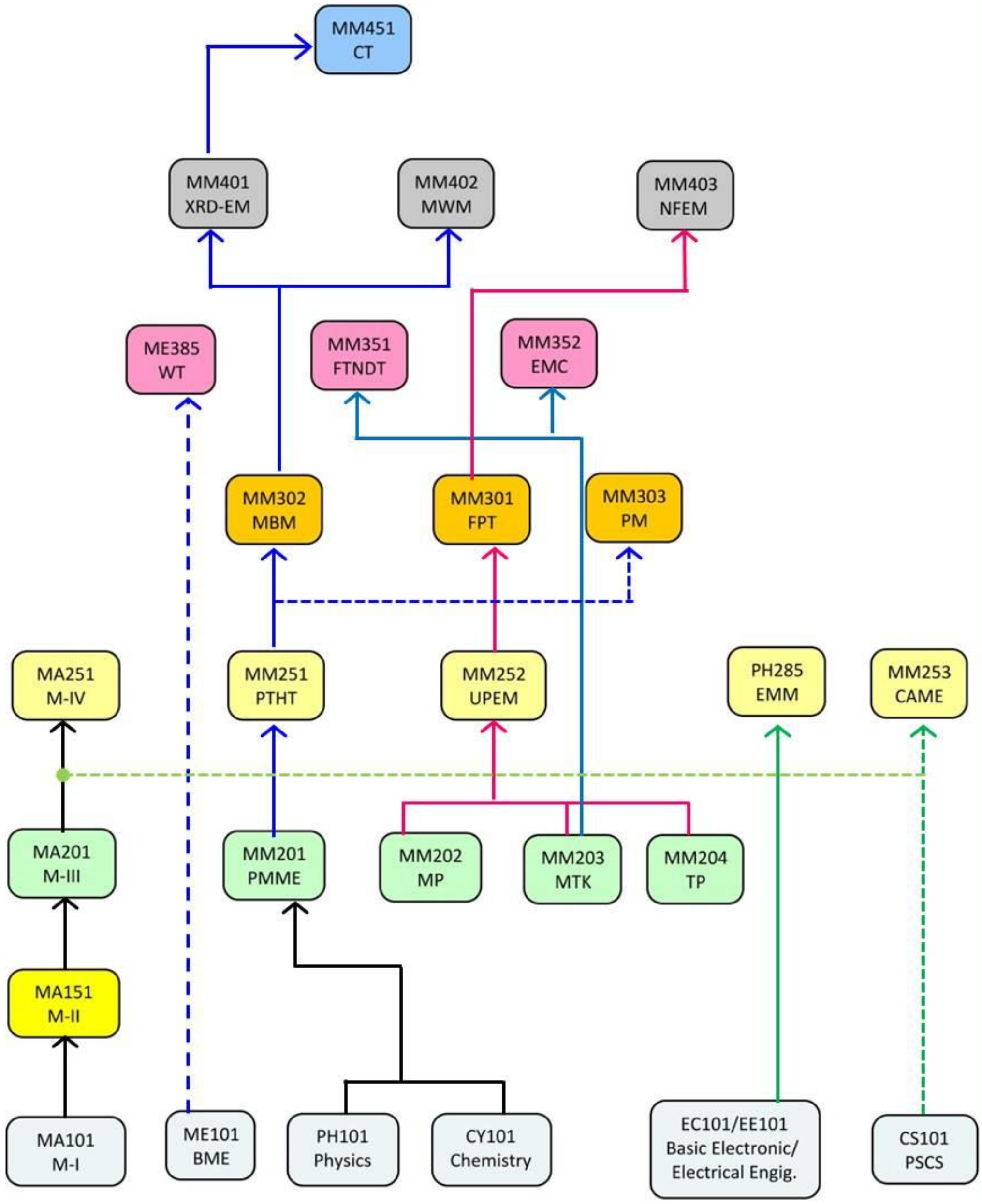
MM411 Advanced Materials
MM412 Biomaterials
MM413 Materials Technology

IV Year II Semester

MM461 Materials Selection and Design
MM462 Electro Finishing
MM463 Surface Engineering
MM464 Nano Science and Nano Technology
MM465 Nuclear Materials
MM466 High Temperature Corrosion

B.TECH IN METALLURGICAL AND MATERIALS ENGINEERING

PRE-REQUISITE CHART



DETAILED SYLLABUS

MA101	Mathematics – I	BSC	4 – 0 – 0	4 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Solve linear system equation
CO2	Determine the Eigen values and vectors of a matrix
CO3	Determine the power series expansion of a function
CO4	Estimate the maxima and minima of multivariable functions
CO5	Solve any given first order ordinary differential equation
CO6	Solve any higher order linear ordinary differential equation with constant coefficients

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			2									
CO2			2									
CO3								1				
CO4			1									
CO5			3									
CO6			1									

Detailed Syllabus:

Matrix Theory: Elementary row and column operations on a matrix, Rank of matrix – Normal form – Inverse of a matrix using elementary operations –Consistency and solutions of systems of linear equations using elementary operations, linear dependence and independence of vectors - Characteristic roots and vectors of a matrix - Caley-Hamillton theorem and its applications, Complex matrices, Hermitian and Unitary Matrices - Reduction to diagonal form - Reduction of a quadratic form to canonical form – orthogonal transformation and congruent transformation.

Differential Calculus: Rolle's theorem; Mean value theorem; Taylor's and Maclaurin's theorems with remainders, Expansions; Indeterminate forms; Asymptotes and curvature; Curve tracing; Functions of several variables, Partial Differentiation, Total Differentiation, Euler's theorem and generalization, maxima and minima of functions of several variables (two and three variables) – Lagrange's method of Multipliers; Change of variables – Jacobians.

Ordinary differential equations of first order: Formation of differential equations; Separable equations; equations reducible to separable form; exact equations; integrating factors; linear first order equations; Bernoulli's equation; Orthogonal trajectories and Newton's law of cooling.

Ordinary linear differential equations of higher order : Homogeneous linear equations of arbitrary order with constant coefficients - Non-homogeneous linear equations with constant coefficients; Euler and Cauchy's equations; Method of variation of parameters; System of linear differential equations, Vibrations of a beam.

Reading:

1. R.K.Jain and S.R.K.Iyengar, Advanced Engineering Mathematics, Narosa Pub. House, 2008.
2. ErwynKreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition, 2008.
3. B.S.Grewal, Higher Engineering Mathematics, Khanna Publications, 2009.

HS101	English for Communication	HSC	3 – 0 – 2	4 Credits

Pre-requisites: None.

Course outcomes: At the end of the course, the student will be able to:

CO1	Understand basic grammar principles
CO2	Write clear and coherent passages
CO3	Write effective letters for job application and complaints
CO4	Prepare technical reports and interpret graphs
CO5	Enhance reading comprehension
CO6	Comprehend English speech sound system, stress and intonation

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												3
CO2										3		1
CO3										2		3
CO4										2	1	1
CO5												2
CO6												3

Detailed syllabus

Grammar Principles and Vocabulary Building: -Exposure to basics of grammar- parts of speech, with emphasis on tenses—active and passive voice- their usage- reported speech -Idioms and Phrases—their meanings and usage, Vocabulary development through prefixes, suffixes and word roots

Effective Sentence Construction –clarity and precision in construction—strategies for effectiveness in writing

Paragraphs: Definition- structure- Types and Composition-unity of theme- coherence-organisation patterns

Note-making – its uses- steps in note-making—identification of important points-reduction to phrases –selection of suitable note format- types of notes—tree diagram, block list, table-

Letter Writing: Business, Official and Informal letters-- communicative purpose-strategy-letter format and mechanics- letters of request , complaint and invitation-

Reading techniques: Skimming and Scanning – quick reading for gist and –suggesting titles- looking for specific information

Description of Graphics- kinds of graphs- their construction and use and application in scientific texts- interpretation of graphs using expressions of comparison and contrast

Reading Comprehension – reading to retrieve information ––—techniques of comprehension -find clues to locate important points- answering objective type questions –inference, elimination

Technical Report-Writing - kinds of reports-proposals, progress and final reports- their structure- features- process of writing a report-editing

Book Reviews- Oral and written review of a chosen novel/play- a brief written analysis including summary and appreciation- oral presentation of the novel before class

Reading

A Textbook of English for Engineers and Technologists (combined edition, Vol. 1 & 2); Orient Black Swan 2010.

PH101	Physics	BSC	4 – 0 – 0	4 Credits

Prerequisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Solve engineering problems using the concepts of wave and particle nature of radiant energy
CO2	Understand the use of lasers as light sources for low and high energy applications
CO3	Understand the nature and characterization of acoustic design, nuclear accelerators and new materials
CO4	Apply the concepts of light in optical fibers, light wave communication systems, and holography and for sensing physical parameters
CO5	Construct a quantum mechanical model to explain the behaviour of a system at microscopic level

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										1		
CO2					2							
CO3					2							
CO4									1			
CO5										1		

Detailed Syllabus:

Interference: Superposition principle, Division of amplitude and wave front division, Interferometers (Michelson, Fabry-Perot, Mach-Zehnder), Applications; Diffraction:Fraunhoffer diffraction (single, double & multiple slits), Resolving power, Dispersive power, Applications.

Polarization: Production & detection of polarized light, wave plates, optical activity, Laurents Half-shade polarimeter, photoelasticity and applications; LASERS: Basic principles of Lasers, He-Ne, Nd-YAG, CO_2 and semiconductors lasers, applications of lasers, Holography and holographic NDT.

Optical fibers: Light propagation in Optical fibers, types of optical fibers, optical fibers for communication and sensing.

Functional materials: Fiber reinforced plastics, fiber reinforced metals, surface acoustic wave materials, biomaterials, high temperature materials, smart materials and their applications, Introduction to Nano materials.

Modern physics: Qualitative review of different experiments, de-Broglie waves, Dual nature of matter, Schrodinger wave equation, wave function and its interpretation, potential well problems in one dimension, Tunneling, Uncertainty principle, Particle Accelerators: Cyclotron, Synchro Cyclotron, Betatron and applications.

Acoustics: Introduction, Reverberation and reverberation time, growth and decay of energy, Sabine's formula, absorption coefficient and its measurement, factors affecting architectural acoustics; Production, detection and applications of Ultrasound.

Reading:

1. Halliday, Resnic and Walker, Fundamentals of Physics, 9thEd.,John Wiley, 2011.
2. Beiser A, Concepts of Modern Physics, 5th Ed., McGraw Hill International, 2003.
3. AjoyGhatak, Optics, 5th Ed., Tata McGraw Hill, 2012.
4. M. Armugam, Engineering Physics, Anuradha Agencies, 2003.

CY101	Chemistry	BSC	4 – 0 – 0	4 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand and apply the concepts in electrochemistry and corrosion science
CO2	Understand the concepts in molecular interactions
CO3	Understand the synthesis and analysis of modern materials
CO4	Apply the concepts of organic chemistry for synthesis
CO5	Understand the synthesis and applications of polymer science
CO6	Identify the structure of organic molecules using photo chemistry and chemical spectroscopy

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							3					
CO2			1									
CO3								1	2			
CO4	1	1										
CO5									1			
CO6									1			

Detailed Syllabus:

Electrochemistry - Review of the concepts of electrode potentials, Nernst equation, Reference electrodes, Ion selective electrodes – Concept – Glass electrode – Determination of pH of a solution using a glass electrode – Derivation of equation between E_{cell} and pH, Determination of F^- ion using fluoride electrode (Numerical calculations), Chemically modified electrodes (CMEs) – Concept, CMEs as potentiometric and amperometric sensors, Electrochemical energy systems, Electrochemistry of secondary cells e.g. Lead – acid and Ni-Cd cells, Rechargeable lithium batteries, Fuel cells – Electrochemistry of a H_2–O_2 fuel cell, methanol–O_2 fuel cell.

Corrosion and Its Prevention - Electrochemical theory of corrosion, Corrosion due to dissimilar metal cells (galvanic cells), Corrosion due to differential aeration cells, Uniform corrosion, pitting corrosion and stress corrosion cracking, Effect of pH, Potential-pH diagram for Iron, temperature and dissolved oxygen on corrosion rate, Corrosion prevention and control by cathodic protection.

Molecular Interactions - Molecular orbital theory applicable to understanding of bonding in heteronuclear diatomic molecules, e.g. CO and NO, Molecular orbital energy diagram of an Octahedral complex, MO diagram of a molecule involving charge transfer (e.g. $KMnO_4$), Nature of supramolecular interactions: ion-ion interactions, ion-dipole interactions, dipole-dipole interactions, hydrogen bonding, cation-л interactions, л-л interactions, van der Walls forces, Concept of self-assembly involving different types of interactions (Micellar formation; Membrane Formation; Surface films).

Chemistry of Nanomaterials - Introduction to Nanomaterials, Chemical synthesis of nanomaterials: sol-gel method, Reverse micellar method, electrolytic method, Characterization of nanoparticles by BET method, Characterization of nanomaterials by TEM (includes basic principle of TEM), Applications of nanomaterials in Industry as drug delivery materials, as catalysts, in water treatment.

Basic Principles Of Organic Chemistry – Introduction,Homolytic and Heterolytic cleavages and free radicals Carbocations, carbanions and addition reactions Elimination and substitution reactions.

Stereochemistry: chirality, optical activity, enantiomers and diastereomers, Projection formulae and geometrical isomerism, Reactions - Hofmann reaction and Riemer-Tiemann reaction, Diels-Alder reaction and Cannizaro reaction, Skraup synthesis.

Polymer Chemistry - Concept of polymerization – Types of polymerization, Chain growth polymerization – mechanisms of free radical and cationic polymerizations, Mechanisms of simple anionic polymerization and co-ordination anionic polymerization (complex forming mechanism), Step-growth polymerization ,Mechanism and examples.

Thermoplastic resins and Thermosetting resins- examples and applications, conducting polymers: Mechanism of conduction in polymers – Examples – and applications.

Review Of Chemical Spectroscopy - Review of electromagnetic spectrum, Quantization of energy, Born – Oppenheimer approximation, Frank Condon Principle Vibrational spectra (Infra-red) of diatomic molecules – Selection rules Determination of force constant Problems, Identification of functional groups using IR spectroscopy Electronic spectroscopy - Types of electronic transitions –calculation of chromophoric absorptions For Diene and ene-one chromophors Qualitative analysis by electronic spectroscopy, Lambert – Beer's law-Applications in Quantitative analysis and problems.

NMR spectroscopy: Basic principles, Concept of chemical shift. Concept of spin-spin splitting and examples, Applications of UV,I.R and ^{1}H NMR spectra in the determination of structures of Ethyl alcohol, Dimethyl ether, Acetic acid and Benzyl alcohol.

Photo Chemistry – Principles of photochemistry – Rates of intermolecular processes, Jablonski diagram – fluorescence, phosphorescene and Chemiluminescence, Types of Photochemical Organic reactions, Laws of photochemistry and quantum yields-problems, Photosensitized reactions.

Reading

1. P. W. Atkins & Julio de Paula, Atkins Physical Chemistryl Chemistry, Oxford University Press York, 7thEdn, 2002.
2. Shashi Chawla, A Text Book of Engineering Chemistry, 3rd Edition, DhanpatRai& Co New Delhi, 2007.
3. S. Vairam, P. Kalyani&Suba Ramesh, Engineering Chemistry, IstEdn, John Wiley & Sons, India, 2011.

4. Lee J.D., Concise Inorganic Chemistry, 7th Edn, Blackwel Science Publications Oxford, London, 2004.
5. Jerry March., Advanced Organic Chemistry, 6thEdn, John Wiley & Sons, New Jersy, 2007.
6. FehFuYen, Chemistry for Engineers, Imperial College Press, 2008.
7. Octave Levenspiel, Chemical Reaction Engineering, 2nd Edition, Wiley India, 2006.
8. Smith J.M., Chemical Engineering Kinetics, 3rd Edition, McGraw Hill, 1981.

EC101	Basic Electronics Engineering	ESC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Characterize semiconductors, diodes, transistors and operational amplifiers
CO2	Design simple analog circuits
CO3	Design simple combinational and sequential logic circuits
CO4	Understand functions of digital multimeter, cathode ray oscilloscope and transducers in the measurement of physical variables
CO5	Understand fundamental principles of radio communication

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1				
CO2								1				
CO3								1				
CO4								1				
CO5								1	1			

Detailed Syllabus:

Electronics Systems: Introduction to electronics, review of p-n junction operation, diode applications, Zener diode as regulator.

Transistor and applications: Introduction to transistors, BJT Characteristics, biasing and applications, simple RC coupled amplifier and frequency response. Cascaded amplifiers, FET and MOSFET characteristics and applications.

Feedback in Electronic Systems: open loop and closed loop systems, Negative and positive feedback merits and demerits, Principle of oscillators, LC and RC oscillators.

Integrated Circuits: Operational amplifiers, Applications: adder, subtractor, Integrator and Differentiators.

Digital Circuits: Number systems and logic gates, Combinational Logic circuits, Flip-Flops, counters and shift registers, data converters, Analog to Digital and Digital to Analog converters (ADC/DAC's).

Electronic Instrumentation: Measurement, Sensors, Laboratory measuring instruments: digital multi-meters and Cathode Ray Oscilloscopes (CRO's).

Principles of Communication: Need for Modulation, Modulation and Demodulation techniques.

Reading

1. Neil Storey, “Electronics A Systems Approach”, 4/e - Pearson Education Publishing Company Pvt Ltd, 2011.
2. Salivahanan, N Suresh Kumar, “Electronic Devices and Circuits” 3/e, McGraw Hill Publications, 2013.
3. Bhargava N. N., D C Kulshreshtha and S C Gupta, “Basic Electronics & Linear Circuits”, Tata McGraw Hill, 2/e, 2013 .

EE101	Basic Electrical Engineering	ESC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Analyze and solve electric and magnetic circuits
CO2	Identify the type of electrical machines for a given application
CO3	Recognize the ratings of different electrical apparatus
CO4	Identify meters for measuring electrical quantities

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							1			1		
CO2					1							
CO3					1							
CO4						1						

Detailed Syllabus:

DC Circuits: Kirchhoff's Voltage & Current laws, Superposition Theorem, Star – Delta Transformations.

AC Circuits: Complex representation of Impedance, Phasor diagrams, Power & Power Factor, Solution of Single Phase Series & Parallel Circuits. Solution of Three Phase circuits and Measurement of Power in Three Phase circuits.

Magnetic Circuits: Fundamentals and Solution of Magnetic Circuits, Concepts of Self and Mutual Inductances, Coefficient of Coupling.

Single Phase Transformers: Principle of Operation of a Single Phase Transformer, EMF equation, Phasor diagram, Equivalent Circuit, Determination of Equivalent Circuit Parameters, Regulation and Efficiency of a single phase transformer. Principle of operation of an Auto Transformer.

DC Machines: Principle of Operation, Classification, EMF and Torque equations, Characteristics of Generators and Motors, Speed Control Methods and Starting Techniques.

Three Phase Induction Motor: Principle of Rotating Magnetic Field, Principle of Operation of 3-φ I.M., Torque-Speed Characteristics of 3-φ I.M., Starting Methods and Applications of Three Phase Induction Motors.

Measuring Instruments: Moving Coil and Moving Iron Ammeters and Voltmeters, Dynamometer Type Wattmeter and Induction Type Energy Meter.

Reading:

1. Edward Hughes, Electrical Technology, 10th Edition, ELBS, 2010.
2. Vincent Del Toro, Electrical Engineering Fundamentals, 2nd Edition, PHI, 2003.
3. V.N. Mittle, Basic Electrical Engineering, TMH, 2000.

CE101	Engineering Mechanics	ESC	4 – 0 – 0	4 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Determine the resultant force and moment for a given system of forces
CO2	Analyze planar and spatial systems to determine the forces in members of trusses, frames and problems related to friction
CO3	Calculate the motion characteristics of a body subjected to a given force system
CO4	Determine the deformation of a shaft and understand the relationship between different material constants
CO5	Determine the centroid and second moment of area

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					2							
CO2					2							
CO3								1				
CO4					2			1				
CO5								1				

Detailed syllabus:

Introduction - Specification of force vector, Formation of Force Vectors, Moment of Force – Cross product – Problems, Resultant of a general force system in space, Degrees of freedom - Equilibrium Equations, Kinematics – Kinetics – De' Alemberts principle, Degree of Constraints – Freebody diagrams.

Spatial Force systems - Concurrent force systems - Equilibrium equations – Problems, Problems (Vector approach) – Tension Coefficient method, Problems (Tension Coefficient method), Parallel force systems - problems, Center of Parallel force system – Problems.

Coplanar Force Systems - Introduction – Equilibrium equations – All systems, Problems on Coplanar Concurrent force system, Coplanar Parallel force system, Coplanar General force system – Point of action, Method of joints, Method of sections, Method of sections, Method of members, Friction – Coulombs laws of dry friction – Limiting friction, Problems on Wedge friction, Belt Friction-problems.

Mechanics of Deformable Bodies - Stress & Strain at a point- Normal and shear stresses, Axial deformations – Problems on prismatic shaft, tapered shaft and deformation due to self-weight, Deformation of Stepped shaft due to axial loading, Poisson's Ratio – Bulk Modulus - Problems, change in dimensions and volume.

Centroid & Moment of Inertia - Centroid & M.I – Arial & Mass M.I – Radius of Gyration, Parallel axis– Perpendicular axis theorem – Simple Problems.

Dynamics of Particles - Rectilinear Motion – Kinematics Problems, Kinetics – Problems, Work & Energy – Impulse Moment, Direct Central Impact – coefficient of restitution, Curvilinear Motion – Projectile Motion, Work & Energy in Curvilinear motion.

Dynamics of Rigid Bodies - Rigid body rotation – Kinematics - Kinetics, Problems – Work & Energy in Rigid body rotation, Plane Motion – Kinematics, Problem – Instantaneous center of rotation.

Reading:

1. J.L.Meriam and L.G. Kraige, Engineering Mechanics, 7th Ed, John Wiley & Sons, 2012.
2. Timoshenko and Young, Engineering Mechanics, 3rd Ed, McGraw Hill Publishers, 2006.
3. Gere and Timoshenko, Mechanics of Materials, 2nd Ed, CBS Publishers, 2011.

CE102	Environmental Science and Engineering	ESC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify environmental problems arising due to engineering and technological activities and the science behind those problems.
CO2	Estimate the population - economic growth, energy requirement and demand.
CO3	Analyse material balance for different environmental systems.
CO4	Realize the importance of ecosystem and biodiversity for maintaining ecological balance.
CO5	Identify the major pollutants and abatement devices for environmental management and sustainable development

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1					1				1	
CO2	1							1			2	1
CO3								1				
CO4								1			1	
CO5								1		1	1	1

Detailed syllabus:

Nature and scope of Environmental Problems: Environment and society, environmental disturbances, role of technology, sustainable development, quantification of environmental issues.

Population and Economic growth: Economic growth and industrialization urbanization, Resource consumption, Renewable and nonrenewable resources, Energy requirement and development.

Global Atmospheric systems: Concept of climate change, green house effect, global energy balance, global warming, carbon cycle, Intergovernmental Panel for Climate Change (IPCC) emission scenarios, impact of climate change.

Mass balance and Environmental chemistry: Mass and Energy balance, Particle dispersion, oxygen demand, carbon emission, enthalpy in environmental systems, chemical equilibria.

Ecology and Biodiversity: Energy flow in ecosystem, food chain, nutrient cycles, eutrofication, value of biodiversity, biodiversity at global, national and local levels, threats for biodiversity, conservation of biodiversity

Water Pollution: water pollutants, effects of oxygen demanding waste on water, water quality in lakes, reservoirs and groundwater, contaminant transport, self cleaning capacity of streams and water bodies, water quality standards, principles of water and wastewater treatment.

Air Pollution: Overview of emissions, pollutant standard index, toxic air pollutants, vehicle emissions, indoor air quality, principles of air pollution control.

Solid and Hazardous Waste: Characteristics of Solid and Hazardous Waste, Collection and transfer system, recycling, composting, waste to energy conversion, landfills.

Environmental Management: Sustainable development, Environmental Impact Assessment (EIA), Environmental Ethics, Legal aspects.

Reading

1. J.G. Henry and G.W. Heinke, Environmental Science and Engineering, Pearson Education, 2004
2. G.B. Masters, Introduction to Environmental Engineering and Science, Pearson Education, 2004.

