JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech. in METALLURGICAL AND MATERIALS ENGINEERING

III YEAR COURSE STRUCTURE AND SYLLABUS (R18)
Applicable From 2018-19 Admitted Batch

III YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	MM501PC	Non-Ferrous Extractive Metallurgy	3	1	0	4
2	MM502PC	Environmental Degradation of Materials	3	1	0	4
3	MM503PC	Mechanical Working of Metals	3	1	0	4
4	SM505MS	Engineering Economics and Accountancy	3	0	0	3
5		Professional Elective - I	3	0	0	3
6	MM504PC	Mechanical Working of metals Lab	0	0	3	1.5
7	MM505PC	Extractive Metallurgy Lab	0	0	3	1.5
8	MM506PC	Environmental Degradation of Materials Lab	0	0	2	1
9	*MC510	Intellectual Property Rights	3	0	0	0
		Total Credits	**18**	**3**	**8**	**22**

III YEAR II SEMESTER

S. No	Course Code	Course Title	L	T	P	Credits
1	MM601PC	Materials Characterization	3	1	0	4
2	MM602PC	Non-Metallic Materials	3	1	0	4
3	MM603PC	Material Processing (Casting & Welding)	3	1	0	4
4		Professional Elective - II	3	0	0	3
5		Open Elective –I	3	0	0	3
6	MM604PC	Material Processing Lab (Casting & Welding experiments)	0	0	3	1.5
7	MM605PC	Modeling and Simulations Lab for Metallurgical and Materials Engineering	0	0	3	1.5
8	EN608HS	Advanced Communication Skills Lab	0	0	2	1
9	*MC609	Environmental Science	3	0	0	0
		Total Credits	**18**	**3**	**8**	**22**

***MC - Environmental Science – Should be Registered by Lateral Entry Students Only.**

Note: Industrial Oriented Mini Project/ Summer Internship is to be carried out during the summer vacation between 6th and 7th semesters. Students should submit report of Industrial Oriented Mini Project/ Summer Internship for evaluation.

Professional Elective – I

MM511PE	Powder Metallurgy
MM512PE	Nuclear Materials
MM513PE	Fatigue and Fracture Mechanics

Professional Elective – II

MM611PE	Nano Materials
MM612PE	Electronic Materials
MM613PE	Furnace Technology and Pyrometry

MM501PC: NON-FERROUS EXTRACTIVE METALLURGY

III B.Tech.(MME) I Semester

L	T	P	C
3	1	0	4

Course objectives:

1. To explain the various methods of extraction of nonferrous metals.
2. To describe the procedure and equipment used for production of nonferrous metals from their ores.

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

1. The course gives an insight into the various methods of production of important nonferrous metals
2. The students get an idea of energy saving methods and environment controlling methods in extractive units.
3. The course is useful for higher studies, R&D, and also for getting jobs in metallurgical processing industries

UNIT - I

Copper: Principal Ore and Minerals; Matte smelting – Blast furnace, Reverberatory, Electric furnace, Flash; Converting; Continuous production of blister Copper; Fire refining; Electrolytic refining; Hydro-Metallurgical copper extraction; Leaching processes, Recovery of copper from leach solutions; Electro-winning.

UNIT - II

Zinc: General Principles: Horizontal and vertical retort processes: Production in a Blast furnace: Leaching purification: Electrolysis, Refining. Lead: Blast furnace smelting, Refining of lead bullion.

UNIT - III

Aluminium: Bayer process: Hall - Heroult process: Anode effect: Efficiency of the process: Refining, Alternative processes of aluminum production.

UNIT - IV

Magnesium: Production of a hydrous Magnesium chloride from seawater and magnesite. Electro-winning practice and problem, refining, Pidgeon and Handspring processes. Titanium: Upgrading of ilmenite, chlorination of titanium, Kroll's process. Refining.

UNIT - V

Uranium: Acid and alkali processes for digestion of uranium ores, Purification of crude salt, Production of reactor grade UO_2 and uranium. Simplified flow sheets for the extraction of nickel, tungsten and gold. Review of non-ferrous metal industries in India.

TEXT BOOKS:

1. Extraction of Non-Ferrous Metals - HS Ray, KP Abraham and R. Sridhar
2. Non-Ferrous Extractive Metallurgy – G B Gill John Wiley & Sons 1980

REFERENCE BOOKS:

1. Extractive Metallurgy 1: Basic Thermodynamics and Kinetics, Alain Vignes (ISTE Ltd.,)
2. Extractive Metallurgy 2: Metallurgical Reaction Processes, Alain Vignes (ISTE Ltd.,)
3. Extractive Metallurgy 3: Processing Operations and Routes, Alain Vignes (ISTE Ltd.)
4. Topics in non-ferrous extractive metallurgy, Burkin, Wiley-Blackwell (1980)

MM502PC: ENVIRONMENTAL DEGRADATION OF MATERIALS

III B.Tech.(MME) I Semester

L	T	P	C
3	1	0	4

Course objectives: To familiarize the student with the extent and importance of material degradation. To study various aspects of corrosion and its control.