ME101	Basic Mechanical Engineering	ESC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand basics of thermodynamics and components of a thermal power plant
CO2	Identify engineering materials, their properties, manufacturing methods encountered in engineering practice
CO3	Understand basics of heat transfer, refrigeration and internal combustion engines
CO4	Understand mechanism of power transfer through belt, rope, chain and gear drives
CO5	Understand functions and operations of machine tools including milling, shaping, grinding and lathe machines

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1				
CO2					1			1				
CO3			2									
CO4					1							
CO5								1				

Detailed Syllabus:

Introduction: Introduction to Thermodynamics - Concept of a System – Types of Systems, Thermodynamic Equilibrium, Properties, State, Process and Cycle, Zeroth Law, Energy Interactions - Heat and Work, Types of Work, Work interactions in a closed System for various processes

First and Second Laws of Thermodynamics: First Law: Cycle and Process, Specific Heats (c_p and c_v), Heat interactions in a Closed System for various processes, Limitations of First Law, Concept of Heat Engine (H.E.) and Reversed H.E. (Heat Pump and Refrigerator), Efficiency/COP, Second Law: Kelvin-Planck and Clausius Statements, Carnot Cycle, Carnot Efficiency, Statement of Clausius Inequality, Property of Entropy, T-S and P-V Diagrams

Thermal Power Plant: Thermal Power Plant Layout – Four Circuits, Rankine Cycle, Boilers: Fire Tube vs Water Tube; Babcock & Wilcox, Cochran Boilers, Steam Turbines : Impulse vs Reaction Turbines, Compounding of Turbines: Pressure Compounding, Velocity Compounding, Pressure-Velocity Compounding, Condensers: Types – Jet & Surface Condensers, Cooling Towers

Manufacturing Processes: Engineering Materials: Classification, Properties of Materials, Manufacturing Processes: Metal Casting, Moulding, Patterns, Metal Working: Hot Working and Cold Working, Metal Forming: Extrusion, Forging, Rolling, Drawing

Internal Combustion Engines and Refrigeration: IC Engines: 2 - Stroke and 4 - Stroke Engines, S.I. Engine and C.I. Engine: Differences, P-V and T-S Diagrams

Refrigeration System and Refrigerants: Principle and working of standard vapor compression refrigeration system and Brief description of Refrigerants

Heat Transfer: Heat Transfer: Modes; Thermal Resistance Concept, Conduction: Composite Walls and Cylinders, Combined Conduction and Convection: Overall Heat Transfer Co-efficient, Simple Numerical Problems: Heat Transfer

Welding: Welding: Gas Welding and Arc Welding, Soldering, Brazing

Power Transmission: Transmission of Mechanical Power: Belt Drives – Simple Numerical Problems, Gear Drives – Simple Numerical Problems

Basics of Automotive Vehicle: Lay out of Automobile Transmission; Brakes – Types, Clutch, Differential

Machine Tools and Machining Processes: Machine Tools Machine Tools: Lathe Machine, Lathe Operations, Milling Machine-Types, Milling Operations, Shaper and Planer Machines: Differences, Quick-Return Motion Mechanism, Drilling Machine: Operations, Grinding Machine: Operations

Reading

1. Mathur, M.L., Mehta, F.S., and Tiwari, R.P., Elements of Mechanical Engineering, Jain Brothers, New Delhi, 2011.
2. Roy, K.P., and HazraChowdary, S.K.., Elements of Mechanical Engineering, Media Promoters and Publishers Pvt. Ltd., 2002.
3. Rudramoorthy, R.., Thermal Engineering, Tata McGraw Hill Book Company, New Delhi, 2003.
4. HazraChowdary., S.K. and Bose, Workshop Technology, Vol. I and II, Media Promoters and Publishers Pvt. Ltd., 2002.

ME102	Engineering Graphics	ESC	2 – 0 – 3	4 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Draw Orthographic projections of Lines, Planes, and Solids
CO2	Construct Isometric Scale, Isometric Projections and Views
CO3	Draw Sections of various Solids including Cylinders, cones, prisms and pyramids
CO4	Draw projections of lines, planes, solids, isometric projections and sections of solids including Cylinders, cones, prisms and pyramids using AutoCAD

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					1			1				
CO2					2							
CO3					1							
CO4					1				1			

Detailed Syllabus:

Introduction: Overview of the course, Examination and Evaluation patterns.

Lines Lettering and Dimensioning: Types of lines, Lettering, Dimensioning, Geometrical Constructions, Polygons, Scales.

Orthographic projection of points: Principles of Orthographic projection, Projections of points.

Projections of Lines: Projections of a line parallel to one of the reference planes and inclined to the other, line inclined to both the reference planes, Traces

Projections of Planes: Projections of a plane perpendicular to one of the reference planes and inclined to the other, Oblique planes.

Projections of Solids: Projections of solids whose axis is parallel to one of the reference planes and inclined to the other, axis inclined to both the planes.

Section of Solids: Sectional planes, Sectional views - Prism, pyramid, cylinder and cone, true shape of the section.

Isometric views: Isometric axis, Isometric Planes, Isometric View, Isometric projection, Isometric views – simple objects.

Auto-CAD practice: Introduction to Auto-CAD, DRAW tools, MODIFY tools, TEXT, DIMENSION, PROPERTIES tool bar, Standard Tool bar, LAYERS

Reading

1. N.D. Bhat and V.M. Panchal, Engineering Graphics, Charotar Publishers 2013
2. E. Finkelstein, “AutoCAD 2007 Bible”, Wiley Publishing Inc., 2007

CS101	Problem Solving and Computer Programming	ESC	4 – 0 – 0	4 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Develop algorithms for mathematical and scientific problems
CO2	Explore alternate algorithmic approaches to problem solving
CO3	Understand the components of computing systems
CO4	Choose data types and structures to solve mathematical and scientific problem
CO5	Develop modular programs using control structures
CO6	Write programs to solve real world problems using object oriented features

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			2									
CO2			1									
CO3			1							1		
CO4								1		1		
CO5			1									
CO6			2									

Detailed Syllabus:

Problem solving techniques – algorithms.

Introduction to computers - Basics of C++ - Number representation, Basic data types - int, float, double, char, bool, void.

Flow of Control - Conditional statements - If-else, Switch-case constructs, Loops - while, do-while, for.

Functions - user defined functions, library functions, parameter passing - call by value, call by reference, return values, Recursion.

Arrays - Single, Multi-Dimensional Arrays, initialization, accessing individual elements, passing arrays as parameters to functions.

Pointers and Dynamic Arrays - Multidimensional Dynamic Arrays, creation and deletion of single and multi-dimensional arrays.

C Strings, Standard String Class

I/O Streams, stream flags, stream manipulators, formatted I/O, binary I/O, Character I/O, File I/O - Opening, closing and editing files.

Structures and Classes - Declaration, member variables, member functions, access modifiers, inheritance, function overloading, overriding, redefinition, virtual functions, operator overloading, polymorphism - compile time and runtime binding.

Reading

1. Walter Savitch, Problem Solving with C++, Sixth Edition, Pearson, 2007.
2. Cay Horstmann, Timothy Budd, Big C++, Wiley, Indian Edition, 2006.

PH102	Physics Laboratory	BSC	0 – 0 – 3	2 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Use CRO, signal generator, spectrometer, polarimeter and GM counter for making measurements
CO2	Test optical components using principles of interference and diffraction of light
CO3	Determine the selectivity parameters in electrical circuits
CO4	Determine the width of narrow slits, spacing between close rulings using lasers and appreciate the accuracy in measurements

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1				
CO2								1				
CO3								1				
CO4								1				

Detailed Syllabus:

1. Determination of Wavelength of Sodium light using Newton's Rings.
2. Determination of Wavelength of He-Ne laser – Metal Scale.
3. Measurement of Width of a narrow slit using He- Ne Laser.
4. Determination of Specific rotation of Cane sugar by Laurent Half-shade Polarimeter.
5. Determination of capacitance by using R-C circuit.
6. Determination of resonating frequency and bandwidth by LCR circuit.
7. Measurement of half-life of radioactive source using GM Counter.
8. Diffraction grating by normal incidence method.

Reading:

1. Physics Laboratory Manual.

CY102	Chemistry Laboratory	BSC	0 – 0 – 3	2 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Synthesize polymers
CO2	Analyze ores and bleaching powder
CO3	Estimate the Hardness of water in terms of Calcium and Magnesium ions
CO4	Determine salt content using chromatographic techniques
CO5	Standardize solutions using titration, conductivity meter, pH-meter, potentiometer and colorimeter
CO6	Verify the Freundlich adsorption isotherm

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1				
CO2	2											
CO3	1											
CO4								1				
CO5								1				
CO6			1									

Detailed Syllabus:

Cycle 1

1. Standardization of potassium permanganate.
2. Determination of MnO2 in Pyrolusite.
3. Determination of Iron in Haematite.
4. Determination of available Chlorine in bleaching powder and of Iodine in Iodized salt.
5. Determination of hardness of water and of calcium in milk powder.
6. Chemistry of blue printing.
7. Preparation of phenol formaldehyde resin.

Cycle 2

1. Conductometric titration of an Acid vs Base.
2. pH-metric titration of an Acid vs Base.
3. Potentiometric titration of Fe^{2+} against $K_2Cr_2O_7$.
4. Colorimetric titration of potassium permanganate.
5. Determination of rate of corrosion of mild steel in acidic environment in the absence and presence of an inhibitor.
6. Determination of salt content by Ion-exchange.
7. Separation of Ions by paper chromatography.
8. Verification of Freundlich adsorption isotherm.

Reading:

1. Valentin, W. G. “A Course of Qualitative Chemical Analysis”Read Books Design, 2010; ISBN: 1446022730, 9781446022733.
2. G. Svehla: Vogel's Qualitative Inorganic Analysis. J. Mendham, R. C. Denny, J. D. Barnes, M. J. K. Thomas: Vogel’s Text Book of Quantitative Chemical Analysis.
3. G. N. Mukherjee: Semi-Micro Qualitative Inorganic Analysis (CU Publications) Vogel’s Text Book of Practical Organic Chemistry (5th Edition).
4. N. G. Mukherjee: Selected Experiments in Physical Chemistry.

CS102	Problem Solving and Computer Programming Laboratory	ESC	0 – 0 – 3	2 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Design and test programs to solve mathematical and scientific problems
CO2	Develop and test programs using control structures
CO3	Implement modular programs using functions
CO4	Develop programs using classes

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										1		1
CO2			1									
CO3										1		1
CO4			1									
CO5			1									

Detailed Syllabus:

1. Programs on conditional control constructs.
2. Programs on loops (while, do-while, for).
3. Programs using user defined functions and library functions.
4. Programs on arrays, matrices (single and multi-dimensional arrays).
5. Programs using pointers (int pointers, char pointers).
6. Programs on structures.
7. Programs on classes and objects.
8. Programs on inheritance and polymorphism.

Reading

1. Walter Savitch, Problem Solving with C++, 6th Edition, Pearson, 2008.
2. R.G. Dromey, How to solve it by Computer, Pearson, 2008.

ME103	WORKSHOP PRACTICE	ESC	0 – 0 – 3	2 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Study and practice on machine tools and their operations
CO2	Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding
CO3	Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping
CO4	Apply basic electrical engineering knowledge for house wiring practice

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1		1		
CO2				1	1							
CO3										1		
CO4								1				1

Detailed Syllabus:

Fitting Trade: Preparation of T-Shape Work piece as per the given specifications, Preparation of U-Shape Work piece which contains: Filing, Sawing, Drilling, Grinding, and Practice marking operations.

Plumbing: Practice of Internal threading, external threading, pipe bending, and pipe fitting, Pipes with coupling for same diameter and with reducer for different diameters and Practice of T-fitting, Y-fitting, Gate valves fitting.

Machine shop: Study of machine tools in particular Lathe machine (different parts, different operations, study of cutting tools), Demonstration of different operations on Lathe machine, Practice of Facing, Plane Turning, step turning, taper turning, knurling and parting and Study of Quick return mechanism of Shaper.

Power Tools: Study of different hand operated power tools, uses and their demonstration and Practice of all available Bosch Power tools.

Carpentry: Study of Carpentry Tools, Equipment and different joints, Practice of Cross Half lap joint, Half lap Dovetail joint and Mortise Tenon Joint

House Wiring: Introduction to House wiring, different types of cables. Types of power supply, types of motors, Starters, distribution of power supply, types of bulbs, parts of tube light, Electrical wiring symbols, Stair case wiring: Demo and Practice (2 switches with one lamp control) and Godown wiring

Foundry Trade: Introduction to foundry, Patterns, pattern allowances, ingredients of moulding sand and melting furnaces. Foundry tools and their purposes, Demo of mould preparation and Practice – Preparation of mould by using split pattern.

Welding: Introduction, Study of Tools and welding Equipment (Gas and Arc welding), Selection of welding electrode and current, Bead practice and Practice of Butt Joint, Lap Joint.

Reading:

1. Raghuwanshi B.S., Workshop Technology Vol. I & II, DhanpathRai& Sons.
2. Kannaiah P. and Narayana K.L., Workshop Manual, 2ndEdn, Scitech publishers.
3. John K.C., Mechanical Workshop Practice. 2ndEdn. PHI 2010.
4. JeyapoovanT.andPranitha S., Engineering Practices Lab Manual, 3rdEdn. Vikas Pub.2008.

MA151	MATHEMATICS – II	BSC	4 – 0 – 0	4 Credits

Prerequisites: Mathematics – I.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Solve linear differential equations using Laplace transforms
CO2	Evaluate multiple integrals and improper integrals
CO3	Convert line integrals to area integrals
CO4	Convert surface integrals to volume integrals
CO5	Determine potential functions for irrotational force fields

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			2									
CO2			1									
CO3			1									
CO4			1									
CO5			1									

Detailed Syllabus:

Laplace Transformation: Laplace transform - Inverse Laplace transform - properties of Laplace transforms - Laplace transforms of unit step function, impulse function and periodic function - convolution theorem - Solution of ordinary differential equations with constant coefficients and system of linear differential equations with constant coefficients using Laplace transform.

Integral Calculus: Fundamental theorem of integral calculus and mean value theorems; Evaluation of plane areas, volume and surface area of a solid of revolution and lengths. Convergence of Improper integrals – Beta and Gamma integrals – Elementary properties – Differentiation under integral sign. Double and triple integrals – computation of surface areas and volumes – change of variables in double and triple integrals.

Vector Calculus : Scalar and Vector fields; Vector Differentiation; Level surfaces - directional derivative - Gradient of scalar field; Divergence and Curl of a vector field - Laplacian - Line and surface integrals; Green's theorem in plane; Gauss Divergence theorem; Stokes' theorem.

Reading

1. R.K.Jain and S.R.K.Iyengar, Advanced Engineering Mathematics, Narosa Pub. House, 2008.
2. ErwynKreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition, 2008.
3. B.S.Grewal, Higher Engineering Mathematics, Khanna Publications, 2009.

MA201	Mathematics III	BSC	4 – 0 – 0	4 Credits

Pre-requisites: Mathematics II

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine Fourier series expansion of functions.
CO2	Evaluate improper integrals involving trigonometric functions.
CO3	Solve finite difference equations by using Z transforms.
CO4	Solve PDEs by variables separable method.
CO5	Evaluate improper integrals by residue theorem

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			1									
CO2			1									
CO3			1									
CO4			1									
CO5			1									

Detailed syllabus

Fourier Series: Expansion of a function in Fourier series for a given range - Half range sine and cosine expansions

Fourier Transforms: Complex form of Fourier series - Fourier transformation and inverse transforms - sine, cosine transformations and inverse transforms - simple illustrations.

Z-transforms: Inverse Z-transfroms – Properties – Initial and final value theorems – convolution theorem - Difference equations – solution of difference equations using z-transforms

Partial Differential Equations: Solutions of Wave equation, Heat equation and Laplace's equation by the method of separation of variables and their use in problems of vibrating string, one dimensional unsteady heat flow and two dimensional steady state heat flow including polar form.

Complex Variables: Analytic function - Cauchy Riemann equations - Harmonic functions - Conjugate functions - complex integration - line integrals in complex plane - Cauchy's theorem (simple proof only), Cauchy's integral formula - Taylor's and Laurent's series expansions - zeros and singularities - Residues - residue theorem, evaluation of real integrals using residue theorem, Bilinear transformations, conformal mapping.

Reading

1. R.K.Jain and S.R.K.Iyengar, Advanced Engineering Mathematics, Narosa Pub. House, 2008.

2. ErwynKreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition, 2008.

3. B.S.Grewal, Higher Engineering Mathematics, Khanna Publications, 2009.

MM201	**Physical Metallurgy & Materials Engineering**	**PCC**	**3 – 1 – 0**	**4 Credits**

Pre-requisites: PH101 Physics& CY101 Chemistry

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify the crystal structures of metallic materials
CO2	Analyse the binary phase diagrams of alloys including Fe-Fe3C, brass, and bronze
CO3	Correlate the microstructure, properties, processing and performance of materials.
CO4	Formulate and solve physical metallurgy related engineering problems.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2						
CO2						3		1				
CO3					2	3		3				
CO4								3				

Detailed syllabus

Structure of metals: Space &Bravais, Coordination number, Relationship between lattice parameter and atomic radius, Packing factor and density calculations, Miller indices, Miller – Bravais indices, Allotropy, Stacking sequence and interstitial voids.

Phase equilibria, thermodynamics of phase evolution, Solid solutions. Vegard's law, Hume Rothery Rules, Intermediate alloy phases, X-ray diffraction, Imperfections in solids.

Construction of equilibrium diagrams, Isomorphous systems, Lever rule, Coring, Miscibility gap, Eutectic system, Congruent melting intermediate phase, Eutectoid, Peritectic, Peritectoid, Monotectic and Syntectic reactions. Phase rule.

Study of Fe-Fe3C, Cu-Zn, Cu-Sn, Al-Cu and Al-Si ternary diagrams.

Diffusion laws: Fick's first and second laws, Solution to Fick's second law, Kirkendall effect, Darken's analysis, Atomic theory of diffusion, other diffusion processes.

Structure and properties of ceramics, polymers and composites, Physical properties of materials.

Construction and Principles of Optical and transmission Electron Microscope. Types of objectives, Eye pieces and common defects of lenses.

Reading

1. Materials Science and Engineering, by William D. CallisterJr (Adapted by R. Balasubramaniam); Wiley India (P) Ltd, 2010.

2. Elements of Materials Science & Engineering – A First Course, by V. Raghavan, PHI Publications, 2008.

3. Fundamentals of Materials Science & Engineering, by Eric J Mittemeijer; Elsevier, 2010.

MM202	Mineral Processing	PCC	3 – 1 – 0	4 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the importance of mineral processing technology.
CO2	Understand techniques of mineral processing for concentration of ore minerals economically.
CO3	Review environment friendly techniques for concentration of sulphide minerals.
CO4	Compute the recovery of ore mineral after concentration.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2	3											
CO3	3											
CO4	3											

Detailed syllabus

Introduction to the course

Sampling of ores by different methods – hand sampling, mechanical sampling, errors in sampling. Theory of liberation of minerals, primary, secondary and special crushers (jaw, gyratory, cone, rolls and toothed rolls crusher). Grinding, ball mills, theory of ball mill operation, rod mills and tube mills.

Theories of comminution – Kick’s, Rittinger’s and Bond’s theories.

Sizing - Sizing scales, laboratory sizing and reporting the data in various numerical and graphical forms, sedimentation, and elutriation. Industrial sizing methods, types of screens. Mechanism of passing through a screening surface and effectiveness of a screen.

Movement of solids in Fluids, Stoke’s and Newton’s laws, Terminal velocity and its relation with size, relation between time and velocity, relation between distance traveled and velocity, free and hindered settling ratios.

Quantifying concentrating operation, ratio of concentration, recovery, selective index and economic recovery.

Classification: Principles, sizing and sorting classifiers. Heavy media separation, processes using heavy liquids, processes using heavy suspensions, coal washing methods. Thickening, filtration and its practice. Jigging - Theory of jigging, jigging machines. Tabling - Theory of flowing film concentration, shaking tables.

Flotation - Principles of flotation, physical and chemical aspects.Application of flotation process for concentration of copper, lead and zinc ores.Principles and applications of magnetic and electrostatic separation processes.Details about Indian ore dressing practices.

Reading

1. A. M. Gaudin, Principles of Mineral Dressing, Tata McGraw Hill, 1993.

2. Barry Wills, Tim Napier- Munn, Wills' Mineral Processing Technology, 4th edition, Elsevier, 2005

3. S. K. Jain, Ore Processing, Oxford- IBH Publishing Company, 2005.

4. Anup Swain, HemlathaPatra,G K Roy, Mechanical Operations, Tata McGraw Hill, 2010

MM203	Metallurgical Thermodynamics and Kinetics	PCC	3 – 1 – 0	4 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Describe the laws of thermodynamics with reference to metallurgical processes and materials.
CO2	Calculate the heat and energy requirements and efficiencies of metallurgical processes.
CO3	Identify the feasibility / non-feasibility of metallurgical processes and reactions.
CO4	Understand the design of alloy systems by applying the concepts of thermodynamics.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			3				2					
CO2			3									
CO3		2	3									
CO4								2				

Detailed syllabus

Laws of thermodynamics, concepts of reversibility, internal energy, enthalpy, entropy, maximum work, free energy, Maxwell’s equations and Gibbs-Helmholtz equation, Clausius-Clapeyron equation, fugacity, activity and equilibrium constant, Sigma function, Concept of chemical potential, homogeneous and heterogeneous equilibria, phase rule, Thermodynamics of solutions, Concept of partial molal properties, thermodynamics of reversible cells, basic kinetic laws, order of reactions, rate constant, elementary and complex reactions, rate limiting steps, Arhenius equation, theories of reaction rates – simple collision theory, activated complex theory.

Reading

1. D. R. Gaskell, Introduction to Thermodynamics of Materials, Taylor and Francis, 2003.
2. Mackowiak, Physical Chemistry for Metallurgists, © George Allen & Unwin Ltd., Pitman Press
3. M. L. Kapoor, Chemical and Metallurgical Thermodynamics, Vol. 1&2, New Chand & Bros; Roorkee.

MM204	Transport Phenomena	PCC	3 – 1 – 0	4 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the concepts of fluid mechanics in extractive metallurgy.
CO2	Apply the concepts of heat transfer in heat treatment and furnaces.
CO3	Determine the material and energy balances in fluid flow systems.
CO4	Illustrate simultaneous heat and mass transfer in metallurgical reaction systems.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3										
CO2						2						
CO3		2	3									
CO4		2	3									

Detailed syllabus

Introduction to Transport phenomena, Units and Dimensional Analysis. Fluid Flow, Properties of fluids, Types of fluid flow, Shell momentum balance and velocity profile, Reynolds experiments, concept of velocity boundary layer, Newton's law of viscosity, Molecular theory of viscosity of liquid, Molecular theory of viscosity of gas, Momentum transfer in fluid, Equation of continuity and motion, Law of conservation of energy, Navier stroke equation, Flow past submerged bodies, Energy and momentum relationships, Friction in pipes and channels, supersonic nozzles, pumps, blowers, compressors, Fourier’s law conduction in solids, conduction in liquids and gases, steady state and unsteady state conduction in solids, Natural convection, Forced convection, concept of heat transfer coefficient and thermal boundary layer, Radiation heat transfer, Gurney-Lurie, Haisler, Hottel and allied charts. Heat transfer with change of phase. Introduction to solidification heat transfer and ablation, Heat transfer in packed and fluid beds. Diffusivity and steady state diffusion, Unsteady state mass transfer, concept of mass transfer coefficient concentration boundary layer, Inter-phase mass transfer – theories, introduction to simultaneous mass and heat transfer. Classification of diffusional operations and conduction of diffusional operations, introduction to stage operations. Similarity criteria and introduction to model and pilot plant studies Similarities of momentum, mass and energy transfer.

Reading

1. R.B Bird, W.E Steward, and E.N Lightfoot: Transport Phenomena, Wiley, 2007.

2. G.H Geiger and D.R Poirier: Transport Phenomena in Metallurgy, Addison Wesley, 1973.

3. J. Szekely and N.J Themelis: Rate Phenomena in Process Metallurgy, Wiley Interscience, 1971.

4. A. K. Mohanty: Rate Phenomena in Metallurgy, Prentice Hall (India), 2001.

MM205	Minerals Processing Laboratory	PCC	0 – 0 – 3	2 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine the size and size distributions of metallurgical ores.
CO2	Understand the operations of crushers and grinders effectively in mineral dressing operation.
CO3	Calculate the reduction ratio of mineral samples using crusher and grinder.
CO4	Use the Stoke's law apparatus and magnetic separator for the separation ore and gangue minerals.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3							1				
CO2	3											
CO3	3											
CO4	2							2				

Detailed syllabus

Sieve analysis, Jaw and Roll crushers, Verification of Stoke's law, Conical and Vibratory ball mills, Hard groove grindability index of minerals, Magentic separation, study of flotation cell and Wilfley table operations.

Reading

1. Minerals Processing Laboratory Manual

CY202	Instrumental Methods of Metallurgical and Materials Analysis Laboratory	BSC	0 –0 – 3	2 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine the concentration of ferrous iron using potentiometry.
CO2	Estimate Ca2+ and Mg2+ ions in alloys and ores.
CO3	Analyze spectrophotometric interference of one species in the determination of other species using colorimetry.
CO4	Determine the amount of aluminum present in the ores and alloys.
CO5	Analyze the nickel content of a steel by gravimetric method.
CO6	Use Flame Photometry, Fourier transform Infrared spectroscopy, High Performance Liquid Chromatography, Polorography, Cyclic voltammetry and Ion – exchange chromatography instruments.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2										
CO2	2	2										
CO3		2										
CO4									1			
CO5									1			
CO6									1			

Detailed syllabus

Determination of Ca^{2+} and Mg^{2+} in a given mixture.