Course outcomes: After completing this course, the student should be able to:

1. Explain the importance of studying corrosion
2. Describe the thermodynamic aspects of corrosion
3. Describe the kinetic aspects of corrosion
4. Indicate the various forms of corrosion
5. Explain the measurement and control of corrosion.

UNIT I

Introduction, Definition, Fundamentals of electrochemistry principles, Forms of environmental degradation, Classification of corrosion, Importance of corrosion studies and cost of corrosion. Corrosion principles, Electrochemical aspects, Thermodynamic aspects of corrosion – Gibbs energy and electrochemical potential

UNIT II

Metal-Electrolyte Interface, EMF series, Nernst relationship and Pourbaix Diagram, Kinetic aspects of corrosion: Corrosion rate, Current density, Exchange current density, Mixed potential theory, Polarization and Passivation.

UNIT III

Forms of corrosion: Uniform Corrosion, Localized Corrosion; Pitting; Crevice Corrosion, Galvanic Corrosion and Protection; Concentration Cells, Intergranular Corrosion; De-alloying, Environmentally assisted failures (SCC, Hydrogen embrittlement; corrosion fatigue, Erosion; Fretting. Experimental methods to identify corrosion susceptibility

UNIT IV

Corrosion Measurements and Corrosion Control: Exposure studies, Electrochemical work bench, DC and AC methods of testing, Polarization measurements- Corrosion rate assessment by Tafel's extrapolation method, Linear polarization resistance (LPR). Coatings, Inhibitors, Cathodic and Anodic protection.

UNIT V

Degradation of polymeric and composite materials and its prevention

TEXT BOOKS:

1. Corrosion Engineering, Mars. G. Fontana, McGraw Hill Education, 2017
2. Electrochemical Techniques in Corrosion Science and Engineering. R.G. Kelly, J.R. Scully, D.W. Shoesmith, R.G. Buchheit, CRC Press., 2002

REFERENCE BOOKS:

1. Corrosion: Metal / Environment Reactions, Volume 1, L.L. Shreir, R.A. Jarman, G.T. Burstein, Butterworth-Heinemann, 1994.
2. Principles and Prevention of Corrosion, Denny A. Jones, Pearson, 1995.

MM503PC: MECHANICAL WORKING OF METALS

III B.Tech.(MME) I Semester

L	T	P	C
3	1	0	4

Course objectives: This course is mainly designed to provide knowledge about various metal forming operations, their process parameters, and mathematical equations associated with the process.

Course outcomes: After completing the course, the student will be able

1. To choose the best forming process for a specific product.
2. Use the Mohr's circle to graphically analyze stresses and strains;
3. Analyze, compare and finally gain theoretical experience for the advantages and limitations of different manufacturing processes
4. To practically appreciate the utilization of these fundamentals in industrial manufacturing processes.
5. To analyze metallurgical and mechanical aspects of forming of metals into useful shapes and properties.

UNIT I

Stress and Strain Relationship for Elastic Behavior: Description of stress at a point. State of stress in two dimensions. Mohrs circle of stress in two dimensions, state of stress in three dimensions. Mohrs circle of stress in three dimensions. Description of strain at point.

UNIT II

Elements of Theory of Plasticity: The flow curve. True stress and true strain. Von-Mises distortion energy criterion, maximum shear stress or Tresca criterion. Octahedral shear stress and shear strain. Basics of the theories of plasticity.

UNIT III

Fundamentals of Metal Working: Classification of forming processes, Mechanics of metal working for slab method and uniform deformation energy method. Cold working, Recovery, recrystallization and grain growth, hot working, Strain-Rate effects, Work of plastic deformation. Forging: Classification of forging processes, forging equipment. Forging in plane strain. Open-die forging, closed-die forging, Forging of a cylinder in plane-strain. Forging defects,

UNIT IV

Rolling of Metals: Classification of rolling process, rolling mills. Hot rolling, cold rolling, rolling of bars and shapes, forging and geometrical relationships in rolling. Simplified analysis of rolling load, rolling variables, problems and defects in rolled products. Theories of hot rolling, torque and horsepower, theories of cold rolling, torque and horsepower.

UNIT V

Extrusion: Classification of extrusion processes, extrusion equipment. Hot extrusion. Deformation and defects in extrusion. Analysis of the extrusion process. Cold extrusion. Extrusion of tubing and production of seamless pipe and tubing. Drawing of Rods, Wires and Tubes: rod and wire drawing, tube drawing processes, deep drawing, residual stresses in rod, wire and tubes.