Determination of Al^{3+} in bauxite ore.

Determination of Ni^{2+} in steel by gravimetry.

Colorimetric determination of Mn^{2+} in a given sample.

Simultaneous spectrophotometric determination of Cr&Mn in a mixture.

Photometric determination of titanium using hydrogen peroxide.

Electro gravimetric determination of copper from its salt solution.

Poteniometric determination of Fe^{2+} with Ce^{4+}.

Flame photometric determination of sodium and potassium.

Spectrophotometric determination of Iron using 1, 10- phenanthroline.

Determination of Lead in solder sample.

Determination of Chromium using diphenylcarbazide.

Metal ions separation using ion exchange method.

Atomic absorption spectrophotometric determination of Zn/Cr/Ni

Solvent extraction of Uranium (VI) using Oxine

Synthesis and characterization of $BaTiO_3$ and $YBa_2Cu_3O_7^{-x}$

Tutorials and Demonstration

(Tutorials based on TGA and electro analytical methods Demonstration of IR, DSC, Electrochemical apparatus and AFM, GC and HPLC)

Reading

IMMMA Laboratory manual

EE235	Basic Electrical Engineering Laboratory	ESC	0–0– 3	2 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Select the range of apparatus based on the ratings of DC machines, transformers and induction machines.
CO2	Understand the operation of KVL, KCL and Superposition theorems applied to simple dc circuits.
CO3	Determine equivalent circuit parameters of transformers by conducting OC and SC tests.
CO4	Evaluate the performance of dc machines and its braking methods.
CO5	Evaluate the performance of asynchronous machines by no-load test, blocked rotor test and load test.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1				
CO2								1				
CO3								1				
CO4								1				
CO5								1				

Detailed syllabus

a) Verification of Kirchhoff's Voltage and Current Laws.

b) Verification of Superposition Theorem.

Calculation of the Power factor and Power in a Single Phase Series R-L circuit.

Measurement of Self and Mutual inductance of Coils.

No load test on a DC Machine.

Load test on a DC Shunt Generator.

Speed Control of a DC Shunt Motor

a) Determination of Equivalent Circuit Parameters of a Single Phase Transformer.

b) Predetermination of Efficiency and Regulation of a Single Phase Transformer.

c) Direct Load test on a Single Phase Transformer.

Separation of No-load Losses of a Single phase Transformer.

Direct Load test on a Three Phase Induction Motor.

Reading

Basic Electrical Engineering Laboratory Manual

MA251	Mathematics IV	BSC	4 – 0 – 0	4 Credits

Pre-requisites: Mathematics III

Course Outcomes: At the end of the course the student will be able to:

CO1	Estimate chance of occurrence of events by normal distribution
CO2	Analyze the null hypothesis for large and small number of samples.
CO3	Construct a given curve for the data by least squares
CO4	Solve initial values problems
CO5	Solve differential equation at a singular point

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										1		
CO2										1		
CO3								1	1			
CO4												
CO5			1									

Detailed syllabus

<u>Statistics and Probability</u>: Probability laws – Addition and Multiplication theorems on probability - Baye's theorem –Expectation, Moments and Moment generating function of Discrete and continuous distributions, Binomial, Poisson and Normal distributions, fitting these distributions to the given data, Testing of Hypothesis - Z-test for single mean and difference of means, single proportion and difference of proportions - t-test for single mean and difference of means, F-test for comparison of variances,. Chi-square test for goodness of fit. – Correlation, regression.(23)

<u>Numerical Analysis</u>:

Curve fitting by the method of least squares. Fitting of (i) Straight line (ii) Second degree parabola (iii) Exponential curves. Calculation of dominant eigen value by iteration, Gauss Seidal iteration method to solve a system of equations and convergence (without proof). Numerical solution of algebraic and transcendental equations by Regula-Falsi method Newton-Raphson'smethod.Lagrange interpolation, Newton's divided differences, Forward, backward and central differences, Newton's forward and backward interpolation formulae, Gauss's forward and backward interpolation formulae, Numerical differentiation at the tabulated points with forward backward and central differences. Numerical Integration with Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule and Romberg integration. Taylor series method, Euler's method, modified Euler's method, Runge-Kutta method of 2^{nd}& 4^{th} orders for solving first order ordinary differential equations. (23)

Series Solution : Series solution of Bessel and Legendre's differential equations.Bessel function of first kind Recurrence formulae Generating function Orthogonality of Bessel functions Legendre polynomial rodrigue's formula Generating function Recurrence formula Orthogonality of Legendre polynomials.

Reading

1. S.C.Gupta and V.K.Kapoor, Fundamentals of Mathematical Statistics, S.Chand& Co, 2006.

2. Jain, Iyengar and Jain, Numerical methods for Scientific and Engineering Computation, New Age International Publications, 2008.

3. ErwynKreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition, 2008.

4. B.S.Grewal, Higher Engineering Mathematics, Khanna Publications, 2009.

MM251	Phase Transformations and Heat Treatment	PCC	3 – 1 – 0	4 Credits

Pre-requisites: MM201 Physical Metallurgy and Materials Engineering

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the theory of nucleation and growth kinetics of solidification.
CO2	Explain the phase transformation reactions of Fe-Fe3C system.
CO3	Apply the fundamentals of phase transformation to heat treatment of steels.
CO4	Analyse the heat treatment processes to enhance/ modify the mechanical properties.
CO5	Formulate the hardening processes based on the hardenability of steels and alloys.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						3						
CO2						3						
CO3						3						
CO4					2	3						
CO5								2				

Detailed syllabus

Theory of Nucleation, Homogeneous and Heterogeneous Nucleation, Nucleation Kinetics, Growth Kinetics, Different types of Diffusion Growth. Nucleation and Grain size, Super Cooling, Directional Solidifications, and Segregations. Study of Fe-Fe_3C Phase Diagram, Phase Transformation in Steel on heating and cooling, Austenitic Grain Growth on heating, Determination of Grain Size, Isothermal Transformation Diagrams, Perlite, Bainite and Martensitic Transformations, Transformation of Austenite on Continuous Cooling. Annealing, Normalizing, Hardening and Tempering of steel, Hardenability, Mechanism of Heat removal during Quenching, Quenching media, Residual stresses and Quench Cracks, Martempering and Austempering, Purpose of alloying, Effect of alloying on Fe-Fe_3C Phase Diagram, Temperature Time Transformation (TTT) and Continuous Cooling Transformation (CCT) Plots,

Secondary Hardening, Temper embrittlement. Classification of alloys steel, high strength low alloys steel, corrosion resistant steel, tool steel, Hadfield Mn steel, Different types of cast irons, White cast iron, grey cast iron, malleable cast iron, S.G iron and alloy cast iron. Flame and Induction Hardening, Laser beam Hardening (LBM), Carburizing (solid, liquid and gas), Nitriding, Cyaniding, Boronizing. Solution Treatment, Ageing treatment, Nucleation of

Precipitates, Theory of Precipitation Hardening, Effect of variables on Precipitation Hardening.

Reading

1. Phase Transformation in Metals and Alloys, VNR International, 1992 – D. A. Porter and K. E. Easterling.

2. Engineering Physical Metallurgy, Mir Publishers, 1997 – Y. Lakhtin.

3. Phase Transformation, Prentice Hall of India, 1992 – V. Raghavan.

4. Introduction to Physical Metallurgy, Tata McGraw-Hill Publisher, 1997, S. H. Avner.

MM252	Unit Processes in Extractive Metallurgy	PCC	3 – 1 – 0	4 Credits

Pre-requisites: MM202 Mineral Processing, MM203 Thermodynamics and Kinetics, and MM204 Transport Phenomena

Course Outcomes: At the end of the course the student will be able to:

CO1	List out ore minerals for ferrous and non-ferrous metals.
CO2	Discuss the principles of fire refining, liquation, distillation refining and zone refining.
CO3	Examine the importance of slag chemistry in the extraction process.
CO4	Recognize the importance of Ellingham diagrams and criteria required for reduction of metals.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3										
CO2		3							1			
CO3		3										
CO4		3	2									

Detailed syllabus

Principles of Unit processes: Calcination, Sintering, Pelletising and Briquetting. Principles and types of roasting (Oxidising roasting, Sulphating roasting, Chloridising roasting), Roasting equipment and methods (Multiple hearth, Flash, Fluidized bed and blast roasting), Predominance area diagrams.

Principles of reduction and Matte Smelting. Industrial methods of smelting such as reverberatory, blast furnace, Electric and Flash smelting. Principles of converting of matte.

Generalised flow sheets for the extraction of metals by pyro and hydro metallurgical routes.

Pyro-metallurgical processes using vacuum, reduction of halide by another element.

Principles of refining processes: Fire refining, Liquation, Distillation, Electro refining and zone refining.

Principles of electro-winning from fused salts.

Processing steps in the extraction of metals from sulphide and oxide ores.

Slags and their properties.

Ellingham diagrams for oxides and sulphides, criteria for reduction.

Principles and types of leaching, purification of leach liquors by solvent extraction and ion exchange, Metal recovery from leach solutions. Comparison of pyro, hydro and electro metallurgical methods of extraction.

Reading

1. Extraction of Non- Ferrous Metals, Affliated EWP Pvt. Ltd., New Delhi, 1997- H. S. Ray, R. Sridhar and K. P. Abraham

2. Principles of Extractive Metallurgy, Wiley Eastern Ltd., 1991 – A. Ghosh.

3. Principles of Extractive Metallurgy, McGraw Hill, 1985 – T. Rosenquist.

4. Unit Processes in Extractive Metallurgy, Elsevier, Amsterdam, 1973 – R. D. Pehlke

MM253	Computer Applications in Materials Engineering	PCC	3 – 0 – 0	3 Credits

Pre-requisites: CS101 Problem Solving in Computer Science and Mathematics I, II, III, IV

Course Outcomes: At the end of the course the student will be able to:

CO1	Recognize the basics of computer programming.
CO2	Understand the techniques of Finite Element Analysis and Monte-Carlo methods in computer simulation.
CO3	Understand the mathematical modelling of physical concepts.
CO4	Design a computational model independently for a particular concept.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			1					2	1			
CO2			1		2	1						
CO3					3	1						
CO4								3				

Detailed syllabus

Computer Basics and programming, Techniques in Computer simulation,Finite Element Analysis, Monte-Carlo Methods, Mathematical Modeling of Physical Concepts, Atomic level design of materials based on the first-principles simulation techniques, CALPHAD, Microstructure Modeling, Process Modeling, Integrated Selection of Materials and Processes, Calculation of materials properties starting from microscopic theories.

Reading

1. R J Arsenault, J R Beeler Jr, D M Easterling (Eds): Computer Simulation in Materials Science, ASM International, 1986.

2. K. Ohno, K. Esfarjani, and Y. Kawazoe : Computational Materials Science - From Ab Initio to Monte Carlo Methods, Springer, 1999.

3. Wolfram Hergert, Arthur Ernst, Markus Dane: Computational Materials Science – From Basic Principles to Materials Properties, Springer, 2004.

PH285	Electronic and Magnetic Materials	PCC	3 – 0– 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Classify magnetic materials and recognize their important engineering applications.
CO2	Recognize the importance of insulators and high temperature superconductors.
CO3	Understand the mechanism of preparing single crystals and high quality thin films for the fabrication of electronic devices.
CO4	Classify semiconductors and evaluate the carrier concentration and energy gap.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								2				
CO2								2				
CO3								1	1			
CO4								1				

Detailed syllabus

Types of magnetic materials, ferrites and garnets, Weiss theory of ferromagnetism, soft and hard magnetic materials, magnetic tapes and films. Classification of Semiconductors, Direct and indirect band gap semiconductors, Hall effect and its applications. High temperature Superconductors, Types of Superconductors, Applications. Dielectric materials, Ferro electricity and Piezo electric effect. Growth of thin films by M B E, C V D, Sputtering and other techniques. Growth of single crystals by CZ and Bridgemann techniques, and applications. Silicon wafer preparation for electronic devices. Different techniques involved for the preparation of electron chip. Photovoltaic effect, Fabrication of single crystal solar cell and its applications.

Reading

1. S.M Sze , VLSI Technology ,McGraw Hill International Edition , 2008 .

2. J.P.Srivastava, Solid state Physics, PrinticeHallPvt Ltd, 2003

3. R.Rose.L.P.SheppardandJ.Wulff , Electronic properties, Wiley Eastern Pvt Ltd

MM254	Unit Processes in Extractive Metallurgy Laboratory	PCC	0 – 0 – 3	2 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the principles of calcination, reduction and smelting
CO2	Estimate the percent reduction of metal from its ore by pyro-metallurgical route.
CO3	Understand the principles of electro-metallurgy.
CO4	Predict the metal recovery of a hydrometallurgical process.
CO5	Interpret the throwing power of copper sulphate solution.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2		2										
CO3							3					
CO4		2										
CO5		2										

Detailed syllabus

Reducibility of cupric oxide with charcoal

cementation of copper

Calcination of lime stone

Galvanic Corrosion

Plating of Copper, Plating of Nickel, Plating of Chromium

Throwing Power

Anodizing

Reading

UPEM Laboratory Manual

MM255	Physical Metallurgy and Heat Treatment Laboratory	PCC	0 – 0 – 3	2 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Classify the crystal structures of ferrous and non-ferrous metals
CO2	Prepare the ferrous and non-ferrous specimens for microstructural observation.
CO3	Determine the grain sizes of steel and copper specimens using ASTM grain size measurement technique.
CO4	Experiment annealing, normalizing, hardening and tempering of ferrous alloys.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1				
CO2								2				
CO3								2				
CO4						3						

Detailed syllabus

Metallographic preparation of ferrous/ nonferrous samples, Grain size, Volume fraction of phases, Annealing, Normalising, Hardening, Tempering, Hardenability.

Grain size measurement by Line Intercept method

Grain size measurement by American Society for Testing and Materials (ASTM) method

Observation of microstructure of different steels / Cast Iron

Observation of microstructure of Non-ferrous samples

Carrying out Annealing, Normalising of steel sample

Hardening of steel

Observation of microstructure of Heat Treated steel samples

Tempering of Hardened steel

Effect of hardness on different Heat Treated steel samples

Determination of Hardenability by Jominy End quench test.

Reading

PMHT Laboratory Manual

EC286	Basic Electronics Laboratory	PCC	0 – 0 – 3	2 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Develop and employ circuit models for elementary electronic components using diodes, transistors, and operational amplifier.
CO2	Design simple circuits containing non-linear elements (transistors) using the concepts of load lines, operating points and incremental analysis.
CO3	Calculate frequency response curves of single stage BJT amplifier and determine bandwidth of the amplifier.
CO4	Demonstrate binary functions electronically using Diodes, BJTs and JFET's
CO5	Build and trouble-shoot simple electronic analog and digital circuits

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1				
CO2								1				
CO3								1				
CO4								1				
CO5								1				

Detailed syllabus

Characteristics of PN junction Diode
Load regulation characteristics of Zener diode
Rectifiers & Filters.
Characteristics of BJT
Characteristics of JFET
Single stage Amplifier.
R.C. Phase shift oscillator.
Clippers and Clampers.
Op-amp Frequency Response
Verification of Logic Gates.

Reading

Basic Electronics Laboratory Manual

SM335	Engineering Economics and Accountancy	HSC	3 – 0 – 0	3 Credits

Prerequisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Prepare accounting records and summarize and interpret the accounting data for managerial decisions
CO2	Understand the macro-economic environment of the business and its impact on enterprise
CO3	Understand cost elements of the product and its effect on decision making
CO4	Understand the concepts of financial management and smart investment

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									3	1		
CO2									1	3		
CO3										1	1	
CO4										2	1	

Detailed Syllabus:

Engineering Economics: Introduction to Engineering Economics – Fundamental concepts – Time value of money – Cash flow and Time Diagrams – Choosing between alternative investment proposals – Methods of Economic analysis. The effect of borrowing on investment- Various concepts of National Income – Significance of National Income estimation and its limitations, Inflation –Definition – Process and Theories of Inflation and measures to control, New Economic Policy 1991 – Impact on industry.

Accountancy: Accounting Principles, Procedure – Double entry system – Journal – Ledger, Trail Balance – Cash Book – Preparation of Trading, Profit and Loss Account – Balance sheet.

Cost Accounting – Introduction – Classification of costs – Methods of costing – Techniques of costing – Cost sheet and preparation of cost sheet- Breakeven Analysis – Meaning and its application, Limitations.

Reading:

1. Henry Malcom Stenar, Engineering Economic Principles, McGraw Hill, 2005.
2. K KDewett, Modern Economic Theory, Siltan Chand & Co., 2005.
3. Agrawal AN, Indian Economy, Wiley Eastern Ltd, New Delhi, 2012.
4. Jain and Narang, Accounting Part-I, Kalyani Publishers, 2012.
5. Arora, M.N., Cost Accounting, Vikas Publications, 2013.

MM301	Ferrous Production Technology	PCC	3 – 1 – 0	4 Credits

Pre-requisites: MM252 Unit Process in Extractive Metallurgy

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the extraction techniques of pig iron by reduction smelting in blast furnace from iron ores.
CO2	Classify alternate routes of iron making.
CO3	Categorize open hearth, Bessemer, LD and Q-BOP process of steel making.
CO4	Understand the secondary refining techniques of steel making.
CO5	Illustrate continuous casting of steel.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3							1			
CO2		3										
CO3		3										
CO4		3										
CO5		3										

Detailed syllabus

Introduction to Iron & Steel making, Raw materials for Iron making, evaluation and occurrence in India, Agglomeration, sintering and pelletising, Details of Blast Furnace, construction and its accessories, Blast Furnace operations, irregularities, and their control, Thermodynamics of iron production, Modern trends in Blast furnace operations, Blast furnace charge calculations, Limitations of Blast furnace, Alternative methods of iron making-Direct Reduction methods and Smelting reduction methods, Conventional Steel making processes, Oxygen steel making processes, Arc and induction furnaces, Physical chemistry of steel making, Desulphurisation and Dephosphorisation reactions, Deoxidation of Steels, Continuous casting of steel, Secondary steel making principles and applications.

Reading

1. A. K. Biswas: Principles of Blast Furnace Iron Making- Theory and Practice, SBA Publications,1984.

2. Amit Chatterjee: Beyond the Blast Furnace, CRC Press, 1992.

3. A K Chakravorthy: Steel Making, Prentice-Hall of India Pvt Ltd., 2007.

4. Ahindra Ghosh and Amit Chatterjee: Iron Making and Steel Making - Theory and Practice, Prentice-Hall of India Pvt. Ltd, 2008.

MM302	Mechanical Behavior of Materials	PCC	3 – 1 – 0	4 Credits

Pre-requisites: MM251 Physical Metallurgy and Heat-treatment

Course Outcomes: At the end of the course the student will be able to:

CO1	Classify mechanical testing of ferrous and non-ferrous metals and alloys.
CO2	Recognize the importance of crystal defects including dislocations in plastic deformation.
CO3	Understand the strengthening mechanisms of materials.
CO4	Examine the mechanisms of materials failure through fatigue and creep

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								3				
CO2						3						
CO3						3						
CO4								3				

Detailed syllabus

HARDNESS TESTING:

- Methods of hardness testing: Brinell hardness testing
- Vickers and Rockwell hardness testing
- Shore scleroscope&Poldi hardness testing
- Micro hardness Testing
- Relation between hardness and other mechanicalproperties. Hot hardness testing.

INTRODUCTION TO DISLOCATIONS:

- Slip, slip planes and directions, slip systems
- Resolved shear stress. Theoretical strength of crystals
- Imperfections in Crystalline materials
- The concept of dislocations – Edge, screw and mixed dislocations
- Burgers circuit, burgers vector, movement of dislocations
- Gide, climb, cross-slip and velocity of dislocations.

TENSION TESTING:

- Mechanism of elastic action, linear elastic properties

- Engineering stress-strain and true stress-true strain curves
- Tensile properties, conditions for necking
- Effect of temperature and strain rate on tensile properties and strain hardening.

Strengthening mechanisms, Hall-Petch relation

STATIC COMPRESSION:

- Elastic and in-elastic action in compression, elastic and in-elastic properties in compression
- The Compression Test.

IMPACT TESTING:

- The brittle failure problem and notch sensitivity, notched bar impact test
- Significance and Specialized test for transition temperature
- Metallurgical factors affecting transition temperature
- Temper Embrittlement.

FRACTURE:

- Elementary theories of fracture
- Griffith's theory of brittle fracture, ductile fracture

FATIGUE TESTING:

- Fatigue testing and its significance, Stress cycles, S-N curve, Goodman diagram, fatigue limit
- Mechanism of fatigue failure, effect of stress concentration, size, surface condition and environments on fatigue
- Effect of metallurgical variables on fatigue properties.

CREEP TESTING:

- Creep Test. The creep curve, creep properties of metals
- Stress-rupture test, deformation and fracture at elevated temperature

Theories of creep, prediction of long time properties
Creep resistant materials. Effect of metallurgical variables on creep.

Reading

1. Mechanical Metallurgy, McGraw Hill Book Company, 2004 – G. E. Dieter.
2. Mechanical Behaviour Materials, McGraw Hill, 1990. – Thomas H. Courtne
3. Derek Hull and D.J. Bacon: Introduction to Dislocations, Pergamon Press, 2008.
4. K. Bowman: Mechanical Behaviour of Materials, Wiley, 2005

MM303	Powder Metallurgy	PCC	4 – 0 – 0	4 Credits

Pre-requisites: MM251 Physical Metallurgy and Heat Treatment

Course Outcomes: At the end of the course the student will be able to:

CO1	Classify powder preparation techniques.
CO2	List out the characterization techniques of powders.
CO3	Describe hot, cold and pressure-less powder compaction techniques.
CO4	Explain the sintering of powder compacts.
CO5	List applications of powder metallurgy.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				3								
CO2								1				
CO3				3								
CO4				3								
CO5				3								

Detailed syllabus

Introduction and History of PM

Why PM? And Future Trends of PM

Different Powder Production Techniques

Analysis of Performance of Different Production Techniques

Importance of Powder Characterization, Particles Size, Distribution, Surface Analysis

Interparticle friction and Powder Compressibility

Microstructure control of Powder

Tailoring of Powder for Shaping and Consolidation, Lubricants and Binders

Powder Compaction and Process variables

Density distribution of compact and Isostatic Pressing

Powder extrusion, Injection molding, Slip Casting

Analysis of defects in Powder Compact

Theory of sintering

Mixed Powder and Alloy powder Sintering

Liquid Phase and Reactive Sintering

Defect analysis of sintered components, Recent Development in Sintering

Structure-Properties Evaluation of Sintered samples

PM of Filter, Friction Parts, W filament, Biomaterials etc.

Reading

1. Powder Metallurgy Technology, Cambridge International Science Publishing, 2002.

2. J. S. Hirschhorn: Introduction to Powder Metallurgy, American Powder Metallurgy Institute, Princeton, NJ, 1976.

3. P. C. Angelo and R. Subramanian: Powder Metallurgy- Science, Technology and Applications, PHI, New Delhi, 2008.

4. ASM Hand Book, vol. 7: Powder Metallurgy, ASM International.

MM304	Mechanical Behavior of Materials Laboratory	PCC	0– 0 – 3	2 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Operate instruments for measuring hardness and impact strength of ferrous and non-ferrous alloys.
CO2	Determine the flow curve using Hounsfield tensometer.
CO3	Understand the ductility of ferrous alloys and non-ferrous materials through Erichson ductility test.
CO4	Interpret hardness and strength of the materials.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					3							
CO2					3							
CO3					3							
CO4					2			1				

Detailed syllabus

Determination of Brinell hardness, Rockwell hardness, Poldi impact hardness, Shore Scleroscopehardness values of given materials. Determination of n and k of given materials, Erichson Ductility test, Standard impact tests, Tension test using Hounsfield tensometer, To draw the true stress-strain curve using the data.

Reading

1 .Mechanical Behavior of Materials Laboratory Manual

MM305	Powder Metallurgy Laboratory	PCC	0 – 0 – 3	2 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Demonstrate the synthesis of iron powder by electrolytic process.
CO2	Evaluate apparent density, tap density, flow rate and surface area of metal powders.
CO3	Practice compaction of metal powders.
CO4	Evaluate sintered density after sintering.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				3								
CO2				3								
CO3				3								
CO4				3								

Detailed syllabus

Introduction of Powder Metallurgy Lab

Compaction and Sintering of different pure elemental powder

Structure-property correlation study of sintered sample

Synthesis of powder

Characterization of as synthesized powder

Sintering of composite powder

Structure-property correlation study of sintered sample

Reading

1. Powder Metallurgy Laboratory Manual

ME385	Welding Technology	PCC	3 – 0 – 0	3 Credits

Pre-requisites: ME101 Basic Mechanical Engineering

Course Outcomes: At the end of the course the student will be able to:

CO1	Classify welding processes.
CO2	Differentiate gas and electric arc welding processes
CO3	Understand edge preparation for weld joint
CO4	Evaluate weld joints
CO5	Explain the importance of welding metallurgy.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					3							
CO2					3							
CO3					3							
CO4					3							
CO5					3							

Detailed syllabus

Classification of welding processes, welding symbols, weld joint design, edge preparation, Oxyacetylene gas welding- Types of flames, process description and application, solid state welding, Ultrasonic, Explosion and Friction welding, Arc welding- Arc characteristics, duty cycle, arc welding processes, welding metallurgy, testing and inspection.