TEXT BOOKS:

1. Mechanical Metallurgy by GE Dieter (3rd edition)
2. Technology of Metal forming Processes – Surendra Kumar PHI 2008
3. Metal Forming: Mechanics and Metallurgy by William F. Hosford and Robert M. Caddel (4th edition), Cambridge University Press

REFERENCE BOOKS:

1. Mechanical working of metals-Avitzur.
2. Engineering Metallurgy-PartII-Higgins.
3. Mechanical Metallurgy- White and Lemay.

SM505MS: ENGINEERING ECONOMICS AND ACCOUNTANCY

III B.Tech.(MME) I Semester

L	T	P	C
3	0	0	3

Course Objective: To prepare engineering students to analyze cost/ revenue/ financial data and to make economic and financial analysis in decision making process and to examine the performance of companies engaged in engineering.

Course Outcome: To perform and evaluate present and future worth of the alternate projects and to appraise projects by using traditional and DCF Methods. To carry out cost benefit analysis of projects and to calculate BEP of different alternative projects.

UNIT - I: Introduction to Engineering Economics- Basic Principles and Methodology of Engineering Economics– Fundamental Concepts- Demand – Demand Determinants - Law of Demand- Demand Forecasting and Methods - Elasticity of Demand- Theory of Firm – Supply- Elasticity of Supply.

UNIT - II: Macro Economic Concepts: National Income Accounting - Methods of Estimation- Various Concepts of National Income - Inflation – Definition – Causes of Inflation and Measures to Control Inflation - New Economic Policy 1991 (Industrial policy, Trade policy, and Fiscal policy) Impact on Industry.

UNIT - III: Cash Flows and Capital Budgeting: Significance of Capital Budgeting - Time Value of Money- Choosing between alternative investment proposals- Methods of Appraisal Techniques- Pay Back Period - Average Rate of Return – Net Present Value- Internal Rate of Return – Profitability Index.

UNIT - IV: Borrowings on Investment: Equity Vs Debt Financing - Leverages- Concept of Leverage- Types of Leverages: Operating Leverage- Financial Leverage and Composite Leverage. (Simple Problems)

UNIT - V: Introduction to Accounting: Accounting Principles- procedure- Double entry system - Journal-ledger- Trial balance- Trading and Profit and Loss account- Balance Sheet. Cost Accounting, Introduction- Classification of costs- Breakeven Analysis, Meaning and its application, Limitations. (Simple Problems).

TEXT BOOKS:

1. Henry Malcom Steinar-Engineering Economics, Principles, McGraw Hill Pub.
2. D.D. Chaturvedi, S.L. Gupta, Business Economics - Theory and Applications, International Book House Pvt. Ltd. 2013.
3. Jain and Narang" Accounting, Kalyani Publishers.
4. Arora, M.N." Cost Accounting, Vikas Publication.
5. S. N. Maheshwari, Financial Management, Vikas Publishing House.
6. Zahid A Khan, Arshad N Siddique, et. al, Principles of Engineering Economics with Applications, 2e, Cambridge University Press.

MM511PE: POWDER METALLURGY (Professional Elective -1)

III B.Tech.(MME) I Semester

L	T	P	C
3	0	0	3

Course objectives: This course introduces the particulate technology to create components from powder route.

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

1. List different stages of manufacturing using the powder metallurgy route
2. Describe characteristics of a P/M component
3. Describe the consolidation process during P/M route and identify the defects that arise
4. Analyse the material and design needs of a P/M component

UNIT I

Introduction. Importance of powder metallurgy. Comparison of powder metallurgy with other manufacturing techniques. Its scope and limitations. Methods of Powder Production: chemical reduction (tungsten, iron), carbonyl decomposition (iron, nickel), atomization (pure metal and multi component alloy powders), milling (oxides), electrolysis (elemental powders).

UNIT II

Characterization of Powders: Importance. Determining powder characteristics: particle shape, size and size distribution, specific surface area, apparent and tap density, angle of repose, green strength. compressibility / compactability, powder conditioning.

UNIT III

Consolidation of Metal Powders I - Compaction: Theory of consolidation; Pressureless powder shaping, pressure transmission in powders. Pressure dependence of densification. Die compaction and Isostatic pressing.

UNIT IV

Consolidation of Metal Powders II- Sintering. Mechanisms of solid state and liquid phase sintering. Factors affecting sintering. Properties of sintered parts. Hot isostatic pressing. Sinter forging. Defects in P/M route and their control, Treatment of powder metallurgy components.

UNIT V

Testing and quality control, metallic and ceramic P/M components; Applications of P/M products: Porous parts, self-lubricating bearings, dispersion strengthened materials, cermets, electrical materials, magnetic materials.