Reading

1. R.S. Parmer: Welding Processes and Technology, Khanna Publishers, 2006.

2. L. M. Gourd: Principles of Welding Technology, ELBS Longman, 2nd Edition, 2008.

MM351	Foundry Technology and Non-Destructive Testing	PCC	3 – 1 – 0	4 Credits

Pre-requisites: MM203 Metallurgical Thermodynamics and Kinetics, MM251 Physical Metallurgy and Heat Treatment

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand pattern and pattern allowances.
CO2	Understand the design of gating and risering of castings.
CO3	Classify moulding processes.
CO4	Describe the melting furnaces.
CO5	Review the non-destructive testing methods including penetrant, radiography and eddy current techniques.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				3								
CO2				3								
CO3				3								
CO4				3								
CO5								3				

Detailed syllabus

Introduction, types of foundries

Pattern making: pattern materials, types of patterns and functions, pattern allowances.

Moulding materials: Molding sands, properties and selection of sands, classification and testing of molding sands, Binders and additivis.

Core sands and core making:

Molding processes: Floor molding, bench molding, stacks molding, plate molding, green sand, dry sand, skin dried and loam sand molding processes.

Special sand molding processes: CO_2 process ferro-silicon process, fluid sand process, cement molding process, shell molding, hot box and cold box molding, furan process, gas setting resin process and other special molding processes such as investment casting, fill mold casting, plaster molding, ceramic molding and vacuum molding, types of molding machines.

Metal mold casting processes: permanent mold casting, pressure die casting, low pressure casting and centrifugal casting.

Gating and risering of castings: gating systems, types of gates and risering.

Melting furnaces: Cupola – construction, operation and efficiency of cupola, development in cupola furnace. Electric arc furnaces and induction furnaces

Casting defects: casting defects arising due to molding, coring, melting and pouring practices.

Non Destructive Testing (NDT)

Principles, equipment, applications and limitations of penetrant testing, ultrasonic testing and magnetic particle inspection. Productions of X-rays and gamma-rays and interpretation of results and limitations of X-rays and gamma ray radiography, eddy current testing.

Reading

1 Principles of metal casting, Tata McGRaw Hill, 1996, Heine, Loper and Roserthal

2 Principles of foundry technology, Tata McGraw Hill, 2001 – P.L.Jain

3 Non Destructive Testing, Macmillan Education Ltd, Houndmills, basingstke, Hampshize, RG 21 2XS, 1988, Barry Hull and Vernon John

4 Non Destructive Evaluation, Theory, Techniques and Applications, Marcel Dekkar – 2002, PeterJ. Shull

5 Text Book of Foundry Technology, DhanpatRai and Sons, 1993, O.P. Khanna and M.Lal.

6 Foundry Engineering, Wiley Eastern Ltd, 1993, Salff, TAyler and Fleming

7 Non Destructive Testing Hand Book Vol. 04, American Society for Non Destructive Society, 1986, P. Malntire (Ed.).

8 ASM Metals Hand Book, Non Destructive Testing and Quality Control, Vol17, ASM 1989.

MM352	Electro Metallurgy and Corrosion	PCC	3 – 1 – 0	4 Credits

Pre-requisites: MM203 Metallurgical Thermodynamics and Kinetics

Course Outcomes: At the end of the course the student will be able to:

CO1	Categorize general, galvanic, crevice and fatigue forms of corrosion.
CO2	Understand the mechanisms of corrosion processes.
CO3	Describe the corrosion prevention techniques.
CO4	Evaluate corrosion rate by Tafel extrapolation and linear polarization techniques.
CO5	Describe high temperature corrosion process.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							3					
CO2							3					
CO3							3					
CO4							3	1				
CO5							3					

Detailed syllabus

Principles of Corrosion: Introduction, Corrosion rate expressions, Electrochemical aspects- Electrochemical reactions, polarization, passivity, Environmental effects- oxygen and oxidizers, velocity, temperature, corrosive concentration, galvanic coupling, Metallurgical aspects

Forms of Corrosion: Galvanic corrosion, Crevice corrosion, Pitting, Intergranular corrosion, Selective leaching, Erosion corrosion, Stress corrosion, Hydrogen damage

Modern Theory-Principles

Free energy, Applications of thermodynamics to corrosion, Pourbaix diagrams, Electrode kinetics, Exchange current density, Activation polarization, Concentration polarization, Combined polarization, Mixed electrodes, Passivity

Corrosion Prevention: Materials selection, Alteration of Environment, Design, Cathodic and anodic protection, Coatings.

Corrosion rate measurement: Tafel extrapolation, Linear polarization

High Temperature Corrosion: Mechanisms and kinetics- pilling-Bed worth ratio, electrochemical and morphological aspects of oxidation, oxide defect structure, oxidation kinetics, effect of alloying, catastrophic oxidation, internal oxidation.

High temperature materials- mechanical properties, oxidation resistance.

Metal-Gas reactions-decarburization and hydrogen attack, corrosion of metals by sulfur components at high temperatures, hot corrosion of alloys.

Reading

1 Fontana: Corrosion Engineering, McGraw Hill, New York, 2005.

2 EinarBardal: Corrosion and protection, Springer, 2004.

3 ZakiAhamad: Principles of Corrosion Engineering and Corrosion Control, Elsevier Science & Technology, 2006.

4 ASM Metal Hand book, Vol 13A: Corrosion-Fundamentals Testing & Protection, ASM Intl, 2004.

MM353	Foundry Technology and Non-Destructive Testing Laboratory	PCC	0 – 0 – 3	2 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine moulding sand properties.
CO2	Understand the preparation of moulding.
CO3	Carryout the liquid penetrant test.
CO4	Determine the tensile strength and ductility of welds.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				3								
CO2				3								
CO3				2	1			1				
CO4					3							

Detailed syllabus

Green and dry strength testing, Determination of permeability, Shatter index, clay content, Moisture content,cured transverse strength of shell sands, CO2 molding process, NDT-Liquid penetrant test, Magnetic particle testing, Analysis of defects by ultrasonic flaw detector.

Reading

FTNDT Laboratory Manual

MM354	Electro Metallurgy and Corrosion Laboratory	PCC	0 – 0– 3	2 Credits

Pre-requisites: MM352 Electrometallurgy and Corrosion

Course Outcomes: At the end of the course the student will be able to:

CO1	Determination of EMF of Copper, Zinc and Iron.
CO2	Cary out polarization studies.
CO3	Demonstrate stress corrosion cracking.
CO4	Illustrate impedance studies.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							3					
CO2							3					
CO3					1		3					
CO4							3					

Detailed syllabus

Determinations of EMF of Metals

Polarization Studies

Stress-Corrosion Cracking of Steels

Tafel Plots

Impedance Studies

To find the corrosion rate by immersion testing

Oxidation studies

Reading

Electro Metallurgy and Corrosion Laboratory manual

MM401	X-ray Diffraction and Electron Microscopy	PCC	3 – 1 – 0	4 Credits

Pre-requisites: MM201 Physical metallurgy and Materials Engineering

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify diffraction conditions for BCC and FCC lattices.
CO2	Classify filters and counters/detectors
CO3	Understand the principle of X-ray diffraction for texture analysis.
CO4	Understand the principles of determination of crystal structure through X-ray and electron diffraction patterns.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								3				
CO2								3				
CO3								3				
CO4								3				

Detailed syllabus

Introduction to crystallography, Symmetry – point group and space group, Reading of the space group tables, X-ray diffraction – Generation of X-rays, characteristic X-ray spectrum, Bragg's Law, Diffraction methods – Laue method, rotating crystal method, powder method, Principle, equipment and applications, structure factor, derivation of diffraction conditions for SC, BCC and FCC Bravais lattice, X-ray diffractometer, filters and counters/detectors, texture, importance of texture, measurement of texture, pole figures (stereographic projections), orientation distribution function, sample symmetry, and its importance, applications of X-ray diffraction in materials characterization – determination of crystal structure, lattice parameter, examples of textures in cubic materials, Introduction of GIXRD, instrumental configuration for texture measurement and GIXRD. Electrons as source, properties of electron beam, elastic and inelastic scattering of electrons, importance in electron microscopy, resolution, principles of transmission electron microscopy, construction, ray-diagram, working, sample preparation, contrast mechanisms, ring and spot diffraction patterns, detectors and imaging modes, Kikuchi lines, measurement of lattice parameter, orientation relationship determination, Introduction to HRTEM.

Reading

1. B D Cullity, S R Stock: Elements of X-ray Diffraction, Prentice Hall, Inc 2001.

2. D. Brandon and W. Kaplan: Microstructural Characterization of Materials, Wiley & Sons, 2000.

3. K R Hebbar: Basics of X-Ray Diffraction and its Applications, I.K. International Publishing House Pvt Ltd, New Delhi, 2007.

4. Goodhew, Humphreys and Beanland: Electron Microscopy and Microanalysis, Taylor and Francis, New York, 2001.

MM402	Mechanical Working of Materials	PCC	3 – 0 – 0	3 Credits

Pre-requisites: MM302 Mechanical Working of Materials

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the stress-strain relationship.
CO2	Describe deformation behaviour, yield criteria and metal working.
CO3	Differentiate metal forming processes of forging, rolling, extrusion, and drawing.
CO4	Classify defects of forging, rolling, extrusion and drawing.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					3							
CO2					3							
CO3					3							
CO4					3							

Detailed syllabus

Forming processes, effect of metallurgical structure & strain-rate, cold working, recovery, recrystalisation and grain growth, hot working, Stress, Strain fields, strain energy & line tension of a dislocation, Forces on and between dislocations, Dislocation reactions in FCC, BCC and HCP crystals, Dislocation intersections, Origin, multiplication and observation of dislocations, plasticity of single crystal of FCC, BCC and HCP structures, Twinning, deformation mechanisms of poly-crystalline metals, effect of grain boundary, solute atoms and second phase particles, Yield point phenomena and strain ageing, Forging processes, forging equipment, Forging in plane strain, Open and closed die forging, Forging defects, Rolling processes, Rolling mills, Rolling of bars and shapes, Forces and geometrical relationships in rolling, Simplified analysis of rolling load, rolling variables, problems and defects in rolled products, Theories of cold and hot rolling, torque and horsepower, Extrusion processes, extrusion equipment, Deformation and defects in extrusion, analysis of the extrusion process, Extrusion of tubing and production of seamless pipes and tubes, Rod, wire and tube drawing, Deep drawing and redrawing, Common defects in sheet metal formed products.

Reading

1. G. E. Dieter: Mechanical Metallurgy, McGraw Hill Book Company, 1988.
2. C. J. Richardson, et.al: Worked Examples in Metal Working, Institute of Metals, London, 1985.
3. ASM Hand Book, Vol. 14: Forming and Forging, ASM, 1988.

MM403	Non Ferrous Extractive Metallurgy	PCC	4 – 0 – 0	4 Credits

Pre-requisites: MM301 Ferrous Production Technology

Course Outcomes: At the end of the course the student will be able to:

CO1	Classify the ores of copper, zinc, lead, nickel, aluminum, magnesium and uranium metals.
CO2	Select techniques for extraction of common, light and nuclear reactor metals.
CO3	Understand the refining processes for copper, zinc, lead, nickel, aluminum, magnesium and uranium.
CO4	Draw flow sheets for the extraction of non-ferrous metals.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3										
CO2		3						1				
CO3		3										
CO4		3										

Detailed syllabus

COPPER:

Principal ore minerals, traditional bath smelting processes viz., Blast furnace, Reverberatory furnace, Electric furnace. Autogenous smelting – Outokumpu flash smelting, INCO flash smelting. Converting. Continuous smelting and converting- Noranda process and Mitsubishi process, other processes. Hydro-metallurgical extraction - principles, leaching processes. Recovery of copper from leach solutions- cementation and electro-winning. Refining - fire refining, electrolytic refining.

ZINC:

General principles, roasting. Retort processes- horizontal and vertical retort processes. Electro-thermal production.Production in shaft furnace- Imperial Smelting Process.Hydro-metallurgical zinc production - leaching practice, solution purification; Electrolytic production.New developments in zinc production.Refining of crude zinc- liquation and fractional distillation.

LEAD:

Ore concentration. Smelting- sintering reduction process, reduction in the blast furnace. Roast reaction processes. Direct smelting reduction processes- air flash smelting, oxygen flash smelting, oxygen - slag bath smelting, QSL Process. Refining of lead bullion – pyro-metallurgical and electrolytic refining.

ALUMINUM:

Raw materials, Production of pure alumina- Bayer process; Deville-Pechiney process; Hall-Heroult cell- electrolyte, electrode reactions, current efficiency, cell voltage, anode effect.Refining of aluminum.Alternate processes for the production of aluminum.

Simplified flow sheets for the extraction of Nickel, Magnesium, Uranium and Titanium.

Non-ferrous metal industry in India.

NUCLEAR REACTOR TECHNOLOGY:

Brief review of fundamental concepts of nuclear reactor engineering.Fuels for nuclear reactors.Basic components of a reactor, characteristics and requirements.Types of reactors.Nuclear power reactors in India.

Reading

1. Extraction of Non-ferrous Metals, Affiliated East- West Press, 2001– H. S. Ray, K. P. Abraham and R. Sridhar

2. Nuclear Reactor Engineering, CBS Publishers and Distributors, Delhi, 1986 – S. Glasstone and A. Sesonke

3. Rare Metals Hand book, Robert E. Krieger Publishing Company, 1971 – C.A. Hampel

4. Hand Book of Extractive Metallurgy, Vols. II and III, Wiley- VCH, 1997– Ed. FathiHabashi

MM404	X-ray Diffraction and Electron Microscope Laboratory	PCC	0 – 0– 3	2 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Practice the sample preparation for SEM/X-Ray Analysis.
CO2	Determine chemical composition using SEM-EDS.
CO3	Determine crystal structure from X-Ray and electron diffraction patterns.
CO4	Interpret X-Ray and Electron diffraction patterns.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								3				
CO2								3				
CO3								3				
CO4								3				

Detailed syllabus

Green and dry strength testing, Determination of permeability, Shatter index, clay content, Moisture content,cured transverse strength of shell sands, CO2 molding process, NDT-Liquid penetrant test, Magnetic particle testing, Analysis of defects by ultrasonic flaw detector.

Reading

1 .XRD& EM Laboratory manual

MM405	**Mechanical Working of Materials Laboratory**	**PCC**	**0 – 0 – 3**	**2 Credits**

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine strain hardening exponent from the stress-strain diagram.
CO2	Understand the effect of cold working and annealing on microstructure.
CO3	Illustrate the effect of strain rate on mechanical properties.
CO4	Practice rolling of copper, brass, plain carbon steel and stainless steel.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					3							
CO2					3	2						
CO3					3	1						
CO4					3							

Detailed syllabus

Determination of minimum bend radii, n and k from tension test, Study of mechanical properties and micro-structural change of cold worked metals, Annealing of cold worked metal and micro-structural changes, Rolling of copper, brass, stainless steel and plain carbon steel using laboratory rolling mill, Effect of strain rate studies on mechanical properties.

Reading

1. MWM Laboratory manual

MM449	**Project Work Part-A**	**PRC**	**0 – 0 – 3**	**2 Credits**

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify a research problem after thorough literature review in metallurgical and materials engineering, plan and execute experimental work to obtain results. Further analyze the results, prepare a technical report and make an oral presentation.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	2	1	3	3	3	1	3	3	1

ME435	Industrial Management	ESC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the basic principles, approaches and functions of management and identify concepts to specific situations.
CO2	Understand marketing management process to discuss marketing mix in formulation of marketing strategies during the life cycle of product.
CO3	Outline various techniques for improving productivity using work study.
CO4	Understand concepts of quality management and use process control charts, concepts and tools of quality engineering in the design of products and process controls.
CO5	Use and distinguish basic methods/tools of inventory classification and control.
CO6	Identify activities with their interdependency and use scheduling techniques of project management PERT/CPM.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									1	1		
CO2									1	1		
CO3									1			
CO4									1			
CO5									1			
CO6									2			

Detailed syllabus

Introduction: Overview of the course, Examination and Evaluation patterns; Nature, significance and role of management in organizations.

Evolution of Industry and Principles of management: Evolution of industry and professional management; Functions of management; Organization structures; Hawthorne Experiments and informal organizational structures; Motivational theories and leadership styles.

Marketing Management: Marketing management process; 4P's of marketing mix; Target marketing; Product life cycle and marketing strategies.

Work Study: Productivity and its role in the economy; Techniques for improving productivity; Method study; Principles of motion economy; Stop watch time study; Work sampling.

Quality Management: Dimensions of quality; Process control charts; Acceptance sampling; Taguchi's Quality Philosophy; Quality function deployment; Introduction to TQM.

Inventory Management: Purpose of inventories; Inventory costs; ABC classification; Economic Order Quantity (EOQ); P and Q systems of inventory control.

Project Scheduling- PERT/CPM: Project activities; Network diagrams; Critical path method (CPM); Programme Evaluation and Review Technique (PERT).

Reading

1. Koontz H and Weihrich H, Essentials of Management, 7th Ed., McGraw-Hill , New York 2007.

2. Kotler P, Marketing Management, 13th Ed., Prentice Hall of India/Pearson, New Delhi 2009.

3. Chase, Shankar, Jacobs and Aquilano, Operations and Supply Management, 12th Ed., Tata McGraw Hill, New Delhi 2010.

MM451	Characterization Techniques	PCC	3 – 0 – 0	3 Credits

Pre-requisites: MM401 X-ray Diffraction and Electron Microscopy

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the principles of optical and electron microscopy.
CO2	Interpret optical and electron micrographs.
CO3	Describe composition analysis techniques in SEM.
CO4	Understand the principle of XRD, thermal analysis techniques includes DSC and TGA.
CO5	Select characterization techniques for a given metallurgical problem.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								3				
CO2								3				
CO3								3				
CO4								3				
CO5								3				

Detailed syllabus

Optical metallography, image analysis, quantitative phase estimation. Analytical transmission electron microscopy (TEM), Selected area of Diffraction bright and dark field imaging. Specimen preparation techniques. Scanning Electron Microscopy (SEM), electron beam specimen interaction, image formation in SEM, Energy Dispersive analysis X-ray analysis, Electron Probe Micro- Analysis (EPMA) to solid samples and biological materials, XRD, STM, SPM, AFM,ICP, Thermal Analysis, Differential Thermal Analysis, Differential Scanning Calorimetry, Thermo Gravemetric Analyzer. Chromotography, mass Chromotography.

Reading

1. Kauffmann, Characterization of Materials, John Wiley, 2003.
2. D.G.Brandon , Modern Techniques in Metallography, Butterworths, London, 1966.
3. F. Weinberg , Tools and Techniques in Physical Metallurgy Vol. I and II, Marcel and Dekkar, 1970.
4. ASM Metal Hand book, Materials Characterization, Vol. 10, ASM Int, 2004.

MM452	Characterization Techniques Laboratory	PCC	0 – 0 – 3	2 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Prepare specimens for optical, SEM and TEM observations
CO2	Analyze the crystal structure using X-ray diffraction technique
CO3	Analyze the composition of material using SEM-EDS technique
CO4	Select a technique to characterize a material for a given application

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								3				
CO2								3				
CO3								3				
CO4						1		2	1			

Detailed syllabus

Study of X-Ray Diffractometer, Structure factor calculations, Determination of SC, BCC, FCC and Tetragonal crystal structures, Precise lattice parameter measurements, Construction of phase diagrams, Study of order disorder transformations, Chemical Analysis of phases, Study of TGA / DTA, DSC Study of operation of Atomic Force microscopy and observations of fracture surfaces.

Reading

Characterization Techniques Laboratory Manual

MM491	**Seminar**	**PCC**	**0 – 0 – 3**	**1 Credit**

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify a topic in metallurgical and materials engineering and conduct thorough literature survey and present them clearly and coherently to faculty and student of the metallurgical and materials engineering department in both the written and oral forms.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										3	1	2

MM499	Project Work Part-B	PRC	0 – 0 – 6	4 Credits

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify a research problem after thorough literature review in metallurgical and materials engineering, plan and execute experimental work to obtain results. Further analyze the results, prepare a technical report and make an oral presentation.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	2	1	3	3	3	1	3	3	1

MM311	Computational Materials Engineering	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the importance of computational modelling in developing and designing new materials.
CO2	Predict the properties and performance of materials based on the simulation data and understanding its relevance for the experimentation.
CO3	Understand the physical and chemical properties of complex materials by molecular dynamics and continuum mechanics.
CO4	Apply the modelling techniques of neural networks, fuzzy logic, genetic algorithms, cellular automata for metallurgical and materials engineering phenomena.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								2	1			
CO2			1	1	1	1		1				
CO3								1	2			
CO4								2				

Detailed syllabus

Review of Computer Basics and programming, Techniques in Computer simulation, Finite element analysis, Monte Carlo methods, General Methodology, Understanding of the physical and chemical properties of complex materials by applying molecular dynamics, Monte Carlo method, and continuum mechanics, Thermodynamics and Phase Diagrams, Kinetics & Microstructure Modeling, Process Modeling, Integrated Selection of Materials and Processes, Calculation of materials properties starting from microscopic theories, Neural Networks, Fuzzy Logic, Genetic Algorithms , Molecular Modelling, Cellular Automata , Designing of new materials, modifying materials properties and optimizing chemical processes. Practical examples and programming in computational materials engineering.

Reading

1. K. Ohno, K. Esfarjani, and Y. Kawazoe: Computational Materials Science - From Ab Initio to Monte Carlo Methods, Springer, 1999.

2. Koenraad George FransJanssens, DierkRaabe,et al: Computational Materials Engineering- An Introduction to Microstructure Evolution, Academic Press, 2007.

3. June Gunn Lee: Computational Materials Science, CRC Press, 2011.

4. C R A Catlow: Computational Materials Science, IOS Pr Inc., 2003.

MM312	Refractory and Rare Metal Extraction	DEC	3 – 0 – 0	3 Credits

Pre-requisites: MM252, Unit Processes in Extractive Metallurgy

Course Outcomes: At the end of the course the student will be able to:

CO1	Classify refractory and reactive metals and their potentiality for engineering applications.
CO2	Understand metals extraction and refining techniques and flow sheets related to processing.
CO3	Compare the principles, techniques and limitations of chemical/pyro-chemical methods of upgrading ores.
CO4	Describe the purification of concentrates/ compounds and production of intermediate salts.
CO5	Select flow sheets for the extraction of uranium, zirconium, titanium, beryllium, niobium, tantalum, tungsten, molybdenum and vanadium.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								2				
CO2	1	3										
CO3	3		2									
CO4	3											
CO5		3	2									

Detailed syllabus

Refractory and reactive metals and their applications, Ore reserves of these metals in India. General steps in refractory and reactive metal extraction, Pre- treatment techniques, typical flow sheets, extraction techniques, refining and problems in the production of uranium, thorium, zirconium, titanium, Beryllium, Niobium, Tantalum, Tungsten, Molybdenum and Vanadium.

Reading

1. C. B. Gill, Non- Ferrous Extractive Metallurgy, John Wiley and Sons, 1980

2. H. S. Ray, K. P. Abraham and R. Sridhar, Extraction of Non-ferrous Metals, Affliated East- West Press, 2001.

3. C.A. Hampel, Rare Metals Hand book, Robert E. Krieger Publishing Company, 1971.

4. FathiHabashi, Hand Book of Extractive Metallurgy, Vols. II and III, Wiley-VCH, 1997.

MM313	Fuels, Refractories and Furnaces	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the production of solid, liquid and gaseous fuels.
CO2	Classify the furnaces / refractories and their operating conditions.
CO3	Select fuels, refractories and furnaces to minimize the overall cost of production for a given application.
CO4	Illustrate the production, composition, properties, testing and applications of refractories.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2										
CO2		2										
CO3			3									
CO4		2										

Detailed syllabus

Origin of coals, coke making, testing of coke, principles of crude petroleum refining, cracking, manufacture, properties and uses of producer, water, coke oven and BF gas, classification of refractories, production, composition, properties, testing and application of common refractories, Characteristic features of blast furnace, cupola, open hearth, arc and induction furnaces.

Reading

1. J. D. Gilchrist, Fuels, Furnaces and Refractories, Pergamon, 1977
2. O. P. Gupta, Elements of Fuels, Furnaces and Refractories, Khanna Publishers, 1998.
3. W. Trinks, M. H. Mawhinney, Industrial Furnaces, John Wiley and Sons, 2003

MM314	Ceramics, Polymers and Composites	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Describe the behaviour of ceramics, polymers and composite materials.
CO2	Interpret crystallinity and molecular forces in polymers on the final property of polymers.
CO3	Differentiate the properties and applications of metals, ceramics, polymers, composite and fiber materials
CO4	List the parameters that affect the property of a composite material.
CO5	Describe processing of ceramics, composites and polymers.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								2				
CO2								2				
CO3								2				
CO4								2				
CO5								2				

Detailed syllabus

Introduction to ceramics and ceramic processing, Powder packing density, Compaction mechanics, Powder granulation, Dry pressing, Rheology, Extrusion, Injection molding, Surface tension, wetting, sorption, lyophilicity, Colloidal stability, colloidal processing, and tape casting, Advanced forming methods.

Polymeric materials- Polymer molecules, basic polymer configurations, molecular weight, degree of polymerization, polymerization process, polymer crystallinity, typical polymer properties, thermoplastics and thermosetting plastics, elastomers, introduction to polymer processing, Composite Materials- Concept of composite materials, rule of mixtures, reinforcement geometry, categories of composite materials, introduction to composite processing, applications of composite materials, Crystal structure and bonding, crystalline ceramic materials, silicate structure and clay materials, polymorphism, non - crystalline phases, equilibria and reactions between ceramic phases. Raw materials and their characteristics, Forming processes- hydro plastic forming, slip casting, cementation, vitreous shaping, Thermal Treatment- drying, firing, annealing crystallization, glazing, Mechanical, electrical, magnetic and thermal properties; high temperature behaviour, Ceramic products- Chemical ceramics, filters, abrasive materials, cermets, ceramic insulators, conductors and dielectric materials, piezo-electric materials, ferrites, nuclear applications, modern structural ceramics like zirconia toughened alumina.

Reading

1. W. David Kingery, H. K. Bowen, Donald R. Uhlmann: Introduction to Ceramics, 2nd Edition, John Wiley &Sons, 2004.

2. F.L. Matthews and R.D. Rawlings: Composite Materials: Engineering and Science, CRC Press, 1999.

3. B. Raymond, Seymour and Charles E. CarraherJr: Polymer Chemistry- An Introduction, 2nd Edition,MarcelDekkar, Inc. New York, 1987.

4. Krishan Kumar Chawla: Composite Materials- Science and Engineering, Springer, 2012.

MM315	Polymer Technology	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand individual polymers properties and their usefulness for engineering applications.
CO2	Understand processing and development of polymers and their properties.
CO3	Select appropriate polymeric material for a particular application.
CO4	State the factors control properties of polymers.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1	1			
CO2			1						1			
CO3								2				
CO4							2					

Detailed syllabus

Introduction- Thermodynamics of Polymer Structures – Molecular weight and its determination – Properties of Polymers – Techniques of Polymerization – Polymer Additives, blends and composites – Polymer processing and Rheology – Individual Polymers – Application of Polymers.

Reading

1. J R Fried: Polymer Science and Technology, Prentice Hall of India Pvt. Ltd., New Delhi, Eastern Economy Edition, 2000

2. V R Gowrarikar, M V Viswanathan&Jayadev Sridhar: Polymer Science, Wiley Eastern Ltd., 1988.

3. Premamoy Ghosh: Polymer Science & Technology, Tata McGraw-Hill Publishing Company, New Delhi, 2002.

4. R. Sinha: Outlines of Polymer Technology: Manufacture of Polymers, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.

MM316	Composite Technology	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the main differences between metal, ceramic and polymer matrix composites.
CO2	Describe strengthening mechanisms in composites.
CO3	Illustrate the production of composite materials and their important characteristic properties.
CO4	Select right composite materials for given applications.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								2				
CO2					2							
CO3				3								
CO4								3				

Detailed syllabus

Composite materials- Introduction, classification, strengthening mechanisms in composites, reinforcing materials, production of composites, metal matrix and ceramic matrix composites, fabrication methods of polymer matrix composites and fibre reinforced plastics, manufacture of glass fibres, properties and application of composites, Ceramic composites and Cermets.

Reading

1. ASM Metal Hand Book, Composites, Vol. 21, ASM Int, 2004.

2. F.L. Matthews and R.D.Rawlings, Composite Materials: Engineering and Science, Chapman & Hall, London,1994.

3. Bryan Harris, Engineering Composite materials, IOM Communications Ltd., 1999.

4. S. C. Sharma, Composite Materials, Narosa, 2000.

MM361	Creep, Fatigue and Fracture	DEC	3 – 0 – 0	3 Credits

Pre-requisites: MM302 Mechanical Behaviour of Materials

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the deformation and fracture behaviour of material at high temperature.
CO2	Calculate theoretical fracture strength and experimental fracture strength through EPFM, CTOD and J-integral.
CO3	Describe the effect of crack on the toughness of brittle and ductile materials.
CO4	Predict the life of materials under fatigue loading.
CO5	Select metals and alloys for desired uses at high temperature.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					1	3						
CO2					1			2				
CO3								2				
CO4								2				
CO5								2				

Detailed syllabus

Fracture- use of fracture mechanics in the prediction of mechanical failure, Griffiths analysis concept of energy release rate and fracture energy, Linear Elastic Fracture Mechanics, (LEFM)- Loading modes, stress ahead of the crack tip, stress concentration factor, stress intensity factor and the material parameter the critical stress intensity factor, Plasticity at the crack tip and the principles behind the approximate derivation of plastic zone shape and size, limits on the applicability of LEFM. The effect of constraint, definition of plane stress and plane strain and the effect of component thickness, Elastic-Plastic Fracture Mechanics (EPFM)- Alternative failure prediction parameters, Crack Tip Opening Displacement, and J integral, measurement of parameters and examples of use, Effect of Microstructure on fracture mechanism and path, cleavage and ductile failure, factors improving toughness, Fatigue- High Cycle Fatigue, Low Cycle Fatigue, mean stress, R ratio, strain and load control, S-N curves, Goodman diagram, fatigue limit, mechanism of fatigue failure, effect of stress concentration, specimen size, Total life and damage tolerant approaches, Paris law, Creep- Creep curve, creep properties of metals, stress-rupture test, deformation and fracture at elevated temperature, theories of creep, prediction of long time properties.. Effect of metallurgical variables on creep, Creep resistant materials.

Reading

1. G. E. Dieter: Mechanical Metallurgy, McGraw Hill, 1988.
2. Michael Kassner: Fundamentals of Creep in Metals and Alloys, 2nd Edition, Elsevier Science, 2009.
3. T. L. Anderson: Fracture Mechanics- Fundamentals and Applications, 3rd Edition, CRC Press, 2011.
4. R. W. Hertzberg: Deformation and Fracture Mechanics of Engineering Materials, 4th edition, John Wiley & Sons Inc., 1995.

MM362	Fracture Mechanics and Failure Analysis	DEC	3 – 0 – 0	3 Credits

Pre-requisites: MM302 Mechanical Behaviour of Materials

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the basic concepts of fracture, elastic stress field and LEFM.
CO2	Understand the factors responsible failure of materials.
CO3	Differentiate fracture modes and understand failure mechanisms for fatigue and creep.
CO4	Determine fracture toughness of brittle and ductile materials.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					3			2				
CO2								2	2			
CO3					3				1			
CO4								2				

Detailed syllabus

Concepts of fracture, elastic stress field and LEFM, crack-tip plastic zone, fracture toughness testing, subcritical crack growth in cyclic loading, Classification of failures, principles of fracture mechanics and types of fracture, fatigue fracture, creep fracture, fracture surface and fracture path analysis to characterize failure mechanism and to locate origin of fracture.

Reading

1. E.E. Gdowan, Fracture Mechanism: An Introduction, Springer, 2005.
2. ASM Metal Hand book, Vol 12, Fractography, ASM Int, 2004.
3. A.F. Liu, Mechanics and Mechanisms of Fracture: An Introduction, ASM, 2004.

MM363	High Temperature Materials	DEC	3 – 0 – 0	3 Credits

Pre-requisites: MM203, Metallurgical Thermodynamics and Kinetics, MM302 Mechanical Behaviour of Materials

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the properties required for high temperature applications.
CO2	Develop materials for high temperature applications.
CO3	Interpret the influence of creep, thermal fatigue, oxidation, high temperature corrosion, erosion and ageing on materials.
CO4	Analyze life of creep resistant steels, superalloys, ceramics and polymers at elevated temperature.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								2				
CO2								2				
CO3							3					
CO4								2				

Detailed syllabus

Creep, thermal fatigue, oxidation, high temperature corrosion, erosion, Ageing, structural changes, material damage, Crack propagation, damage mechanics, life time analysis, Creep resistant steels, superalloys, ceramics and polymers for high temperature applications, intermetallics, Usage of high strength steels, Spring materials, Fatigue, Evaluation of property data, extrapolation.

Reading

1. Evans, R.W and Wilshire, B. Creep of Metals and Alloys. Institute of Metals, 1985, London.

2. J. R. Davis, ASM Specialty Hand Book: Heat – Resistant Materials, ASM, 1997.

MM364	Advanced Ferrous Production Technology	DEC	3 – 0 – 0	3 Credits

Pre-requisites: MM301 Ferrous Production Technology

Course Outcomes: At the end of the course the student will be able to:

CO1	Learn basic principles of iron making and steel making.
CO2	Understand physical chemistry of steel making and refining.
CO3	Explain conventional and modern steel making.
CO4	Evaluate the secondary steel making technologies.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2	2									
CO2		3										
CO3		3										
CO4		3										
CO5		2				1						

Detailed syllabus

Blast Furnace Iron production and its limitations, Alternative routes of iron production, Sponge Iron Processes: HYL, SL/RN, Midrex, HIB and Fluidized bed Processes. Uses of sponge iron, Smelt reduction Processes: COREX, INRED and ELRED and mini blast furnaces, Review of conventional and modern steel making processes, Physical Chemistry of steel making, Inclusions, refining by synthetic slags and remelting, Vacuum degassing, stream and recirculation degassing, Vacuum arc degassing, ingot casting practice, continuous casting ingot defects, Recent advances in converter and electric arc steel making furnaces, Secondary Steel Making processes, Review of Iron and Steel Industry in India.

Reading

1. Amit Chatterjee: Beyond the Blast Furnace, CRC Press., 1992.
2. Ahindra Ghosh & Amit Chatterjee: Iron Making and Steel Making- Theory and Practice, Prentice-Hall of India Pvt Ltd, 2008.
3. Ahindra Ghosh: Secondary Steel Making- Principles and Applications, CRC Press, 2001.
4. B IIschner& N J Grant (Eds): Ladle Metallurgy, Springer Verlag, New York, 1989.

MM365	Alternate Route for Iron Production	DEC	3 – 0 – 0	3 Credits

Pre-requisites: MM301 Ferrous Production Technology

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the basic principles of Iron making.
CO2	Categorize alternative production routes of Iron.
CO3	Describe the kinetics of iron oxides reduction.
CO4	Summarize the smelting reduction processes

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3										
CO2		3	2									
CO3			3									
CO4		3										

Detailed syllabus

Blast furnace Iron making, Alternate routes of Iron making, Kinetics of Iron Oxides Reduction, Coal based DR processes, Gas based DR processes using Retorts, Fluidized bed shaft furnaces, Future out look of DR processes, Smelting Reduction processes, classification, Corex, Kawasaki smelting, INRED, ELRED, Plasma smelt etc., processes.

Reading

1. Amit chatterjee, Beyond Blast furnaces, CRC Press, 1994.
2. FathiHabashi, Hand Book of Extractive Metallurgy, Vols. I, Wiley- VCH, 1997.

MM366	Secondary Steel Making	DEC	3 – 0 – 0	3 Credits

Pre-requisites: MM301 Ferrous Production Technology

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the importance of secondary steel making.
CO2	Describe secondary steel making processes and refining techniques
CO3	Illustrate the physical chemistry of steel making.
CO4	Understand vacuum degassing, stream and recirculation degassing and vacuum arc degassing.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									3			
CO2			3									
CO3			3									
CO4			3									

Detailed syllabus

Physical chemistry of steel making, production of high quality steels, inclusions, refining by synthetic slags, refining by synthetic slags and remelting, Vacuum degassing, stream and recirculation degassing, vacuum arc degassing.

Reading

1. Ahindra Ghosh: Secondary Steel Making- Principles and Applications, CRC Press, 2001.

2. B IIschner& N J Grant (Eds): Ladle Metallurgy, Springer verlag, New York, 1989.

MM411	Advanced Materials	DEC	3 – 0 – 0	3 Credits

Pre-requisites: MM201, Physical metallurgy and Materials Engineering

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the materials requirement for aircraft, low temperature, high temperature and bio applications.
CO2	Differentiate structural and functional materials.
CO3	Identify main ideas of quasi crystals, metallic glasses and carbon materials.
CO4	Select materials for automobiles.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								2	2			
CO2								3				
CO3								1	2			
CO4								2				

Detailed syllabus

Special purpose steels, Light metals and alloys, Titanium and Ti-based alloys and Intermetallics, Advanced Aluminum alloys, High temperature materials, Ultra high temperature materials, Cryogenic materials, Functional and Functionally graded materials-synthesis and their thermal and mechanical treatment, Quasi Crystals, Metallic Glasses, Amorphous materials, Biomaterials, Carbon-based materials, Advanced Magnetic, Electrical and Electronic materials, Optical materials, Shape Memory Alloys, Smart Materials, Materials for Automobiles, Lasers, Sensors, etc.

Reading

1. M.F. Ashby: Engineering Materials, 4th Edition, Elsevier, 2005.

2. M.F. Ashby: Materials Selection in Mechanical Design, Butterworth Heinemann, 2005.

3. ASM Publication, Vol.20: Materials Selection and Design, ASM, 1997.

4. Pat L. Mangonon: The Principles of Materials Selection and Design, Prentice Hall International, Inc. 1999.

MM412	Bio-materials	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand materials requirements for bio applications.
CO2	List metallic, ceramic and polymeric materials for bio applications
CO3	Review thin films and coatings in bio applications.
CO4	Differentiate bioresorbable and bioerodible materials.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									2			
CO2							2	1	1			
CO3								2				
CO4							2					

Detailed syllabus

Properties of Materials, Materials in Medical Applications, Stainless steel alloys, Cobalt based alloys, titanium based alloys, polymers, Bioresorbable and Bioerodible materials, bioceramics, porous ceramics, bioactive glasses, calcium phosphates, collagen, thin films, grafts and coatings, biological functional materials Latex products.

Reading

1. Shi, D, Biomaterials and Tissue Engineering, Springer, 2004
2. Buddy D. Ratner, Bio Material Science: An introduction to Materials in Medicine, Elsevier, 2004.
3. S. V. Bhatt, Biomaterials, Narosa, 2002.

MM413	Materials Technology	DEC	3 – 0 – 0	3 Credits

Pre-requisites: MM201, Physical metallurgy and Materials Engineering

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify the reasons for strengthening of steels.
CO2	Review the hardening of aluminium and titanium alloys.
CO3	List alloys of tin and lead.
CO4	Describe Ni, Co and Fe superalloys.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1				
CO2					2							
CO3								1				
CO4								1	1			

Detailed syllabus

Effect of alloying elements in steels, heat resistant steels, Precipitation hardening stainless steels, Dual phase steels, micro alloyed steels, Hadfield manganese steels, Ball bearing steels, Ni - Cr - Mo low alloy steels, Maraging steels, Ausformed steels, Precipitation hardening in Al alloys, Modification of Al-Si alloys, Magnesium and Titanium and their alloys, Lead, Tin and their alloys, applications of Ni, Fe, Ni and Co based super alloys.

Reading

1. Reed-Hill, Physical Metallurgy Principles, Affiliated East West Press, 2004.

2. Budinski, Engineering Materials: Properties and Selection, Prentice Hall of India Private Limited, 2002.

3. Y. Lakhtin, Engineering Physical Metallurgy, Mir Publishers, 1998.

MM461	Materials Selection and Design	DEC	3 – 0 – 0	3 Credits

Pre-requisites: MM201, Physical metallurgy and Materials Engineering, MM302, Mechanical Behaviour of Materials

Course Outcomes: At the end of the course the student will be able to:

CO1	Review the criteria for materials selection.
CO2	Describe heat treatment for modifying microstructure and mechanical properties.
CO3	Mention ceramic and polymeric materials.
CO4	Judge materials for structural, functional and bio applications

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								3				
CO2						2						
CO3								2				
CO4								2	2			

Detailed syllabus

Limitations in properties and applications of plain carbon steels and common non-ferrous alloys, criteria for selection of materials, application of statistics in materials, application of statistics in materials selection, specification of steels, Composition, heat treatment, microstructure and properties of ferrous and non-ferrous alloys, ceramics and polymers for light and heavy structural, corrosion resistant, high temperature, low-temperature and cryogenic, wear resistant, magnetic, electrical and electronic applications, pressure vessels and boilers, springs, bearings, tools, medical implants and prostheses application, Composites, shape memory alloys, metallic glasses.

Reading

1. M.F. Ashby: Engineering Materials, 4th Edition, Elsevier, 2005.
2. M.F. Ashby: Materials Selection in Mechanical Design, Butterworth Heinemann, 2005.
3. ASM Publication, Vol.20: Materials Selection and Design, ASM, 1997.
4. Pat L. Mangonon: The Principles of Materials Selection and Design, Prentice Hall International, Inc. 1999.

MM462	Electro Finishing	DEC	3 – 0 – 0	3 Credits

Pre-requisites: MM203 Metallurgical Thermodynamics and Kinetics, MM252 Unit processes in Extractive Metallurgy

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the principles of electroplating.
CO2	Review the process parameters of electroplating.
CO3	Summarize electroplating techniques for metals including Cu and Ni.
CO4	Describe testing methods of coating for its mechanical properties.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			2									
CO2							3					
CO3							2					
CO4								3				

Detailed syllabus

Concepts of cathode polarization processes, Theories of metal and alloy plating. Mechanism of electro deposition, Preparation for electro plating, Effects of current density, temperature and agitation on the properties of deposits, plating of common metals and alloys, electro forming of metals, electro less plating of Cu and Ni, anodizing, Testing of deposits.

Reading

1. Bard A. and L. R. Faulkner, Electro-chemical Methods: Fundamentals and Applications, John – Wiley, 1980.

2. N. V. Parthasardhy& F. C. Walsh , Practical Electro Plating Hand Book, Prentice Hall Inc., 1989.

3. Kanani, N, Electro Plating Basic Principles, Processes and Practice, Elsevier, 2004.

MM463	**Surface Engineering**	**DEC**	**3 – 0 – 0**	**3 Credits**

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the significance of surface modification processes.
CO2	Describe the principles of surface modification processes.
CO3	Identify testing approaches to evaluate a modified surface.
CO4	Suggest a surface modification process for a particular wear situation.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							2	2				
CO2			1									
CO3							2	1				
CO4								2				

Detailed syllabus

Introduction: Importance and need of surface engineering; Past, present and future status of surface engineering; Classification of surface engineering processes; Substrates and their pretreatments; Coating characteristics: Coating thickness, continuity, hardness, adhesion, porosity, bond strength

Overlay coatings: Process fundamentals, advantages, limitations and applications of the following technologies:

Thermally sprayed coatings: Plasma spraying; Flame spraying; Detonation spray coating; High velocity oxy-fuel spraying; Cold gas dynamic spray process; Thermal barrier coatings; Powders for thermal spraying and Factors influencing thermal spray coatings; Applications of thermal spraying, Recent developments in thermal spraying;

Electrochemical coatings: Electroplating (Cu, Ni, Cr, Zn); Electro-less nickel plating and anodizing; Precious metal coatings; Functional and decorative electroplated coatings with Tin and Tin Alloys; Coating on plastics

Micro arc oxidation: Basics, technology and fundamentals of micro-arc oxidation; Advantages, shortcomings and applications of micro-arc oxidation

Electro-spark coating-process: Fundamentals, mechanism of coating formation, advantages and limitations, applications; Case studies

Diffusion coatings: Introduction: Difference between diffusion coatings and overlay coatings; Coating medium-Coating forming elements, Basic mechanism of coating formation, Advantages and disadvantages

Process fundamentals, advantages, limitations and applications of the following technologies: Carburising – Overview of pack, liquid, and gas carburizing; Nitriding – Overview of gas and liquid nitriding; Carbonitriding and Nitrocarburising; Boronizing, Aluminized coatings, Chromized and Siliconized coatings

Plasma processes: Plasma carburizing and Plasma nitriding; Plasma immersed ion implantation; Plasma enhanced physical vapourdeposition ; Plasma enhanced chemical vapour deposition

Thermal modification processes: Different types of lasers and their applications; Laser assisted surface modification processes-Laser surface cleaning, Laser surface hardening, Laser surface cladding, Laser surface alloying

Thin film coating technology: Chemical vapour deposition (CVD); Physical vapour deposition (PVD); Electron beam evaporation; Magnetron sputtering; Diamond like carbon coating technology; Sol-gel coating technologies

Evaluation of coatings: Thickness, bond strength and porosity measurement; Hardness, wear and corrosion resistance

Reading

1. TadeuszBurakowski and TadeuszWierzchon, Surface Engineering of Metals: Principles, Equipment, Technologies, CRC Press LLC, 1999.

2. K. G. Budinski, Surface Engineering for Wear Resistance, Prentice Hall, New Jersey, 1998.

3. Surface Engineering, Process Fundamentals and Applications, Vol I &Vol II, Lecture Notes of SERC School on Surface Engineering, 2003.

4. Howard E. Boyer (Editor), Case Hardening of Steel, ASM International, Metals Park, OH 44073.

MM464	Nano Science and Nano Technology	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the need for nano materials.
CO2	Identify testing approaches for nano material.
CO3	Describe the size effect on optical, electrical, mechanical, magnetic and thermal properties.
CO4	Review the applications of nano materials and nano devices.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									3			
CO2								3				
CO3								3				
CO4									2			

Detailed syllabus

Significance of Nano materials, properties of materials at nano level, nano clusters, synthesis of metal and ceramic nano materials, classical, chemical and biological methods, carbon nano tubes, aerogels, zeolites and special nanomaterials, Changes in order behavior and compositional changes due to reduction in size

Carbon nano structures- carbon molecules, carbon clusters, carbon nano tubes- synthesis, formation mechanisms, strength, separation, stability and applications,Properties of Nano materials- Mechanical and structural properties, Elastic and plastic behavior of nano materials, effect of temperature and nature of dislocations and their mobility super plasticity in nano materials, improvements in strength and ductility, Nano indentation, principles and mechanisms leading to enhanced properties of composite materials, Fatigue, super plastic behavior of nano grained materials, nano control for high strength and high ductility in light weight alloys, Ceramic nano systems- nano ceramic powders, nano grained ceramics, Quantum effects, quantum confinement, quantum wells, wires and dots, effect of size reduction on optical, electrical , electronic, mechanical, magnetic and thermal properties of materials due to size. Surface effects, nano electronics, Differences between nano and micro electronics, 1-D, 2-D, 3-D nano structures, Nano fluidics, nano layered composites, nano filamentary and nano wire composites, nano particulate composites, Capacity building in nano materials such as capacitors, superconductors, super capacitors etc., nano electromechanical systems (NEMS) organic optoelectronic nanostructures, photonic crystals, biomimetic nano structures.

Reading

1. Sulabha K. Kulkarni: Nanotechnology Principles and Practices, Capital Publishing Company, 2007.
2. H. Hosono, Y. Mishima, H. Takezoe and K.J.D Mackenzie: Nanomaterials- From Research to Applications, Elsevier Ltd., Noida, 2008.
3. Massimilano Di Ventra, S. Evoy and James R. Heflin, Jr.: Introduction to Nanoscale Science and Technology, Springer, Noida, 2009.
4. Charles P. Poole Jr. and Frank J. Owens: Introduction to Nanotechnology, Wiley India, 2010.

MM465	Nuclear Materials	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the principles of nuclear power generation.
CO2	Describe the requirements of materials for a breeder reactor.
CO3	Understand failure mechanisms of material in a nuclear reactor.
CO4	Review the status of nuclear power production in India and world.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			2									
CO2								2	2			
CO3								2				
CO4									1			

Detailed syllabus

Nuclear radiation, microscopic flux and microscopic cross-section, attenuation of radiation fission, elastic collision slowing down infinite multiplication constant, Fuel and breeder materials manufacture and properties, Structural materials, Radiation damage in fuel elements, Structural coolant and control rod materials, Nuclear power, present and future states.

Reading

1. Bodansky, Nuclear Energy: Principles, Practices and Projects, Springer, 2004.
2. C.A. Hampel, Rare Metals Handbook, Robert E. Krieger Publishing Company, 1971.
3. S. Glasstone and A. Sesonke, Nuclear Reactor Engineering, CBS Publishers and Distributors, Delhi, 2003.

MM466	High Temperature Corrosion	DEC	3 – 0 – 0	3 Credits

Pre-requisites: MM352 Electrometallurgy and Corrosion

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand mechanisms of high temperature oxidation, hot corrosion and erosion.
CO2	List the testing methods of high temperature oxidation, hot corrosion and erosion.
CO3	Analyze the macro and microstructures of materials degraded at high temperature.
CO4	Select a material resistant to particular high temperature environment.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			2				2					
CO2							2	2				
CO3							3					
CO4								3				

Detailed syllabus

Introduction, high temperature gaseous reaction (dry), single metal-single oxidant systems, aspects of thermodynamics, kinetics, transport properties, scale morphologies, electrochemical emphasis, thermodynamic phase stabilities in metal/gas systems, scale growth kinetics and mechanisms, Wagner’s parabolic scale growth, alloy oxidation.