TEXT BOOKS:

1. Powder Metallurgy: science, technology and materials – Anish Upadhyaya, G.S. Upadhyaya, Universities Press (2011)
2. Power Metallurgy: science, technology and materials – P.C. Angelo, R. Subramanian, Prentice Hall India Learning Pvt. Ltd., (2008)

REFERENCE BOOKS:

1. Volume 7: Powder Metallurgy, ASM Handbook – P.K. Samal and J. W. Newkird, ASM (2015)
2. Powder Metallurgy Science – R.M. German, Metal Powder Industry (1994)

MM512PE: NUCLEAR MATERIALS (Professional Elective - I)

III B.Tech.(MME) I Semester

L	T	P	C
3	0	0	3

Course Objectives: The objective of this course is to make understand the concepts of Nuclear Science and Special Properties required for materials to meet nuclear reactor requirements.

Course outcomes: By the end of the course student will get good knowledge on

1. Fundamentals of nuclear chemistry and Physics
2. Functional requirements of various reactor components and suitable materials
3. Extraction of nuclear grade materials applicable in nuclear reactors
4. Application of principles of physical metallurgy in understanding the changes takes place in materials after irradiation

UNIT I

Elementary Nuclear Physics and Chemistry; Structure of nucleus, radioactivity, binding energy; nuclear interaction; fission and fusion; nuclear reaction; energy release and chain reactions; neutron absorption cross-section; multiplication and criticality concepts and factors.

UNIT II

Reactor components; Types of reactors; PWR, BWR, Graphite Moderator Reactor, Heavy water Reactor, Graphite moderator Reactor, Light Water moderator Reactor, Liquid metal coolant reactor. Mechanisms of moderation, radiation detection, radiation effects on fissile and non-fissile materials; radiation damage and radiation growth; thermal cycling; protection against radiations.

UNIT III

Materials for nuclear reactors; Considerations in selection and properties of common materials used as fuels, their physical and chemical properties; canning materials; coolants; control rods; reflectors and shielding materials. Production of reactor materials.

UNIT IV

Indian resources: Occurrence and general characteristics of nuclear minerals. Flow sheets of processing of nuclear minerals for the production of nuclear grade uranium, thorium, beryllium and zirconium with emphasis on basic scientific principles involved.

UNIT V

Production and enriched uranium and fabrication of fuel elements. Irradiated fuel processing for recovery of Plutonium. Nuclear power production in India and its economics and safety measures.

TEXT BOOKS:

1. Wright JC -Metallurgy in Nuclear Power Technology; Iliffe Book Ltd., 1962
2. Glasstone S and Snesonske A; Principles of Nuclear Reactor Engineering; Macmillan, London

REFERENCE BOOKS:

1. Wilkinson WD and Mrphy WF Nuclear Reactor Metallurgy Van Nostrand 1958
2. Symposium on Rare matierals; Indian Institute of Metals.
3. Gurinsky DH and Dienes JL Nulcears Fuels, Macmillan.
4. Proceedings of the symposium on Nuclear Science and Engineering – Bhabha Atomic Research Centre, Bombay.

MM513PE: FATIGUE AND FRACTURE MECHANICS (Professional Elective – I)

III B.Tech.(MME) I Semester

L	T	P	C
3	0	0	3

Course Objectives:

1. To study the different types of fatigue failures and their mechanisms in the engineering applications
2. To study the basic theory of fracture mechanics and its relationship with fatigue and creep failure mechanisms
3. To understand the damage tolerance approach in the life estimation of structures

Course outcomes: After completing this course, the student will have:

1. The ability identify the characteristic fatigue failures in the engineering structures
2. Knowledge of connecting fracture mechanics concepts to fatigue failure
3. Knowledge of fatigue failure mechanisms in non-metallic materials

UNIT I

Introduction and historical overview, Types of fatigue – low cycle fatigue, high cycle fatigue, very high cycle (giga cycle) fatigue, Fatigue test methods and equipment, Total life approaches based on cyclic stress and cyclic strain, Cyclic hardening and softening in single crystals and polycrystals

UNIT II

Crack initiation and propagation, Mechanisms, Macrostructural and microstructural aspects, Use of fracture mechanics in fatigue.

UNIT III

Local strain approach, effect of different factors on fatigue – Stress concentration, Size, Surface, Temperature, Frequency, Environment, Microstructure, Residual stresses, Fretting, Creep-fatigue interaction, Multi axial stresses, Thermo mechanical loading, Variable amplitude loading, Load sequence, Crack closure.

UNIT IV

Fatigue behaviour of different materials – Metallic materials and weldments, Ceramics, Polymers, Composites, Metallic glasses, Shape memory alloys,

UNIT V

Fatigue behaviour of ultrafine grained materials, Nano crystalline materials, Biomaterials, Metallic foams Case studies on fatigue failures, Design considerations, Methods for fatigue life improvement

TEXT BOOKS:

1. Fatigue of Materials, Suresh, Cambridge India, 2015
2. Fracture Mechanics, Fundamentals and Applications, T.L. Anderson, CRC Press 2017

REFERENCE BOOKS:

1. Dieter
2. Thomas. H. Courtney

MM504PC: MECHANICAL WORKING OF METALS LAB

III B.Tech.(MME) I Semester

L	T	P	C
0	0	3	1.5

Course objectives: This lab course is designed to know the various testing methods for evaluation of metal forming techniques

Course outcomes: Upon successful completion of this course, the student will be able to

1. Determine strain hardening exponent from the stress-strain diagram.
2. Understand the difference between simple, progressive and compound dies.
3. Understand the effect of cold working and annealing on microstructure.
4. Illustrate the effect of friction and semi die –angle on metal flow in extrusion.
5. Practice various deformation processes like extrusion, deep drawing and redrawing.

LIST OF EXPERIMENTS:

1. To determine the formability of given materials by Erichson cup test
2. To manufacture washer components using fly press (progressive dies /compound dies)
3. Deep drawing of a cup with / without blank holder by hydraulic press
4. Redrawing of a cup with / without blank holder by hydraulic press
5. To determine the friction factor by ring compression test
6. Determination of strain hardening exponent ‘n’ and strength coefficient ‘k’
7. To verify Hall-Petch relation in MS specimen.
8. To determine the effects of cold working on the microstructure and mechanical properties of given metal.
9. To demonstrate the effect of friction and height-to-diameter ratio in the axi-symmetric compression of a cylinder.
10. To analyze the load and metal flow in extrusion with different friction conditions and semi-die angles.

List of Equipment:

1. UTM, 2. Hydraulic press, 3. Fly press, 4. Erichson cup Tester

MM505PC: EXTRACTIVE METALLURGY LAB

III B.Tech.(MME) I Semester

L	T	P	C
0	0	3	1.5

Course objectives: The basic objective of the course is to provide hands on practice on various types of unit process industrially important nonferrous metals

List of experiments:

1. To find the efficiency of electrolytic cell for Cu refining
2. To find the effect of time on leaching of an oxide ore
3. To find the effect of temperature on leaching of an oxide ore
4. To conduct cementation of Copper ore
5. Electro wining of a nonferrous metal
6. To determine the effect of temperature on calcination of lime stone
7. To find the effect of time on calcination of lime stone
8. To find the weight loss on calcination of lime stone
9. To find the effect of time on roasting of a sulphide ore
10. To find the effect of temperature on roasting of a sulphide ore

List of equipment:

1. Muffle Furnace, 2. Oxygen Cylinder, 3. Digital electronic balance, 4. Ceramic crucible, 5. Electrochemical cell

Course outcome: Upon successful completion of this course, the student will:

1. Understand pyrometallurgical extraction concepts like roasting, calcination
2. Realize Hydrometallurgical extraction fundamentals
3. Understand the elctrometallurgical extraction concepts

MM506PC: ENVIRONMENTAL DEGRADATION OF MATERIALS LAB

III B.Tech.(MME) I Semester

L	T	P	C
0	0	2	1

Course Objective: This lab course is designed to conduct the experiments on electrodeposition, verification of Faraday's laws and evaluation of factors affecting on corrosion

Course outcomes: Through this laboratory practice, the student will be able

1. To judge the process variables like current efficiency, current density.
2. To obtain desired electro deposition.
3. Hands on experience on equipment designed for evaluation of corrosion studies.

LIST OF EXPERIMENTS:

1. Study the effect of concentration and temperature on conductivity of an aqueous electrolyte (NaCl)
2. Verification of Faraday's laws
3. Electroplating of copper on brass and to study the influence of current density on current efficiency.
4. Electroplating of Nickel using watt's bath and to study the influence of current density on current efficiency
5. Electroplating of chromium on mild steel and to study the influence of current density on current efficiency.
6. To anodise the given aluminium sample and observation of microstructure
7. To understand the principles in galvanic cell corrosion using "Ferroxyl" indicating test solution.
8. To determine the throwing power of electroplating bath
9. To study the intergranular corrosion of Austenitic stainless steels
10. To conduct electropolishing of stainless steel using Nitric acid batch.

List of equipment:

1. Rectifier 2. Ammeters 3. Rheostats 4. D C Regulated Power Supply instrument 5. Electropolishing Equipment 6. Multimeters 7. Conductometers 8. Digital weighing balance

*MC510: INTELLECTUAL PROPERTY RIGHTS

III B.Tech.(MME) I Semester

L	T	P	C
3	0	0	0

UNIT – I

Introduction to Intellectual property: Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.

UNIT – II

Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

UNIT – III

Law of copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.

Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer

UNIT – IV

Trade Secrets: Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation.

Unfair competition: Misappropriation right of publicity, false advertising.