Reading

1. A .S. Khanna, Introduction to High Temperature Oxidation and Corrosion, ASM, 2002.

2. ASM Hand Book, Vol. 13, Corrosion, 1987.

OPEN ELECTIVE COURSES

CE390	Environmental Impact Analysis	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, student will be able to:

CO1	Identify the environmental attributes to be considered for the EIA study.
CO2	Formulate objectives of the EIA studies.
CO3	Identify the suitable methodology and prepare Rapid EIA.
CO4	Prepare EIA reports and environmental management plans.
CO5	Plan the methodology to monitor and review the relief and rehabilitation works.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							2	2				
CO2							2	2				
CO3							1	3				
CO4								3	1			
CO5									3	1	1	

Detailed Syllabus:

Introduction: The Need for EIA, Indian Policies Requiring EIA , The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the EIA Process. Government of India Ministry of Environment and Forest Notification (2000), List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements.

Identifying the Key Issues:Key Elements of an Initial Project Description and Scoping, Project Location(s), Land Use Impacts, Consideration of Alternatives, Process selection: Construction Phase, Input Requirements, Wastes and Emissions, Air Emissions, Liquid Effluents, Solid Wastes, Risks to Environment and Human, Health, Socio-Economic Impacts, Ecological Impacts, Global Environmental Issues.

EIA Methodologies**:** Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation & Evaluation, impact communication, Methods-

Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods, Environmental index using factor analysis, Cost/benefit analysis, Predictive or Simulation methods. Rapid assessment of Pollution sources method, predictive models for impact assessment, Applications for RS and GIS.

Reviewing the EIA Report:Scope, Baseline Conditions, Site and Process alternatives, Public hearing. Construction Stage Impacts, Project Resource Requirements and Related Impacts, Prediction of Environmental Media Quality, Socio-economic Impacts, Ecological Impacts, Occupational Health Impact, Major Hazard/ Risk Assessment, Impact on Transport System,Integrated Impact Assessment.

Review of EMP and Monitoring: Environmental Management Plan, Identification of Significant or Unacceptable Impacts Requiring Mitigation, Mitigation Plans and Relief & Rehabilitation, Stipulating the Conditions, What should be monitored? Monitoring Methods, Who should monitor? Pre-Appraisal and Appraisal.

Case Studies: Preparation of EIA for developmental projects- Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant, Nuclear fuel complex, Highway project, Sewage treatment plant, Municipal Solid waste processing plant, Tannery industry.

Reading:

1. Jain, R.K., Urban, L.V., Stracy, G.S., *Environmental Impact Analysis*, Van Nostrand Reinhold Co., New York, 1991.
2. Barthwal, R. R., *Environmental Impact Assessment*, New Age International Publishers, 2002
3. Rau, J.G. and Wooten, D.C., *Environmental Impact Assessment,* McGraw Hill Pub. Co., New York, 1996.
4. Anjaneyulu.Y., and Manickam. V., Environmental Imapact Assessment Methodologies, B.S. Publications, Hyderabad, 2007.
5. Wathern.P., Environmental Impact Assessment- Theory and Practice, Routledge Publishers, London, 2004.

EE390	Linear Control Systems	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, student will be able to:

CO1	Analyze electromechanical systems using mathematical modelling
CO2	Determine Transient and Steady State behavior of systems using standard test signals
CO3	Analyze linear and non-linear systems for steady state errors, absolute stability and relative stability
CO4	Design a stable control system satisfying requirements of stability and reduced steady state error

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			2									
CO2							2					
CO3			1				1	1				
CO4			1				1	1				

Detailed syllabus:

Introduction - control system, types, feedback and its effects-linearization

Mathematical Modelling of Physical Systems. Block diagram Concept and use of Transfer function. Signal Flow Graphs- signal flow graph, Mason's gain formula.

Time Domain Analysis of Control Systems - BIBO stability, absolute stability, Routh-Hurwitz Criterion.

P, PI and PID controllers. Root Locus Techniques - Root loci theory, Application to system stability studies.

Frequency Domain Analysis of Control Systems - polar plots, Nyquist stability criterion, Bode plots, application of Bode plots.

Reading:

1. B.C. Kuo, Automatic Control Systems, 7th Edition, Prentice Hall of India, 2009.
2. I.J. Nagarath and M. Gopal: Control Systems Engineering, 2nd Edition, New Age Pub. Co. 2008.

ME390	Automotive Mechanics	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, student will be able to:

CO1	Analyze operation and performance indicators of transmission systems, internal combustion engines and after treatment devices.
CO2	Understand operation of engine cooling system, lubrication system, electrical system and ignition system.
CO3	Understand fuel supply systems in an diesel and petrol vehicles
CO4	Analyze current and projected future environmental legislation and its impact on design, operation and performance of automotive power train systems.
CO5	Understand operation and performance of suspension, steering and braking system.
CO6	Understand layout of automotive electrical system and importance of electronics

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1		1		
CO2							2					
CO3			1							1		
CO4							1	1				
CO5										1		
CO6										1		

Detailed syllabus

Introduction: Layout of an automotive chassis, engine classification.

Cooling Systems:Air cooling, air cleaners, Water cooling: Thermosyphon and pump circulation systems, Components of water cooling systems- Radiator, thermostat etc.

Engine Lubrication:Petroilssystem,Splash system, Pressure lubrication and dry sump system

Ignition System: Battery, Magneto and Electronic, Engine Starting drives

Fuel supply system:Components in fuel supply system, types of feed pumps, air cleaners, fuel and oil filters, pressure and dry sump systems.

Engine testing and Performance:Performance parameters, constant and variable speed test, heat balance test, performance characteristics. Engine Emissions: SI and CI engine emissions, emission control methods

Automotive electrical and electronics:Electrical layout of an automobile,ECU, sensors, windscreen wiper, Electric horn.

Transmission: Clutch**-** Single and multiplate clutch, semi & centrifugal clutch and fluid flywheel, Gear box: Sliding mesh, constant mesh and synchromesh gear box, selector mechanism, over drive, Propeller shaft and Differential.

Suspension System:Front and rear suspension, shock absorbers, Rear Axles mountings, Front Axle. Steering Mechanism:Manual and power steering systems, Braking System: Mechanical, Hydraulic and Air braking systems.

Engine service:Engine service procedure.

Reading:

1. S. Srinivasan, Automotive Mechanics, Tata McGraw-Hill, 2004.
2. K.M.Gupta, Automobile Engineering, Vol.1 and Vol.2, Umesh Publications, 2002
3. Kirpal Singh, Automobile Engineering, Vol.1 and Vol.2, Standard Publishers, 2003.
4. William H.Crouse and Donald L. Anglin, Automotive Mechanics, Tata McGraw-Hill, 2004
5. Joseph Heitner, Automotive Mechanics, East-West Press, 2000.

ME391	Robust Design	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand stages in engineering design and concept of robust design.
CO2	Develop quality loss functions and S/N ratios for S, N and L type objective functions.
CO3	Identify control and noise factors for a given product or process.
CO4	Conduct experiments using DOE concepts to decide the optimal setting of parameters
CO5	Apply quality loss function approach for fixing the component tolerances.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1		1		
CO2										1		
CO3			1									
CO4								1	1			
CO5				1								

Detailed syllabus

Introduction: Taguchi's quality philosophy, causes of performance variation, concept of robust design, stages in product/process design, need for experimentation, QFD, process flow analysis, cause and effect diagram.

Design of Experiments**:** Principles of experimentation, Basic concepts of probability and statistics, Comparison of two means and two variances, Comparison of multiple (more than two) means &Anova, Factorial designs, fractional factorial designs, orthogonal arrays, standard orthogonal arrays & interaction tables, modifying the orthogonal arrays, selection of suitable orthogonal array design, analysis of experimental data.

Parameter Design**:** Loss function, average quality loss, S/N ratios, objective functions, selection of control & noise factors and their levels, strategy for systematic sampling of noise, classification of control factors, inner-array and outer-array design, data analysis, selection of optimum levels/values for parameters.

Tolerance Design: Experiments, selection of tolerances to be tightened, fixing the final tolerances.

Reading:

1. Taguchi G, Chowdhury S and Taguchi S, Robust Engineering, TMH, 2000.
2. Ross PJ, Taguchi Techniques for Quality Engineering, TMH, 2005.

ME392	Entrepreneurship Development	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand entrepreneurship and entrepreneurial process and its significance in economic development.
CO2	Develop an idea of the support structure and promotional agencies assisting ethical entrepreneurship.
CO3	Identify entrepreneurial opportunities, support and resource requirements to launch a new venture within legal and formal frame work.
CO4	Develop a framework for technical, economic and financial feasibility.
CO5	Evaluate an opportunity and prepare a written business plan to communicate business ideas effectively.
CO6	Understand the stages of establishment, growth, barriers, and causes of sickness in industry to initiate appropriate strategies for operation, stabilization and growth.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									1	1		
CO2											2	
CO3										1	1	
CO4									2			
CO5										2		
CO6											1	

Detailed syllabus

Entrepreneur and Entrepreneurship:Introduction; Entrepreneur and Entrepreneurship; Role of entrepreneurship in economic development; Entrepreneurial competencies and motivation; Institutional Interface for Small Scale Industry/Enterprises.

Establishing Small Scale Enterprise:Opportunity Scanning and Identification; Creativity and product development process; Market survey and assessment; choice of technology and selection of site.

Planning a Small Scale Enterprsies**:** Financing new/small enterprises; Techno Economic Feasibility Assessment; Preparation of Business Plan; Forms of business organization/ownership.

Operational Issues in SSE**:** Financial management issues; Operational/project management issues in SSE; Marketing management issues in SSE; Relevant business and industrial Laws.

Performance appraisal and growth strategies**:** Management performance assessment and control; Causes of Sickness in SSI, Strategies for Stabilization and Growth.

Reading:

1. G.G. Meredith, R.E.Nelson and P.A. Neek, The Practice of Entrepreneurship, ILO, 1982.
2. Dr. Vasant Desai, Management of Small Scale Enterprises, Himalaya Publishing House, 2004.
3. A Handbook for New Entrepreneurs, Entrepreneurship Development Institute of India, Ahmedabad, 1988.
4. Bruce R Barringer and R Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, 3rd ed., Pearson Edu., 2013.

EC390	Communication Systems	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand different modulation and demodulation schemes for analog communications.
CO2	Design analog communication systems to meet desired application requirements
CO3	Evaluate fundamental communication system parameters, such as bandwidth, power, signal to quantization noise ratio etc.
CO4	Elucidate design tradeoffs and performance of communications systems.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			1									
CO2								1				
CO3							1	1		1		
CO4								1		1		

Detailed syllabus

Signal Analysis**:** Communication Process, Sources of Information, Communication Channels, Modulation Process, Types of Communication, Random Process, Gaussian Process, Correlation Function, Power Spectral Density, Transmission of Random Process through an LTI Filter.

Noise Analysis:External Noise, Internal Noise, White Noise, Narrow Band Noise, Representation of Narrow Band noise In phase and Quadrature Components, Noise Figure, Noise Bandwidth, Noise Temperature.

Amplitude (Linear) Modulation: Linear Modulation Schemes, Generation of AM, Envelope Detector, DSB-SC Product Modulator, Switching Modulator, Ring Modulator, Coherent Detection, Costas receiver, SSB Signal Representation, Filtering Method, Phase Shift Method, Coherent Demodulation, VSB Modulator and Demodulator, Carrier Acquisition using Squaring Loop and Costas Loop, Receiver Model, SNR, Noise in SSB and DSB receivers using coherent detection, Noise in AM Receiver using Envelope detection, Threshold Effect.

Angle (Exponential) Modulation:Types of Angle Modulation, Relation between FM and PM, Narrow Band FM, Wideband FM, Transmission Bandwidth of FM Signals, Generation of FM using Direct and Indirect methods, FM Demodulation using Slope

Circuit, Frequency Discriminator, Interference in Angle Modulation, Noise in FM Receiver, FM Threshold Effect, Pre-emphasis and De-emphasis in FM, Model of PLL for FM Demodulation.

Pulse Modulation: Sampling Process, PAM, PWM, PPM, Quantization, PCM, TDM, Digital Multiplexer Hierarchy, DM, DSM, Linear Prediction, DPCM, ADPCM, Noise in PCM System, Companding, Comparison of the Noise Performance of AM,FM,PCM and DM.

Information Theory:Uncertainty, Information, Entropy, Source Coding Theorem, Data Compaction, Mutual information, Channel Capacity, BSC Channel, Information Capacity Theorem, Bandwidth - Power Tradeoff, Huffman Coding.

Reading:

1. S. Haykin, Communication Systems, 4th Edn, John Wiley & Sons, Singapore, 2001.
2. B.P. Lathi, Modern Digital & Analog Communication Systems, 3rdEdn, Oxford University Press, Chennai, 1998.
3. Leon W.Couch II., Digital and Analog Communication Systems, 6thEdn, Pearson Education inc., New Delhi, 2001.
4. A Bruce Carlson, PB Crilly, JC Rutledge, Communication Systems – 4thEdn, MGH, New York, 2002.

EC391	Microprocessor Systems	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Develop basic understanding of microprocessor architecture.
CO2	Design Microprocessor and Microcontroller based systems.
CO3	Understand C, C++ and assembly language programming
CO4	Understand concept of interfacing of peripheral devices and their applications

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			1					1	1			
CO2								1				
CO3									1	1		
CO4			1									

Detailed syllabus

Microcomputer Organization:CPU, Memory, I/O, Operating System, Multiprogramming, Multithreading, MS Windows

80386 Micro Processors : Review of 8086,salient features of 80386,Architecture and Signal Description of 80386,Register Organization of 80386,Addressing Modes,80386 Memory management, Protected mode, Segmentation, Paging, Virtual 8086 Mode, Enhanced Instruction set of 80386, the Co- Processor 80387

Pentium & Pentium-pro Microprocessor: Salient features of Pentium microprocessor, Pentium architecture, Special Pentium registers, Instruction Translation look aside buffer and branch Prediction, Rapid Execution module, Memory management, hyper-threading technology, Extended Instruction set in advanced Pentium Processors

Microcontrollers: Overview of micro controllers-8051 family microcontrollers, 80196 microcontrollers family architecture, instruction set, pin out, memory interfacing.

ARM Processor Fundamentals: Registers, current Program Status Registers, Pipeline Exceptions, Interrupts and Vector Table, Architecture Revisions, ARM Processor families, ARM instruction set, Thumb Instruction set-Exceptions Handing, Interrupts, Interrupt Handling schemes, firmware, Embedded operating systems, Caches-cache architecture, Cache policy, Introduction to DSP on the ARM, DSP on the ARM7TDMI,ARM9TDMI.

Case study-Industry Application of Microcontrollers

Reading:

1. Barry B.Brey: Intel Microprocessor Architecture, Programming and Interfacing-8086/8088,80186,80286,80386 and 80486, PHI,1995.
2. Muhammad Ali Mazidi and Mazidi: The 8051 Microcontrollers and Embedded systems, PHI, 2008
3. Intel and ARM Data Books on Microcontrollers.

MM390	Metallurgy For Non-Metallurgists	OPC	3 – 0 – 0	3 Credits

Note: This course is offered for students of other departments

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand the characteristics and usefulness of metals and alloys.
CO2	Differentiate metals and alloys and their fabrication techniques.
CO3	Correlate the microstructure, properties, processing and performance of materials.
CO4	Select metal/alloy for engineering applications.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												

Detailed Syllabus:

Introduction to Metallurgy:

Structure of Metals and Alloys: Nature of Metallic Bonding, Crystal Structures of Metals, Structure of Alloys, Imperfections in Crystals

Mechanical Properties: Plastic Deformation Mechanisms, Tensile, Creep, Fatigue, Fracture

Strengthening Mechanisms: Strain Hardening, Grain Size Refinement, Solid Solution Strengthening, Precipitation Hardening

Discovering Metals: Overview of Metals, Modern Alloy Production

Fabrication and Finishing of metal products: Metal Working and Machining

Testing of Metals: Both Destructive and Non-Destructive, Inspection and Quality Control of Metals

Engineering Alloys: Steel Products and Properties, Cast Irons, Tool Steels and High Speed Steels, Stainless Steels, Nonferrous Metals

Heat Treatment: Annealing, Normalizing, Hardening, Tempering

Corrosion and its Prevention: Electro chemical considerations, Corrosion Rates, Passivity, Environmental Effects, Forms of Corrosion, Corrosion Environments, Oxidation; Durability of Metals and Alloys

The material selection processes: Case studies

Reading:

1. M. F. Ashby: Engineering Metals, 4th Edition, Elsevier, 2005.
2. R. Balasubramaniam (Adapted): Calister's Materials Science and Engineering, 7th Edition, Wiley India (P) Ltd, 2007.
3. Reza Abbaschian, Lara Abbaschian, R E Reed-Hill: Physical Metallurgy Principles, Affiliated East-West Press, 2009.
4. V Raghavan: Elements of Materials Science and Engineering- A First Course, 5th Edition, PHI, 2006

CH390	Nanotechnology and Applications	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the properties of Nano-materials and applications
CO2	Apply chemical engineering principles to Nano-particle production
CO3	Solve the quantum confinement equations.
CO4	Characterize Nano-materials.
CO5	Scale up the production of Nanoparticles for Electronics and Chemical industries.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								2				
CO2			1					1				
CO3								1				
CO4						1		2				
CO5										1		

Detailed Syllabus:

Introduction to Nanotechnology: Introduction to nanotechnology and materials, Nanomaterials, Introduction to nano-sizes and properties comparison with the bulk materials, Different shapes and sizes and morphology.

Fabrication of Nanomaterials: Top Down Approach Grinding, Planetory milling and Comparison of particles, Bottom Up Approach, Wet Chemical Synthesis Methods, Microemulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods, Sonochemical Approach, Microwave and Atomization, Gas phase Production Methods : Chemical Vapour Depositions.

Kinetics at Nanoscale: Nucleation and growth of particles, Issues of Aggregation of Particles, Oswald Ripening, Stearic hindrance, Layers of surface charges, Zeta Potential and pH.

Carbon Nanomaterials: Synthesis of carbon bucky-balls, List of stable carbon allotropes extended, fullerenes, metallofullerenes, solid C_{60}, bucky onions, nanotubes, nanocones

Quantum mechanics: Quantum dots and its Importance, Pauli exclusion principle, Schrödinger's equation, Application of quantum Dots: quantum well, wire, dot, characteristics of quantum dots, Synthesis of quantum dots Semi-conductor quantum dots

Nanomaterials characterization: Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, Zeta potential, Electronic band structure Electron statistics Application: Optical transitions in solids, photonic crystals, Microscopies SEM, TEM, Atomic Forced Microscopy, Scanning and Tunneling Microscopy.

Applications: Self-assembly and molecular manufacturing, Surfactant based system Colloidal system applications, Functional materials Applications, commercial processes of synthesis of nanomaterials.

Nano inroganic materials of $CaCO_3$ synthesis, Hybrid Waste Water Treatments systems, Electronic Nanodevices,

Nanobiology: Biological synthesis of nanoparticles and applications in drug delivery, Nanocontainers and Responsive Release of active agents, Layer by Layer assembly for nanospheres, Safety and health Issues of nano materials, Environmental Impacts, Case Study for Environmental and Societal Impacts

Reading:

1. Kulkarni Sulabha K, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007
2. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
3. Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005.
4. Gabor L. Hornyak , H.F. Tibbals , Joydeep Dutta , John J. Moore Introduction to Nanoscience and Nanotechnology CRC Press
5. Davies, J.H. 'The Physics of Low Dimensional Semiconductors: An Introduction', Cambridge University Press, 1998.

CH391	Industrial Safety and Hazards	OPC	3 – 0 – 0	3 Credits

Prerequisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze the effects of release of toxic substances.
CO2	Select the methods of prevention of fires and explosions.
CO3	Understand the methods of hazard identification and preventive measures.
CO4	Assess the risks using fault tree diagram.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								2				
CO2								1				
CO3							1	1				
CO4								1	1		1	

Detailed syllabus:

Introduction-Safety Programs, Engineering Ethics, Accident and Loss Statistics, Acceptable Risk , Public Perceptions ,The Nature of the Accident Process ,Inherent Safety.

Industrial Hygiene- Anticipation and Identification, Hygiene Evaluation, Hygiene Control.

Toxic Release and Dispersion Models- Parameters Affecting Dispersion, Neutrally Buoyant Dispersion Models, Dense Gas Dispersion, Toxic Effect Criteria, Effect of Release Momentum and Buoyancy, Release Mitigation.

Fires and Explosions- The Fire Triangle, Distinction between Fires and Explosions, Flammability Characteristics of Liquids and Vapors, Limiting Oxygen Concentration and Inerting, Flammability Diagram

Hazards Identification- Process Hazards Checklists, Hazards Surveys, Hazards and Operability Studies, Safety Reviews.

Risk Assessment- Review of Probability Theory, Event Trees, Fault Trees.

Safety Procedures: Process Safety Hierarchy, Managing Safety, Best Practices, Procedures—Operating, Procedures—Permits, Procedures—Safety Reviews and Accident Investigations.

Reading

1. D. A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications), Prentice Hall,2011.
2. R.K. Sinnott, Coulson & Richardson's Chemical Engineering, Vol. 6, Elsevier India, 2006.

CS390	Object Oriented Programming	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand fundamental concepts in object oriented approach.
CO2	Analyze design issues in developing OOP applications.
CO3	Write computer programs to solve real world problems in Java.
CO4	Analyze source code API documentations.
CO5	Create GUI based applications.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										1		1
CO2								1				1
CO3												1
CO4												1
CO5								1		1		1

Detailed Syllabus:

Object- oriented thinking, History of object-oriented programming, overview of java, Object-oriented design, Structure of java program. Types and modifiers, Classes, declaring objects in classes, Methods, constructors, garbage collection, Method overloading, passing objects as parameters, Inheritance, various forms and types of inheritance, Multilevel hierarchy, use of super, method overriding, Applications of method overriding, abstract classes, Packages with examples

Interfaces and implementation, Exception handling, types, throwing, creating own exceptions, Multithreading and concepts, its usage and examples, Input/output streams, String operations and examples, Collection classes-array, stack collection, bitset collection, Utility classes-string tokenizer, bitset, date, Applets- methods, creation, designing and examples, Event handling-event classes, Event listener interfaces, AWT classes, working with frames, AWT controls-layout manager, user interface components, Graphics programming

Reading:

1. Timothy Budd, “Understanding object-oriented programming with Java”, Pearson,
2. Herbert Schildt, “ The complete reference Java 2”, TMH,

BT390	Green Technology	OPC	3 – 0 – 0	3 Credits

Pre-requisites: Chemistry

Course Outcomes: At the end of the course, the student will be able to:

CO1	Address smart energy and green infrastructure
CO2	Build models that simulate sustainable and renewable green technology systems
CO3	Understand the history, global, environmental and economical impacts of green technology
CO4	Address non-renewable energy challenges

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							1	1				
CO2								2				
CO3									1			1
CO4								1		1		

Detailed Syllabus:

Biomass Energy, basic concepts, sources of biomass energy, uses of biomass energy, science and engineering aspects of biomass energy, production of biomass electricity, transmission of biomass electricity, storage of biomass electricity.

Energy transformation from source to services; Energy sources, sun as the source of energy; biological processes; photosynthesis; food chains, classification of energy sources, quality and concentration of energy sources; fossil fuel reserves - estimates, duration; theory of renewability, renewable resources; overview of global/ India's energy scenario.

Environmental effects of energy extraction, conversion and use; sources of pollution from energy technologies, Criteria for choosing appropriate green energy technologies, life cycle cost; the emerging trends – process/product innovation-, technological/ environmental leap-frogging; Eco/green technologies for addressing the problems of Water, Energy, Health, Agriculture and Biodiversity.

First and second laws of thermodynamics and their applications – Thermodynamic processes - Irreversibility of energy – Entropy. Properties of steam and classification of steam engines. Carnot cycle - Rankine cycle, Current energy requirements, growth in future energy requirements, Review of conventional energy resources- Coal, gas and oil reserves and resources, Tar sands and Oil, Shale, Nuclear energy Option.

Biomass fuels, market barriers of biomass fuels, biomass fuel standerdization, biomass fuel life cycle, Sustainability of biomass fuels, economics of biomass fuels, Fuel stoichiometry and analysis: Fuel stoichiometry relations; Estimation of air required for complete combustion; Estimation of minimum amount of air required for a fuel of known composition; Estimation of dry flue gases for known fuel composition; Calculation of the composition of fuel & excess air supplied, from exhaust gas analysis; Dew point of products; Flue gas analysis (O_2, CO_2, CO, NOx, SOx).

Biomass as a major source of energy in India: Fuel-wood use in rural households. Consequences for ecosystems. Future energy scenario in rural areas. Utilization of biomass in industrial and semi-industrial settings. Future utilization of biomass in India. Future of landscape management: optimal management.

Reading:

1. AyhanDemirbas, Green Energy and Technology, Biofuels, Securing the Planet's Future Energy Needs, 1st Edition, Springer, 2009.
2. Jay Cheng, Biomass to Renewable Energy Processes, 1st Edition, CRC press, 2009.
3. Samir K. Khanal, Rao Y. Surampally, 1st edition, American Society of Civil Engineers, 2010.

SM390	Marketing Management	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand concepts and scope of marketing and market oriented strategic planning
CO2	Analyze macro level environment
CO3	Identify factors influencing consumer behavior in competitive global business environment
CO4	Identify tools and techniques for marketing management through integrated marketing communication systems.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									1	1		
CO2										1		
CO3										1	1	
CO4										1		1

Detailed Syllabus:

Importance of Marketing, Scope of Marketing, Core Marketing concepts company orientation towards market place-production concept, Product concept, selling concept and Marketing concept.

Market oriented Strategic planning – Defining corporate Mission and Vision Statement at Corporate level and at Business unit level. Assigning resources to Strategic Business units through B.C.G Matrix and G.E Model.

Analyzing Macro environment-Demographic environment. Economic Environment, Technical Environment, Social-Cultural Environment and political – Legal Environment.

Components of Marketing information systems- Internal Records, Marketing intelligence, Marketing research and Marketing Decision support system.

Consumer Behavior- Buying Decision process and the factors influencing consumer Behavior- Psychological factors, social factors, cultural factors and personal factors.

Importance of Market segmentation, Target market selection and positioning.

Importance of new product development process and the various stages involved.

The concept of product lifecycle and the various strategies used by the marketer in each stage.

Product characteristics and classification, Product mix and product line decisions Branding Decisions, Building Brand Equity.

Importance of Pricing, Factors influencing pricing decisions. Various pricing methods-cost based and demand based methods.

Role of Marketing channels-Channel functions and channel levels channel Design and channel Management Decisions, Managing Retailing. Wholesaling and logistics. Importance of Electronic channels.

Importance of integrated Marketing communication. Advantages and Disadvantages of Various promotional tools- Advertising, Sales promotion, personal selling, publicity and public Relations and Direct marketing.

Reading:

1. Philip Kotler, Marketing Management, PHI, 14th Edition, 2013.
2. William Stonton&Etzel, Marketing Management, TMH, 13th Edition, 2013.
3. Rama Swamy&Namakumari, Marketing Management, McMillan, 2013.

MA390	Numerical Solution of Differential Equations	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Solve nonlinear differential equations by numerical methods.
CO2	Determine the convergence region for a finite difference method.
CO3	Solve elliptic PDE by finite difference method
CO4	Solve a parabolic PDE by finite difference method
CO5	Solve a hyperbolic PDE by finite difference method

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			1									
CO2			1									
CO3			1									
CO4			1									
CO5			1									

Detailed Syllabus:

Ordinary Differential Equations: Multistep (explicit and implicit) methods for initial value problems, Stability and Convergence analysis, Linear and nonlinear boundary value problems, Quasi-linearization, Shooting methods

Finite difference methods: Finite difference approximations for derivatives, boundary value problems with explicit boundary conditions, implicit boundary conditions, error analysis, stability analysis, convergence analysis.

Partial Differential Equations: Classification of partial differential equations, finite difference approximations for partial derivatives and finite difference schemes for Parabolic equations, Schmidt's two level, multilevel explicit methods, Crank-Nicolson's two level, multilevel implicit methods, Dirichlet's problem, Neumann problem, mixed boundary value problem, stability analysis.

Hyperbolic Equations: Explicit methods, implicit methods, one space dimension, two space dimensions, ADI methods.

Elliptic equations: Laplace equation, Poisson equation, iterative schemes, Dirichlet's problem, Neumann problem, mixed boundary value problem, ADI methods.

Reading:

1. M.K. Jain, Numerical Solution of Differential Equations, Wiley Eastern, 1984.
2. G.D. Smith, Numerical Solution of Partial Differential Equations, Oxford Univ. Press, 2004.
3. M.K.Jain, S.R.K. Iyengar and R.K. Jain, Computational Methods for Partial Differential Equations, Wiley Eastern, 2005.

MA391	Fuzzy Mathematics and Applications	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Apply operations on Fuzzy sets
CO2	Solve problems related to Propositional Logic.
CO3	Apply Fuzzy relations to cylindric extensions.
CO4	Apply logic of Boolean Algebra to switching circuits.
CO5	Develop Fuzzy logic controllers

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			1					1				
CO2			1					1				
CO3			1					1				
CO4			1			1		1				
CO5			1					1				

Detailed Syllabus:

Crisp set theory (CST): Introduction, Relations between sets, Operations on sets, Characteristic functions, Cartesian products of crisp sets, crisp relations on sets.

Fuzzy set theory (FST): Introduction, concept of fuzzy set (FS), Relation between FS, operations on FS, properties of standard operations, certain numbers associated with a FS, certain crisp sets associated with FS, Certain FS associated with given FS, Extension principle.

Propositional Logic (PL1): Introduction, Syntax of PL1, Semantics of PL1, certain properties satisfied by connectives, inference rules, Derivation, Resolution.

Predicate Logic (PL2): Introduction, Syntax of PL2, Semantics of PL2, certain properties satisfied by connectives and quantifiers, inference rules, Derivation, Resolution

Fuzzy Relations (FR): Introduction, Operations on FR, □-cuts of FR, Composition of FR, Projections of FR, Cylindric extensions, Cylindric closure, FR on a domain.

Fuzzy Logic (FL): Introduction, Three-valued logics, N-valued logics and infinite valued logics, Fuzzy logics, Fuzzy propositions and their interpretations in terms of fuzzy sets, Fuzzy rules and their interpretations in terms of FR, fuzzy inference, More on fuzzy inference, Generalizations of FL.

Switching functions (SF) and Switching circuits (SC): Introduction, SF, Disjunctive normal form, SC, Relation between SF and SC, Equivalence and simplification of circuits, Introduction of Boolean Algebra BA, Identification, Complete Disjunctive normal form.

Applications: Introduction to fuzzy logic controller (FLC), Fuzzy expert systems, classical control theory versus fuzzy control, examples, working of FLC through examples, Details of FLC, Mathematical formulation of FLC, Introduction of fuzzy methods in decision making.

Reading:

1. M. Ganesh, Introduction to Fuzzy Sets and Fuzzy Logic, PHI, 2001.
2. G.J. Klir and B.Yuan, Fuzzy sets and Fuzzy Logic–Theory and Applications, PHI, 1997.
3. T. J. Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 1995.

PH390	Medical Instrumentation	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the origin of bio-potentials and their physical significance.
CO2	Understand anatomy and functioning of human heart and its common problems.
CO3	Analyze ECG, ENG and EMG signals and instrumentation.
CO4	Compare different techniques of measuring blood pressure, blood flow and volume.
CO5	Interpret the principle and operation of therapeutic and prosthetic devices.
CO6	Differentiate between the various techniques for measurement of parameters.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1				
CO2								1				
CO3								1				
CO4								1				
CO5							1	1				
CO6								1				

Detailed Syllabus:

General Introduction: The cell, body fluids, Musculoskeletal system, respiratory system, gastrointestinal system, Nervous system, endocrine system and circulatory system.

Origin of Bio potentials: electrical activity of Excitable cells: the resting state, The active state, Volume conductor fields, Functional organization of the peripheral nervous system: Reflex are &Junctional transmission.

The Electroneurogram (ENG): The H-Reflex, The Electromyogram (EMG), The Electrocardiogram (ECG), heart and the circulatory system, Electro conduction system of the heart and heart problems, ECG waveform and Physical significance of its wave features, Electrical behavior of cardiac cells, The standard lead system, The ECG preamplifier, DC ECG Amplier, Defibrillator protection circuit, Electro surgery Unit filtering, Functional blocks of ECG system, Multichannel physiological monitoring system, Common problems encountered and remedial techniques.

Blood Pressure: indirect measurement of blood pressure, korotkoff sounds, auscultatory method using sphygmo manometer, Oscillometric and ultrasonic non invasive pressure measurement, Direct measurement of blood pressure H2O manometers, electronic manometry, Pressure transducers,. Pressure amplifier designs, Systolic, diastolic mean detector circuits

Blood flow and Volume Measurement: indicator dilution methods, Transit time flow meter, DC flow meter, Electromagnetic flow meter AC electromagnetic flow meter, Quadrature suppression flow meter, Ultrasonic flow meter, Continuous-wave Doppler flow meter, Electric impedance plethysmography, chamber plethysmography, Photo plethysmography.

Pulse Oximetr: Principles of Operation, Absorption Spectrum, Sensor design, Pulse oximeter, Therapeutic and Prosthetic Devices.

Cardiac Pacemakers: Lead wires and electrodes, Synchronous Pacemakers, rate responsive pacemaking, Defibrillators, cardioverters, Electrosurgical unit, Therapeutic applications of laser, LithotripsyHaemodialysis.

Reading:

1. John G Webster, Medical Instrumentation: Application and Design , John Wiley,3rd Ed. 2012.
2. Joseph J. Carr & John M. Brown , Introduction to biomedical Equipment Technology, 4th Ed., Prentice Hall India, 2001

PH391	Advanced Materials	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the synthesis and properties of nanomaterials
CO2	Evaluate the usefulness of nanomaterials in medicine, biology and sensing
CO3	Understand modeling of composite materials by finite element analysis
CO4	Differentiate superconducting materials
CO5	Understand the characteristics and uses of functional materials

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			1					1				
CO2								1				
CO3			1									
CO4								1	1			
CO5								1	1			

Detailed Syllabus:

Nano Materials: Origin of nano technology, Classification of nano materials, Physical, chemical, electrical, mechanical properties of nano materials. Preparation of nano materials by plasma arcing, physical vapour deposition, chemical vapour deposition (CVD), Sol-Gel, electro deposition, ball milling, carbon nano tubes(CNT).Synthesis, preparation of nanotubes, nano sensors, Quantum dots, nanowires,nano biology, nanomedidcines.

Biomaterials: Overview of biomaterials. Biomaterials, bioceramics, biopolymers, tissue grafts, soft tissue applications, cardiovascular implants, biomaterials in ophthalmology, orthopeadiac implants, dental materials.

Composites: General characteristics of composites , composites classes, PMCs, MMCs, CMCs, CCCs, IMCs, hybrid composites, fibers and matrices, different types of fibers, whiskers, different matrices materials, polymers, metal, ceramic matrices, toughening mechanism, interfaces, blending and adhesion, composite modeling, finite element analysis and design.

Optical materials: Mechanisms of optical absorption in metals, semiconductors and insulators. Nonlinear optical materials, optical modulators, optical fibers. Display devices and materials photo-emissive, photovoltaic cells, charge coupled devices(CCD), laser materials.

Super conducting materials: Types of super conductors, an account of mechanism of superconductors, effects of magnetic field currents, thermal energy, energy gap, acoustic attenuation, penetration depth, BCS theory, DC and AC Josephson effects, high Tc superconductors, potential applications of superconductivity, electrical switching element, superconductor power transmission and transformers, magnetic mirror, bearings, superconductor motors, generators, SQUIDS etc.

Smart materials: An introduction, principles of smart materials, input – output decision ability, devices based on conductivity changes, devices based on changes in optical response, biological systems smart materials. Devices based on magnetization, artificial structures, surfaces, hetero structures, polycrystalline, amorphous, liquid crystalline materials.

Surface Acoustic Wave (SAW) Materials and Electrets: Delay lines, frequency filters, resonators, Pressure and temperature sensors, Sonar transducers. Comparison of electrets with permanent magnets, Preparation of electrets, Application of electrets..

Reading:

1. T.Pradeep, Nano: The Essentials; TaTa McGraw-Hill,2008.
2. B.S. Murthy et al., Textbook of Nano science and Nanotechnology, University press
3. Krishan K Chawla, Composite Materials; 2nd Ed., Springer 2006.

CY390	Instrumental Methods In Chemical Analysis	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Characterize materials using ultraviolet and visible absorption and fluorescence techniques
CO2	Analyze materials, minerals and trace samples using atomic absorption, emission and X-ray fluorescence techniques
CO3	Analyze environmental, industrial, production-line materials by liquid, gas and size-exclusion chromatographic techniques.
CO4	Characterize interfaces and traces of surface adsorbed materials using electro-analytical techniques
CO5	Understand principles of thermogravimetry and differential thermal analyses.
CO6	Characterize chemical, inorganic and engineering materials using analytical techniques

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1							1				
CO2	1							1				
CO3							1	1				
CO4					1		1	1				
CO5						1		1				
CO6			1									

Detailed Syllabus:

UV-Visible Spectrophotometry and FluorescenceBeer-Lambert's law, limitations, Molecular fluorescence, influencing factors, basic instruments, standardization, quantitative methods, applications.

Atomic spectrometry, atomic absorption, X-ray fluorescence methods Flame atomic emission and absorption, flame emission photometer, flame absorption spectrometer, spectral interferences, quantitative aspects, X-ray fluorescence principle, Instrumentation, quantitative analysis.

Separation techniquesSolvent extraction, Principle, Extraction of solutes, Soxhlet extraction

Chromatography methods Gas chromatography, High performance liquid chromatography, Size exclusion chromatography, Principle, Basic instrumentation, Capillary Electrophoresis: Principle and application.

Thermoanalytical methods Thermogravimetry, Differential thermal analysis, differential scanning calorimetry, Principle, Block diagram, Applications, Quantitative determinations.

ElectroanalyticalmethodsCoulometric methods, Polarography, Pulse voltammetric methods, Amperometry, Principles, Applications, Electrochemical sensors, Ion selective, Potentiometric and amperometric sensors, Applications.

Spectroscopic methodsMolecular absorption, Woodward rules, applications, Infra red absorption, functional group analysis, qualitative analysis, 1H- and 13C-NMR spectroscopy, Principle, Basic instrumentation, terminology, Interpretation of data, Quantitative applications.

Mass spectrometryPrinciples, Instrumentation, Ionization techniques, Characterization and applications.

Reading:

1. Mendham, Denny, Barnesand Thomas, Vogel: Text book of Quantitative Chemical Analysis, Pearson Education, 6th Edition, 2007.
2. Skoog, Holler and Kouch, Thomson, Instrumental methods of chemical analysis, 2007.
3. Willard, Meritt and Dean, Instrumental methods of chemical analysis, PHI, 2005.

CY391	Chemical Aspects of Energy Systems	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand traditional and alternative forms of energy
CO2	Understand energy production, storage, distribution and utilization.
CO3	Model environmental impacts of energy generation and conservation
CO4	Apply concepts of engineering design to energy challenges

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		1										
CO2		1										
CO3		1	1					1				
CO4								1	1			

Detailed Syllabus:

Unit I: THERMOCHEMISTRY AND CHEMICAL KINETICS OF ENERGY SOURCES:

Chemistry of Fuels and Characteristics of a Good Fuel; Heats of Combustion of Fuels; Determination of Heats of Combustion by Bomb Calorimetry and Differential Scanning Calorimetry; Thermodynamics of Electrochemical Cells; Determination of Various Thermochemical Functions of Energy Materials by Electroanalytical Methods (Potentiometry, Coulometry and Voltammetry)

Rates of Combustion Processes; Determination of Ignition Point, Flash Point and Other Kinetic Parameters of Chemical Energy Sources

Unit-II: CHEMISTRY OF CONVENTIONAL AND NON-CONVENTIONAL ENERGY MATERIALS:

Chemical Composition of Finite Energy materials (Petroleum Products, Petroleum Refinery, Fractional Distillation and Petroleum Cracking; Natural Gas, Water Gas, Biomass and Goober Gas; Hydrogen as a Fuel and Its Controlled Combustion; Coal Carbonization and Gasification; Pulverization of Cellulose and Firewood

UNIT -III: ELECTROCHEMICAL ENERGY SYSTEMS:

Primary and Secondary batteries, Reserve batteries, Solid state and molten solvent batteries, Recent technological trends, Lithium ion batteries, Nanostructured electrode materials, Lithium and carbon based nanomaterials and nanocomposites, Solid-state Lithium ion batteries, Energy storage and backup. Fuel cells, Scientific prospects of fuel cells, Electrochemistry, In-situ and ex-situ electrochemical characterizations, Current-Voltage measurement, Current Interrupt measurements, Porosity, BET surface area analysis, Gas permeability, Hydrogen as future fuel, Alkaline-, acid- and molten carbonate-fuel cells, Solid oxide fuel cells.

UNIT-IV: SOLAR ENERGY HARNESSING:

Fundamentals, Conversion into electrical energy, Photovoltaic and Photogalvanic energy storage, Semiconductor photoelectrochemical cells, Photoelectrochemical reactions, Regenerative photoelectrochemical cells, Basic problems, Photocorrosion and protection of semiconductor electrodes, Protective coatings, Coatings of metals and electrically conductive polymers, Electrodes with chemically modified surfaces.

UNIT-V: PHOTOCHEMICAL AND PHOTOELECTROCHEMICAL CLEAVAGE OF WATER:

Photochemistry and Photocatalysis of Splitting of Water Molecule; Chemically Modified Electrodes for Water Cleavage; Coordination Chemistry of Water Cleavage

UNIT-VI: ENVIRONMENTAL CONCERNS AND GREEN METHODS OF ENERGY SOURCES:

Quality of Chemical Energy Sources; Pollution Control and Monitoring of Energy Extraction from Materials; Nanochemical Methods in Energy Extraction; Modeling of Combustion and Other Energy Tapping from Materials

Reading:

1. TokioOhta, Energy Systems, Elsevier Science, 2000.
2. R. Narayan and B. Viswanathan, Chemical and Electrochemical Energy Systems, Universities Press, 1998

HS390	Soft Skills	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand corporate communication culture
CO2	Prepare business reports and proposals expected of a corporate professional
CO3	Employ appropriate speech in formal business situations
CO4	Exhibit corporate social responsibility and ethics
CO5	Acquire corporate email, mobile and telephone etiquette

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										1		1
CO2										1		
CO3										1		2
CO4											2	
CO5										1		2

Detailed Syllabus:

English Language Enhancement: Verbs and tenses, Phrasal verbs, Synonyms, Antonyms, Homonyms - Descriptive Words, Combining Sentences, Business Idioms, Indianisms in English.

Art of Communication, Communication process- Non-verbal Communication- Effective Listening.

Interpersonal and Intra Personal Communication Skills- Self-Awareness- Self-Esteem and Confidence- Assertiveness and Confidence- Dealing with Emotions-Team Concept- Elements of Teamwork- Stages of Team Formation- Effective Team-Team Player Styles-Leadership.

Campus to Company- Dressing and Grooming- The Corporate Fit- Business Etiquette- Communication; media etiquette- Group Discussions, Interviews, and Presentation Skills.

Interview Handling skills- Effective Resume-- Common Interview Mistakes- Body-language- Content Aid, Visual Aids- Entrepreneurial Skills Development.

Reading:

1. Robert M. Sherfield, Developing Soft Skills, Montgomery and Moody Fourth Edn. Pearson, 2009.
2. K.Alex, Soft Skills: Know Yourself & Know The world, S. Chand; 2009.
3. Robert Bramson, Coping with Difficult People, Dell, 2009

CE440	Building Technology	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Apply basic principles to develop stable, sustainable and cost-effective building plans.
CO2	Identify effective measures for fire proofing, damp proofing, and thermal insulation.
CO3	Adopt standard building provisions for natural ventilation and lighting.
CO4	Identify different materials, quality and methods of fabrication & construction.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1	1			
CO2								1	1			
CO3								1				
CO4				1	1		1	1	1			

Detailed Syllabus:

Overview of the course, basic definitions, Buildings – Types, components, economy and design, Principles of planning of buildings and their importance.

Definitions and importance of Grouping and circulation; Lighting and ventilation; How to consider these aspects during planning of building

Termite proofing: Inspection, control measures and precautions, Lighting protection of buildings: General principles of design of openings, Various types of fire protection measures to be considered while planning a building.

General requirements and extra requirements for safety against fire, special precautions, Vertical transportation in building – types of vertical transportation, Stairs, different forms of stairs, planning of stair cases, Other modes of vertical transportation – lifts, ramps, escalators.

Prefabrication systems in residential buildings – walls, openings, cupboards, shelves etc., planning and modules and sizes of components in prefabrication.

Planning and designing of residential buildings against the earthquake forces, Principles, Seismic forces and their effect on buildings.

Air conditioning – process and classification of air conditioning, Dehumidification. Systems of air-conditioning, ventilation, functional requirements of ventilation.

Acoustics, effect of noise, properties of noise and its measurements, Principles of acoustics of building. Sound insulation – importance and measures.

Plumbing services – water supply system, maintenance of building pipe line, Sanitary fittings, principles governing design of building drainage.

Reading:

1. Building Construction - Varghese, PHI Learning Private Limited, 2008
2. Building Construction - Punmia, B C, Jain, A J and Jain A J, Laxmi Publications, 2005.
3. Building Construction by S.P. Arora and S.P. Bindra – Dhanpatrai and Sons, New Delhi, 1996.
4. Building Construction – Technical Teachers Training Institute, Madras, Tata McGraw Hill, 1992.
5. National Building code of India, Bureau of Indian Standards, 2005.

EE 440	New Venture Creation	OPC	3–0– 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the process and practice of entrepreneurship and new venture creation
CO2	Understand conceptual frameworks for identifying entrepreneurial opportunities and for preparation of business plan
CO3	Explore opportunities for launching a new venture
CO4	Identify functional management issues of running a new venture

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										1		
CO2										1		
CO3										1		
CO4										1	1	1

Detailed syllabus:

ENTREPRENEUR AND ENTREPRENEURSHIP:

Entrepreneurship and Small Scale Enterprises (SSE) – Role in Economic Development, Entrepreneurial Competencies, Institution Interface for SSE.

ESTABLISHING THE SMALL SCALE ENTERPRISE:

Opportunity Scanning and Identification, Market Assessment for SSE, Choice of Technology and Selection of Site, Financing the New/Small Enterprises, Preparation of the Business Plan, Ownership Structures and Organizational Framework.

OPERATING THE SMALL SCALE ENTERPRISES:

Financial Management Issues in SSE, Operational Management Issues in SSE, Marketing Management Issues in SSE, Organizational Relations in SSE.

Reading:

1. Kuratko: New Venture Management : The Entrepreneur's Roadmap, Pearson Education India, 2008.
2. Holt, "Entrepreneurship: New Venture Creation", PHI(P), Ltd.,2001.
3. Lisa K. Gundry, Jill R. Kickul: Entrepreneurship Strategy: Changing Patterns in New Venture Creation, Growth, and Reinvention, Sage Publications, 2007.

ME440	Alternative Sources of Energy	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify renewable energy sources and their utilization.
CO2	Understand basic concepts of solar radiation and analyze solar thermal systems for its utilization.
CO3	Understand working of solar cells and its modern manufacturing technologies.
CO4	Understand concepts of Fuel cells and their applications
CO5	Identify methods of energy storage.
CO6	Compare energy utilization from wind energy, geothermal energy, biomass, biogas and hydrogen.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1				
CO2								1				
CO3								1	1			
CO4								1				
CO5								1				
CO6									1			

Detailed Syllabus:

Introduction: Overview of the course; Examination and Evaluation patterns; Global warming; Introduction to Renewable Energy Technologies

Energy Storage: Introduction; Necessity of Energy Storage; Energy Storage Methods

Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data

Solar Thermal systems: Introduction; Basics of thermodynamics and heat transfer; Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar cooker; Solar refrigeration and air conditioning; Thermal energy storage systems

Solar Photovoltaic systems: Introduction; Solar cell Fundamentals; Characteristics and classification; Solar cell: Module, panel and Array construction; Photovoltaic thermal systems.

Wind Energy: Introduction; Origin and nature of winds; Wind turbine siting; Basics of fluid mechanics; Wind turbine aerodynamics; wind turbine types and their construction; Wind energy conversion systems

Fuel cells: Overview; Classification of fuel cells; operating principles; Fuel cell thermodynamics

Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies; Urban waste to energy conversion; Biomass gasification.

Other forms of Energy: Introduction: Nuclear, ocean and geothermal energy applications; Origin and their types; Working principles

Reading:

1. Sukhatme S.P. and J.K.Nayak, Solar Energy - Principles of Thermal Collection and Storage, Tata McGraw Hill, New Delhi, 2008.
2. Khan B.H., Non-Conventional Energy Resources,Tata McGraw Hill, New Delhi, 2006.
3. J.A. Duffie and W.A. Beckman, Solar Energy - Thermal Pro

EC440	Electronic Measurements and Instrumentaion	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Apply knowledge of instruments for effective use
CO2	Select suitable instruments for typical measurements.
CO3	Identify various transducers to measure strain, temperature and displacement.
CO4	Understand data acquisition system and general purpose interfacing bus.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			1					1				
CO2			1	1				1				
CO3			1	1	1			1				
CO4						1		1				

Detailed syllabus

Measurement And Error:Sensitivity, Resolution, Accuracy and precision, Absolute and Relative types of errors, Statistical analysis, Probability of and Limiting errors, Linearity.

Instruments:D'Arsonval movement and basic principles of Measurement of Voltage, Current and Resistance in instruments. Analog and Digital Multimeters, Measurement of time and Frequency – Digital Frequency Meter and applications.

Impedance Measurement:KelvinBridge;Megger; Maxwell, Hay and Shering Bridges. Q-meter; Noise and Interference reduction techniques in Measurement Systems.