UNIT – V

New development of intellectual property: new developments in trade mark law; copy right law, patent law, intellectual property audits.

International overview on intellectual property, international – trade mark law, copy right law, international patent law, and international development in trade secrets law.

TEXT BOOKS & REFERENCES:

1. Intellectual property right, Deborah. E. Bouchoux, Cengage learning.
2. Intellectual property right – Unleashing the knowledge economy, prabuddha ganguli, Tata McGraw Hill Publishing company ltd.

MM601PC: MATERIALS CHARACTERIZATION

III B.Tech.(MME) II Semester

L	T	P	C
3	1	0	4

Course objectives:

1. To obtain knowledge on various structural and microstructural characterization techniques of materials.
2. To study the principles, theory and practice of various characterization techniques

Course Outcomes: After completing this course the student will be able to:

1. Determine crystal structures of materials
2. Analyze microstructure of materials at different length scales
3. Analyze defects and fracture surfaces of the tested materials
4. Indicate instrumentation associated with and operating principles of various techniques

UNIT I

Optical Microscopy: Principle, Image formation, Resolving power, Numerical aperture, Magnification, Depth of focus, Components of microscope, Important lens defects and their corrections, Resolving power and Magnification, Principle of phase contrast, Interference and Polarized light microscopy, Elements of quantitative, Metallography and Image processing.

UNIT II

Scanning Electron Microscopy: Principle, Interaction of electron beams with matter, Construction and Working principle, Working Distance, Depth of field, Depth of focus and Spot Size, Specimen preparation, Different types of modes used in SEM (SE and BSE) and their applications, Advantages, limitations and applications.

UNIT III

Transmission Electron Microscopy: Principle, Construction and Working principle, Resolving power and Magnification, Depth of field and Depth of focus, Bright and dark field, Specimen preparation, Selected area diffraction (SAD), Applications, Advantage and Limitations.

UNIT IV

X-Ray Diffraction: Introduction, Production and properties of x-rays, Bragg's law of diffraction, Experimental methods, Intensity of diffracted beams - Scattering by an electron by an atom, by a unit cell, structure-factor calculations, factors affecting diffraction intensities.

UNIT V

Applications of XRD: Orientation of single crystals, Effect of plastic deformation, the structure of polycrystalline Aggregates, Determination of crystal structure, Precise lattice parameter measurements, Phase - diagram determination, Order-disorder transformation, Chemical analysis by Diffraction, Stress measurement.

TEXT BOOKS:

1. Material Characterization: Introduction to Microscopic and Spectroscopic Methods – Yang Lang – John Wiley & Sons (Asia) Pvt. Ltd. 2008
2. Microstructural Characterization of Materials – David Brandon, Wayne D Kalpan, John their applications, Advantages, limitations and applications.

REFERENCE BOOKS:

1. The Principles of Metallographic Laboratory and Practices (Metallurgy) – George L. Khel-McGraw- Hill, 1949.

2. Experimental Techniques in Materials and Mechanics – C. Suryanarayana, CRC Press, Taylor & Francis Group, 2011.
3. Metallography: Principles and Practices – George F. Vander Voort, ASM International, 1984 – Technology & Engineering
4. Elements of X-ray diffraction – Bernard Dennis Cullity & Stuart R Stocks, Prentice Hall, 2001 – Science.

MM602PC: NON-METALLIC MATERIALS

III B.Tech.(MME) II Semester

L	T	P	C
3	1	0	4

Course objectives:

1. To introduce the student to the range of non-metallic materials available for engineering.
2. To understand the classification and significance of nonmetallic materials to apply them in Industries
3. To get an exposure to the techniques associated with the synthesis, processing and characterization of these materials and
4. To become aware of the applications where these materials are preferred.

Course outcomes: After completing this course the student can:

1. List the prominent non-metallic materials available for engineering applications
2. Indicate the uses for which these materials are preferred
3. Indicate the structure property relations in these materials
4. Indicate the synthesis and processing steps associated with these materials

UNIT I

Definition and classification of nonmetallic materials, comparison of properties of metals and nonmetallic materials. Introduction to Polymers: Concept of polymers, types of polymers reactions, Mechanism of polymerization, Synthesis, properties and application of some of the significant polymers viz., PVC, PAN, PMMA, and Teflon

UNIT II

Ceramics: Introduction, classification, structure, and applications of ceramics. Brief introduction to some of the Ceramic processing techniques. Special ceramics: ferroelectric, piezoelectric, magnetic, superconducting, laser and bio-ceramics.

UNIT III

Glasses: Introduction, formation of glasses, structural features of glasses, classification, processing and applications of glasses. Manufacturing methods of glasses.

UNIT IV

Composites: Introduction, classification, and applications of composite materials. Manufacturing of Polymer matrix, metal matrix, and ceramic matrix composites.