Oscilloscopes: Block diagram, probes, Deflection amplifier and delay line, Trigger Generator, Coupling, Automatic Time Base and Dual Trace Oscilloscopes, Pulse Measurements, Delayed Time Base, Analog Storage, Sampling and Digital Storage Oscilloscopes.

Special instruments: Wave Analyzer, Harmonic Distortion Analyzer, Spectrum Analyzer, FFT Analyzer.

Transducers (Qualitative Treatment Only):Classification and selection of Transducers, Introduction to strain, Load, force, Displacement, Velocity, Acceleration, Pressure and Temperature Measurements.

Introduction to Data Acquisition Systems (DAS): Block Diagram, Specifications and various components of DAS.

General purpose Instrumentation Bus (GP-IB): Protocol, SCPI Commands and Applications to DSO and DMM.

Reading:

1. Oliver and Cage, Electronic Measurements and Instrumentation, McGraw Hill, 2009
2. Helfrick Albert D. and Cooper William D., Electronic Instrumentation & Measurement Techniques, PHI, 2008.
3. D.A. Bell, Electronic Instrumentation and Measurements, 3/e, Oxford, 2013.

MM440	Materials for Engineering Applications	OPC	3 – 0 – 0	3 Credits

Note: This course is offered for students of other departments

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Correlate processing, microstructure and properties of materials.
CO2	Understand behaviour of materials under various conditions.
CO3	Characterize modes of failure of engineering materials and design new materials with better properties and cost effective processes.
CO4	Identify suitable materials for engineering applications.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												

Detailed Syllabus:

Materials Science and Engineering Materials, Classification of Materials and Properties: Mechanical, Dielectric, Magnetic and Thermal

Metallurgical Aspects of Materials: Structure of Metals and Alloys, Nature of Metallic Bonding, Crystal Structures of Metals, Structure of Alloys, Imperfections in Crystals, Significance of microstructural features

Heat Treatment: effect of cooling and heating rates and ageing materials for mechanical load bearing applications

Corrosion Resistant Materials: Some important Metals, Alloys, Ceramics and Polymers

Materials for Electrical Applications: Conductors, Dielectrics, insulators

Materials for Civil Engineering Applications

Materials for Biomedical applications: Steels, Ti and its alloys, Ni-Ti alloys, bioceramics, porous ceramics, bioactive glasses, calcium phosphates, collagen, thin films, grafts and coatings, biological functional materials Latex products

Reading:

1. M.F. Ashby: Engineering Materials, 4th Edition, Elsevier, 2005.
2. M.F. Ashby: Materials Selection in Mechanical Design, B H, 2005.
3. ASM Publication Vol. 20, Materials Selection and Design, ASM, 1997
4. Pat L. Mangonon: The Principles of Materials Selection and Design, PHI, 1999.

CH440	Industrial Pollution Control	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Analyze the effects of pollutants on the environment.
CO2	Understand meteorological aspects of air pollution
CO3	Understand air pollution control methods
CO4	Select treatment technologies for water/wastewater/solid waste.
CO5	Design unit operations for pollution control.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1				
CO2							1	1				
CO3								1				
CO4								1	1			
CO6									1			

Detailed Syllabus:

Introduction: Biosphere, hydrological cycle, nutrient cycle, consequences of population growth, pollution of air, water and soil.

Air pollution sources & effects: Classification and properties of air pollutants, emission sources, behavior and fate of air pollutants, effect of air pollution.

Meteorological aspects of air pollutant dispersion: Temperature lapse rates and stability, wind velocity and turbulence, plume behavior, dispersion of air pollutants, estimation of plume rise.

Air pollution sampling and measurement: Types of pollutant sampling and measurement, ambient air sampling, stack sampling, analysis of air pollutants.

Air pollution control methods & equipment: Control methods, source correction methods, cleaning of gaseous effluents, particulate emission control, selection of a particulate collector, control of gaseous emissions, design methods for control equipment.

Water pollution: Water resources, origin of wastewater, types of water pollutants and there effects.

Waste water sampling, Analysis and Treatment: Sampling, methods of analysis, determination of organic matter, determination of inorganic substances, physical characteristics, bacteriological measurement, basic processes of water treatment, primary treatment, secondary treatment, advanced wastewater treatment, recovery of materials from process effluents.

Solid Waste Management: Sources and classification, public health aspects, methods of collection, disposal Methods, potential methods of disposal.

Hazardous Waste Management: Definition and sources, hazardous waste classification, treatment methods, disposal methods.

Reading:

1. Rao C.S. – Environmental Pollution Control Engineering- Wiley Eastern Limited, India, 1993.
2. Noel de Nevers- Air Pollution and Control Engineering- McGraw Hill, 2000.
3. Glynn Henry J. and Gary W. Heinke - Environmental Science and Engineering, 2^{nd} Edition, Prentice Hall of India, 2004.
4. Rao M.N. and Rao H.V.N - Air Pollution, Tata – McGraw Hill Publishing Ltd., 1993.
5. De A.K - Environmental Chemistry, Tata – McGraw Hill Publishing Ltd., 1999.

CH441	Fuel Cell Technology	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand fuel cell fundamentals.
CO2	Analyze the performance of fuel cell systems.
CO3	Understand construction and operation of fuel cell stack and fuel cell system.
CO4	Apply the modeling techniques for fuel cell systems

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1				
CO2			1	1				1				
CO3								1				
CO4			1						1			

Detailed syllabus

Overview of Fuel Cells: What is a fuel cell, brief history, classification, how does it work, why do we need fuel cells, Fuel cell basic chemistry and thermodynamics, heat of reaction, theoretical electrical work and potential, theoretical fuel cell efficiency.

Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels, effect of impurities such as CO, S and others.

Fuel cell electrochemistry: electrode kinetics, types of voltage losses, polarization curve, fuel cell efficiency, Tafel equation, exchange currents.

Fuel cell process design: Main PEM fuel cell components, materials, properties and processes: membrane, electrode, gas diffusion layer, bi-polar plates, Fuel cell operating conditions: pressure, temperature, flow rates, humidity.

Main components of solid-oxide fuel cells, Cell stack and designs, Electrode polarization, testing of electrodes, cells and short stacks, Cell, stack and system modeling

Fuel processing: Direct and in-direct internal reforming, Reformation of hydrocarbons by steam, CO_2 and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, carbon decomposition, Sulphur tolerance and removal , Using renewable fuels for SOFCs

Reading:

1. GregorHoogers, Fuel Cell Technology Hand Book, CRC Press, 2003.
2. Karl Kordesch& Gunter Simader, Fuel Cells and Their Applications, VCH Publishers, NY, 2001.
3. F. Barbir, PEM Fuel Cells: Theory and Practice (2nd Ed.) Elsevier/Academic Press, 2013.
4. Subhash C. Singal and Kevin Kendall, High Temperature Fuel Cells: Fundamentals, Design and Applications

CS440	Management Information Systems	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine key terminologies and concepts including IT, marketing, management, economics, accounting, finance in the major areas of business.
CO2	Design, develop and implement Information Technology solutions for business problems.
CO3	Analysis of computing systems and telecommunication networks for business information systems.
CO4	Understand ethical issues that occur in business, evaluate alternative courses of actions and evaluate the implications of those actions.
CO5	Plan projects, work in team settings and deliver project outcomes in time.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										1		1
CO2										1	1	
CO3										1		
CO4											3	
CO5										3		

Detailed syllabus

Organization and Information Systems, Foundation Concepts, Information Systems in Business, The Components of Information Systems, Competing with Information Technology, Fundamentals of Strategic Advantage, Using Information Technology for Strategic Advantage.

Changing Environment and its impact on Business, Kinds of Information Systems.

Computer Fundamentals, Computer Hardware, Computer Systems: End User and Enterprise Computing, Computer Peripherals: Input, Output, and Storage Technologies, Computer Software, Application Software, System Software, Computer System Management, Data Resource Management, Technical Foundations of Database Management, Managing Data Resources

Telecommunication and Networks, Telecommunications and Networks, The Networked Enterprise, Telecommunications Network Alternatives

System Analysis and Development and Models, Developing Business/IT Strategies, Planning Fundamentals, Implementation Challenges, Developing Business/IT Solutions, Developing Business Systems, Implementing Business Systems

Manufacturing and Service Systems Information systems for Accounting, Finance, Production and Manufacturing, Marketing and HRM functions, Enterprise Resources Planning (ERP), Choice of IT, Nature of IT decision, Managing Information Technology, Managing Global IT,

Security and Ethical Challenges, Security and Ethical Challenges, Security and Ethical, and Societal Challenges of IT, Security Management of Information Technology, Enterprise and Global Management of Information Technology

Reading:

1. Kenneth J Laudon, Jane P. Laudon, *Management Information Systems*, 10th Edition, Pearson/PHI, 2007.
2. W. S. Jawadekar, *Management Information Systems*, 3rd Edition, TMH, 2004.

BT440	Biosensors	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand biosensing and transducing techniques
CO2	Understand principles of linking cell components and biological pathways with energy transduction, sensing and detection
CO3	Demonstrate appreciation for the technical limits of performance of biosensor
CO4	Apply principles of engineering to develop bioanalytical devices and design of biosensors

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1				
CO2								1				
CO3				1				1				
CO4						1		1	1			

Detailed Syllabus:

General principles: A historical perspective; Signal transduction; Physico-chemical and biological transducers; Sensor types and technologies, Definitions and Concepts Terminology and working vocabulary; Main technical definitions: calibration, selectivity, sensitivity, reproducibility, detection limits, response time.

Physico-chemical transducers: Electrochemical transducers (amperometric, potentiometric, conductimetric); optical transducers (absorption, fluorescence, SPR); Thermal transducers; Piezoelectric transducers.

Biorecognition systems: Enzymes; Oligonucleotides and Nucleic Acids; Lipids (Langmuir-Blodgett bilayers, Phospholipids, Liposomes); Membrane receptors and transporters; Tissue and organelles (animal and plant tissue); Cell culture; Immunoreceptors; Chemoreceptors; Limitations & problems. Immobilization of biomolecules.

Biosensor Engineering: Methods for biosensors fabrication: self-assembled monolayers, screen printing, photolithography, micro-contact printing, MEMS. Engineering concepts for mass production.

Application of modern sensor technologies: Clinical chemistry; Test-strips for glucose monitoring; Urea determination; Implantable sensors for long-term monitoring; Environmental monitoring; Technological process control; Food quality control; Forensic science benefits; Problems & limitations.

Reading:

1. Donald G. Buerk, Biosensors: Theory and Applications, 1st Edition, CRC Press, 2009.
2. Alice Cunningham, Introduction to Bioanalytical Sensors, John Wiley& Sons, 1998.
3. Brian R. Eggins, Chemical Sensors and Biosensors, John Wiley& Sons, 2003.

SM440	Human Resource Management	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand principles, processes and practices of human resource management.
CO2	Apply HR concepts and techniques in strategic planning to improve organizational performance.
CO3	Understand tools to manage HR systems and procedures.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										1	1	
CO2										1		1
CO3										2		

Detailed Syllabus:

Introduction to Human Resource Management, Objectives, Scope and Significance of HRM, Functions of HRM, Problems and Prospects in HRM, Environmental scanning.

Human Resource Planning, Demand Forecasting Techniques, Supply Forecasting Techniques,

Analyzing work and designing jobs, Recruitment and Selection, Interviewing Candidates.

Human Resource Development, Orientation, Training and Development, Management Development, Performance Appraisal and Employee Compensation, Factors Influencing Employee Remuneration and Challenges of Remuneration.

Industrial Relations, Industrial Disputes and Discipline, Managing Ethical Issues in Human Resource Management, Workers Participation in Management, Employee safety and health, Managing Global Human Resources and Trade Unions

International HRM, Future of HRM and Human Resource Information Systems

Reading:

1. Aswathappa, Human Resource Management — TMH., 2010.
2. Garry Dessler and BijuVarkkey ,Human Resource Management, PEA., 2011.
3. Noe&Raymond ,HRM: Gaining a Competitive Advantage, TMH, 2008.
4. Bohlander George W, Snell Scott A, Human Resource Management, Cengage Learning, 2009.

MA440	Optimization Techniques	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Formulate and solve linear Programming Problems
CO2	Determine the optimum solution to constrained and unconstrained problems.
CO3	Apply dynamic programming principle to Linear programming problems.
CO4	Determine the integer solutions to Linear Programming Problems.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									1	1		
CO2										1		
CO3										1		
CO4										1		

Detailed Syllabus:

Linear Programming: Introduction and formulation of models, Convexity, Simplex method, Big-M method, Two-phase method, Degeneracy, non-existent and unbounded solutions, revised simplex method, duality in LPP, dual simplex method, sensitivity analysis, transportation and assignment problems, traveling salesman problem .

Nonlinear Programming: Introduction and formulation of models, Classical optimization methods, equality and inequality constraints, Lagrange multipliers and Kuhn-Tucker conditions, quadratic forms, quadratic programming problem, Wolfe's method.

Dynamic Programming: Principle of optimality, recursive relations, solution of LPP.

Integer Linear Programming: Gomory's cutting plane method, Branch and bound algorithm, Knapsack problem, linear 0-1 problem.

Reading:

1. KantiSwarup, Man Mohan and P.K.Gupta, Introduction to Operations Research, S.Chand& Co., 2006
2. J.C. Pant, Introduction to Operations Research, Jain Brothers, New Delhi, 2008.
3. N.S.Kambo, Mathematical Programming Techniques, East-West Pub., Delhi, 1991.

MA441	Operations Research	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Formulate and solve linear programming problems
CO2	Determine optimum solution to transportation problem
CO3	Determine average queue length and waiting times of queuing models.
CO4	Determine optimum inventory and cost in inventory models.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										1		
CO2										1		
CO3										1		
CO4										1		

Detailed Syllabus:

Linear Programming: Formulation and graphical solution of LPP's. The general LPP, slack, surplus and artificial variables. Reduction of a LPP to the standard form. Simplex computational procedure, Big-M method, Two-phase method. Solution in case of unrestricted variables. Dual linear programming problem. Solution of the primal problem from the solution of the dual problems.

Transportation Problems: Balanced and unbalanced Transportation problems. Initial basic feasible solution using N-W corner rule, row minimum method, column minimum, least cost entry method and Vogel's approximation method. Optimal solutions. Degenracy in Transportation problems.

QueueingTheory: Poisson process and exponential distribution. Poisson queues - Model (M/M/1):(∞/FIFO) and its characteristics.

Elements of Inventory Control : Economic lot size problems - Fundamental problems of EOQ. The problem of EOQ with finite rate of replenishment. Problems of EOQ with shortages - production instantaneous, replenishment of the inventory with finite rate. Stochastic problems with uniform demand (discrete case only).

Reading:

1. KantiSwarup, Man Mohan and P.K.Gupta, Introduction to Operations Research, S. Chand & Co., 2006
2. J.C. Pant, Introduction to Operations Research, Jain Brothers, New Delhi, 2008.
3. N.S.Kambo : Mathematical Programming Techniques, East-West Pub., Delhi, 1991.

PH440	Nanomaterials and Technology	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand synthesis and properties of nanostructured materials.
CO2	Analyze magnetic and electronic properties of quantum dots
CO3	Understand structure, properties and applications of Fullerenes and Carbon nanotubes.
CO4	Understand applications of nanoparticles in nanobiology and nanomedicine

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			1	1		1		1				
CO2								1				
CO3				1				1				
CO4							1	1				

Detailed Syllabus:

General properties of Nano materials : Origin of nanotechnology. Classification of nanomaterials. Fullerene,carbon, Nanotubes (CNT's), Nanoparticles. Physical, Chemical, Electrical, Optical, Magnetic and mechanical properties of nanomaterials.

Fullerenes and Carbon Nanotubes (CNT's): Introduction: Synthesis and purification. Preparation of fullerenes in the condensed phase,Transport, mechanical, physical properties of CNT's.

Investigation and manipulating materials in the Nanoscale: Electron microscope, scanning probe microscopes, optical microscopes for Nanoscience and Technology, X-Ray Diffraction.

SAMs and clusters: Growth process. Patterning monolayers. Types of clusters. Bonding and properties of clusters.

Semi conducting Quantum Dots: Introduction: Synthesis of Quantum Dots. Electronic structure of Nanocrystals, properties.

Nanobiology: Interaction between Biomolecules and Nanoparticle surgaces. Different types of Inorganic materials used for the synthesis of Hybrid Nano-bio assemblies. Nanoprobes for Analytical Applications.

Nanosensors: Nanosensors based on optical properties. Nanosensors based on quantum size effects. Nanobiosensors.

Nanomedicines: Developments of nanomedicines. Nanotechnology in Diagnostic Applications, materials for use in Diagnostic and therapeutic Applications.

Reading:

1. T. Pradeep, Nano: The Essentials; Tata McGraw-Hill, 2008.
2. W.R. Fahrner, Nanotechnology and Nanoelectronics; Springer,2006.
3. Rechard Booker and Earl Boysen, Nanotechnology, Willey, 2006.

PH441	Biomaterials and Technology	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the structure and properties of biomaterials
CO2	Classify implant biomaterials
CO3	Evaluate biocompatibility of implants
CO4	Identify appropriate biomaterials for specific medical applications

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1				
CO2								1				
CO3				1			1	1				
CO4				1		1		1				

Detailed Syllabus:

Overview of biomaterials: Historical developments, impact of biomaterials, interfacial phenomena, tissue responses to implants.

Structure and properties of biomaterials: Crystal structure of solids, phase changes, imperfections in solids, non-crystalline solids, surface properties of solids, mechanical properties, surface improvements.

Types of biomaterials: Metallic implant materials, ceramic implant materials, polymeric implant materials composites as biomaterials.

Characterization of materials: Electric properties, optical properties, X-ray absorption, acoustic and ultrasonic properties.

Bio implantation materials: Materials in ophthalmology, orthopedic implants, dental materials and cardiovascular implant materials.

Tissue response to implants : Normal wound healing processes, body response to implants, blood compatibility, structure – property relationship of tissues.

Reading:

1. Joon Park, R.S. Lakes , Biomaterials an introduction; 3rd Ed., Springer, 2007
2. Sujatha V Bhat ,Biomaterials; 2nd Ed., Narosa Publishing House, 2006.

CY440	Corrosion Science	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the electrochemical Principles of Corrosion.
CO2	Apply eight forms of corrosion to industrial problems.
CO3	Evaluate corrosion rates for industrial problems
CO4	Evaluate the corrosion rates of steel in RCC under corrosive environments.
CO5	Perform case studies using microbially induced corrosion of metals.
CO6	Perform case studies using appropriate methods of corrosion control of metals and alloys

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							1	1				
CO2							2					
CO3			1				2					
CO4							1					
CO5							1	1				
CO6							1					

Detailed Syllabus:

Understanding Corrosion:

Types of corrosion: uniform corrosion, Galvanic corrosion, pitting corrosion, stress corrosion cracking, corrosion fatigue, stray current corrosion, selective leaching, microbial corrosion Pourbaix potential-pH diagrams for iron, for aluminium, limitations of Pourbaix diagram Passivity- characteristics of passivation and the Flade potential, Theories of passivity, passive-active cells, critical pitting potential, Anodic protection and transpassivity.

Methods of corrosion monitoring:

Polarisation and corrosion rates, polarisation diagrams of corroding metals, calculation of corrosion rates from polarization data. Electrochemical impedance spectroscopy: Nyquist plots, Bode plots, simple equivalent circuits for fitting the impedance data, calculation of corrosion parameters from impedance measurements. Electrochemical cell assembly for polarization and impedance studies. Gravimetric method of determination of corrosion rates.

Measurement of corrosion rates of carbon steel in reinforced cement concrete, Corrosion rates of metals due to micriobially induced corrosion .

Methods of corrosion prevention and control:

Cathodic protection; By impressed current, By the use of sacrificial anodes, combined use with coatings, Advances in cathodic protection.

Metallic coatings: Methods of application, Electroplating, Electroless plating, specific metal platings like Cu, Ni and Cr.

Inhibitors and passivators: Picking inhibitors, vapour phase inhibitors, Inhibitors for cooling water systems, understanding of action of inhibitors through polarization and impedance.

Corrosion prevention and control strategies in different industries – case studies

Reading:

1. R. Winston Revie, Herbert H. Uhlig, Corrosion and Corrosion control, 4th edition, Wiley-Interscience, 2007
2. McCafferty and Edward, Introduction to Corrosion Science, 1st Edition, Springer, 2010.
3. Mars G. Fontana, Corrosion Engineering, 3rd edition, Tata McGraw- Hill, New Delhi, 2008.

CY441	Chemistry of Nanomaterials	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the state of art synthesis of nano materials
CO2	Characterize nano materials using ion beam, scanning probe methodologies, position sensitive atom probe and spectroscopic ellipsometry.
CO3	Analyze nanoscale structure in metals, polymers and ceramics
CO4	Analyze structure-property relationship in coarser scale structures
CO5	Understand structures of carbon nano tubes.

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			1	1								
CO2								1				
CO3								1				
CO4								1				
CO5								1				

Detailed Syllabus:

Introduction: Scope of Nano science and nanotechnology, Nano science in nature, classification of nanostructured materials, importance of nano materials.

Synthetic Methods: Chemical Routes (Bottom-Up approach):- Sol-gel synthesis, micro emulsions or reverse micelles, solvothermal synthesis, microwave heating synthesis and sonochemical synthesis. Physical methods (Top-Down approach):- Inert gas condensation, plasma arc technique, ion sputtering, Laser ablation, laser pyrolysis, and chemical vapour deposition method.

Techniques for characterization:

Diffraction Technique: - Powder X-ray diffraction for particle size analysis.

Spectroscopy Techniques: - Operational principle and applications of spectroscopy techniques for the analysis of nanomaterials, UV-VIS spectrophotometers and its application for band gap measurement.

Electron Microscopy Techniques:- Scanning electron microscopy (SEM) and EDAX analysis, transmission electron microscopy (TEM), scanning probe microscopy (SPM).

BET method for surface area determination.

Dynamic light scattering technique for particle size analysis.

Reading:

4. T. Pradeep, NANO: The Essentials: McGraw-Hill, 2007.
5. B. S. Murty, P. Shankar, BaldevRai, BB Rath and James Murday, Textbook of Nanoscience and nanotechnology: Univ. Press, 2012.
6. Guozhong Cao, Nanostructures &Nanomaterials; Synthesis, Properties & Applications: Imperial College Press, 2007.
7. M.A. Shah and Tokeer Ahmad, Principles of Nanoscience and Nanotechnology: Narosa Pub., 2010.
8. ManasiKarkare, Nanotechnology: Fundamentals and Applications: IK International, 2008.
9. C. N. R. Rao, Achim Muller, K.Cheetham, Nanomaterials Chemistry, Wiley-VCH, 2007

HS440	Corporate Communication	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand corporate communication culture
CO2	Prepare business letters, memos and reports
CO3	Communicate effectively in formal business situations
CO4	Exhibit corporate social responsibility and ethics
CO5	Practice corporate email, mobile and telephone etiquette
CO6	Develop good listening skills and leadership qualities

Mapping of course outcomes with program outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										1		
CO2										1		1
CO3										1		1
CO4											2	
CO5										1		1
CO6										2		1

Detailed Syllabus:

Importance of Corporate communication - Introduction to and definition of corporates – Communication, process, patterns and channels of communication- Barriers to communication and strategies to overcome them- Evolution of corporate culture- Role and contribution of individual group and organization - Role of psychology in communication.

Oral Communication- Techniques for improving oral fluency-Speech mechanics-Group Dynamics and Group Discussion – Debate and oral presentations.

Written Communication- Types and purposes- Writing business reports, and business proposals- Memos, minutes of meetings- Circulars, persuasive letters- Letters of complaint- ; language and formats used for drafting different forms of communication. Internal and external communication.

Corporate responsibility- Circulating to employees vision and mission statements- ethical practices- Human rights -Labour rights-Environment- governance- Moral and ethical debates surrounding -Public Relations - Building trust with stakeholders.

Corporate Ethics and Business Etiquette- Integrity in communication-Harmful practices and communication breakdown- Teaching how to deal with tough clients through soft skills. Body language- Grooming- Introducing oneself- Use of polite language- Avoiding grapevine and card pushing – Etiquette in e-mail, mobile and telephone.

Listening Skills - Listening- for information and content- Kinds of listening- Factors affecting listening and techniques to overcome them- retention of facts, data and figures- Role of speaker in listening.

Leadership Communication Styles - Business leadership -Aspects of leadership-qualities of leader- training for leadership-delegation of powers and ways to do it-humour-commitment.

Reading:

1. Raymond V. Lesikar, John D. Pettit, Marie E. FlatleyLesikar's Basic Business Communication - 7th Edition: Irwin, 1993
2. Krishna MohanandMeeraBanerji, Developing Communication Skills: Macmillan Publishers India, 2000
3. R.C. Sharma & Krishna Mohan Business Correspondence and Report Writing: – 3rd Edition Tata McGraw-Hill, 2008
4. Antony Jay & Ross Jay,Effective Presentation, University Press, 1999.
5. Shirley Taylor, Communication for Business, Longman, 1999