UNIT V

Textiles. Adhesives, and Foams: Introduction, classification and applications of textile materials. Structure of Adhesives and their applications. Classification and applications of foam materials, Manufacturing methods of industrially important adhesives and foams

TEXT BOOKS:

1. Textbook of Polymer Science; Fred W. Billmeyer, Wiley 2007
2. Introduction to Ceramics; Kingery, Bowen, Uhlman. Wiley India Pvt Limited, 2012

REFERENCE BOOKS:

1. Composite Materials: Science and Engineering; Krishan K. Chawla, Springer, 2012
2. W.S. Smith: Principles of Materials Science and Engineering, McGraw-Hill.
3. V. Raghavan: Materials Science and Engineering, Prentice-Hall.

MM603PC: MATERIAL PROCESSING (CASTING & WELDING)

III B.Tech.(MME) II Semester

L	T	P	C
3	1	0	4

Course objectives: This course is mainly intended to introduce and explain various moulding, casting techniques and equipment used. Principles of Solidification of casting, defects in castings and their remedies are also dealt in detail. This course also provides in depth knowledge about various metal joining techniques, the thermal and residual stresses associated with, the equipment used, their modern developments, and defects of weldments.

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

1. Understand basics of metal casting, casting defects and remedies.
2. Design gating system for metal casting processes
3. Understand the casting technology, solidification of metals and alloys.
4. Understand the basics of various metal joining processes
5. Understand weldability of cast iron and high carbon steel and weldability characteristics.

UNIT I

Introduction to Foundry – Types of Foundries, Patterns: Materials for patterns, types of patterns; functions and pattern allowance. Moulding materials; moulding sands, properties and selection of materials and additives Moulding Processes: Green and dry sand moulding; shell moulding, CO_2 moulding. Core making. Gating, Risering and their design.

UNIT II

Casting Methods: Permanent mould casting, pressure die-casting, Gravity die casting, Vacuum die casting, centrifugal casting, Investment Casting, Squeeze casting and Composite Casting, Casting defects arising due to moulding, cores, melting and pouring practice. Inspection and Testing of castings.

UNIT III

Melting and Solidification: Cupola and Induction Melting. Nucleation and growth. Freezing of metals and alloys. Dendritic freezing. Progressive and Directional Solidification. Classification of welding processes: Principles, advantages disadvantages and fields of application of the following welding processes: Gas Welding, Arc Welding processes, MMAW, GTAW, MIG, SAW and Resistance Welding

UNIT IV

Metal Joining Techniques: Principles, advantages disadvantages of Electron Beam Welding, Laser welding, Solid state welding, Friction stir welding, and explosive welding processes.

UNIT V

Weldability, Microstructure of fusion zone and heat affected zone. Influence of heat input, thermal and residual stresses, pre heat and cooling rate, PWHT. Weldability of high carbon steel, cast irons, stainless steels use of Schaeffler diagram and Delong diagrams. Welding of non-ferrous alloys - Aluminum alloys, Welding of dissimilar metals.

TEXT BOOKS:

1. Principles of Metal casting by Heine – Loper and Rosenthal, Tata McGraw Hill, 2nd Edition.
2. Metal Casting: Principles and practice – T.V. Ramana Rao, New Age International, 2007.
3. Welding Technology – R.S. Parmar

REFERENCE BOOKS:

1. Metals Handbook Vol. 5 published by ASM, Ohio.
2. Manufacturing Technology – Vol. I: Foundry, Forming and Welding, P.N.Rao, McGraw Hill 3rd Edition.
3. Castings – John Campbell – Second Edition – Elsevier.
4. Welding Metallurgy - JF Lancaster

MM611PE: NANO MATERIALS (Professional Elective - II)

III B.Tech.(MME) II Semester

L	T	P	C
3	0	0	3

Course objectives:

1. This course is primarily intended to expose the students to a highly interdisciplinary subject.
2. This would emphasize on the classification, synthesis and applications of Nano materials.

Course outcomes: After completing this course, the student should be able to:

1. Indicate the differences between nanomaterials and conventional materials
2. Indicate how specific synthesis techniques can result in nanomaterials
3. Give examples of specific nanomaterials and explain the scientific reasons for the properties displayed by them
4. Describe how specific characterization techniques can be used to analyze nanomaterials

UNIT I

Introduction, Importance of Nano-technology, Emergence of Nano-Technology, Bottom-up and Top-down approaches, challenges in Nano Technology.

UNIT II

Zero Dimensional Nano-structures, Nano particles through homogenous nucleation; Growth of nuclei, synthesis of metallic Nano particles, Nano particles through heterogeneous nucleation; Fundamentals of heterogeneous nucleation and synthesis of nano particles using micro emulsions and Aerosol.

UNIT III

One Dimensional Nano-structures, Nano wires and nano rods, Spontaneous growth: Evaporation and condensation growth, vapor-liquid-solid growth, stress induced recrystallization. Template based synthesis: Electrochemical deposition, Electro-phoretic deposition. Electro-spinning and Lithography.

UNIT IV

Two dimensional Nano-Structures, Fundamentals of film growth. Physical vapour Deposition (PVD): Evaporation molecular beam epitaxy (MBE), Sputtering, Comparison of Evaporation and sputtering. Chemical Vapour Deposition (CVD): Typical chemical reactions, Reaction kinetics, transport phenomena, CVD methods, diamond films by CVD.

UNIT V

Thin films, Atomic layer deposition (ALD), Electrochemical deposition (ECD), Sol-Gel films. Special Nano Materials, Carbon fullerene and nano tubes: carbon fullerenes, formation, properties and applications. Carbon nano tubes: formation and applications.

TEXT BOOKS:

1. Nano structures and Nano materials: Synthesis, properties and applications - Guozhong Cao-Imperial College press in 2004, 2nd edition.
2. Text book of Nano Science and Technology, B S Murthy, Universities press-IIM series in Metallurgy and Material Science

REFERENCE BOOKS:

1. Springer Handbook of Nanotechnology
2. Nano Materials Synthersis, Properties and applications, 1996 Edlstein and Cammarate.
3. Nano Materials A.K. Bandhopadyay/ New age Publications
4. Nano Essentials T Pradeep / TMH

MM612PE: ELECTRONIC MATERIALS (Professional Elective - II)

III B.Tech.(MME) II Semester

L	T	P	C
3	0	0	3

Course objectives: To become familiar with the science, synthesis, evaluation, and applications of electronic materials. To know the manufacturing processes associated with use of electronic materials for devices.

Course Outcomes: After completing this course, the student will be able to:

1. Indicate and explain important scientific parameters associated with electronic materials
2. Describe different semiconductors and their properties with examples
3. Explain the features and functioning of several electronic devices
4. Describe the manufacturing processes associated with electronic materials and devices

UNIT I

Review of quantum mechanics: Electron as waves and particles; Wave-function; Electron as a plane-wave, Schrodinger Equation, DC conductivity in metals. Wigner-Seitz cell; k-space: Origin of energy bands and band-gap; Free electron band diagram, Extended-, Periodic and reduced-zone representation for ε - k diagram; Allowed number of states in a band

UNIT II

Conductivity in relation to band structure; Band structure of metals and semiconductors, and insulators; Band-overlap: why some metals show positive charge carriers in Hall-effect. Band diagrams, direct and indirect bandgap, applications of semiconductors;

UNIT III

Intrinsic semiconductors: Maxwell-Boltzman equation; Law-of mass-action; Direct vs Indirect Semiconductors, Extrinsic-semiconductor: n- and p-type semiconductors; Degenerate and non-degenerate semiconductors. p-n junction and solar cells; Bandgap engineering: Solid-state LEDs, Lasers and IR detectors. Dia, para and, Ferro magnetism, ferrites, magnetic hysteresis, Applications.

UNIT IV

Ionic conduction, conduction in glasses; Effect of stoichiometric and extrinsic defects on conduction, Applications in sensors and fuel cells. Dielectric constants and polarization, linear dielectric materials, capacitors; Polarization mechanisms; Non-linear dielectrics, pyro- , piezo-, and ferro-electric properties, hysteresis and ferroelectric domains; Applications in sensors, actuators and memory devices.

UNIT V

Semiconductor manufacturing, overview of process flow, manufacturing goals. Scaling. Wafer manufacturing. Si ingot preparation. Poly to single crystal conversion. Czochralski vs. float zone method. IC device manufacturing overview. Thermal oxidation. Doping. Lithography. Etching and growth. Metallization and growth.

TEXT BOOKS:

1. Electronic Properties of Materials: An Introduction for Engineers, Rolf E. Hummel, Springer Verlag, 1985
2. Physical Properties of Semiconductors, Charles M. Wolfe, Nick Holonyak and Gregory E. Stillman, Prentice Hall, 1989
3. “Electronic Properties of Materials” by R. E. Hummel, Springer, 2017.

REFERENCE BOOKS:

1. Advanced Theory of Semiconductor Devices, Karl Hess, Prentice Hall, 1988
2. Advanced Semiconductor Fundamentals, Robert F. Pierret as part of Modular Series on Solid State Devices Vol. 6, Addison Wesley, 1989
3. Introduction to Solid State Physics, Charles Kittel, John Wiley & Sons 1991
4. Electrical Properties of Materials, L. Solymar and D. Walsh, Oxford University press, 1998.
5. Physics of Solids, C. A. Wert and R.M. Thomson, McGraw-Hill Book Company, 1970 or later

MM613PE: FURNACE TECHNOLOGY AND PYROMETRY (Professional Elective - II)

III B.Tech.(MME) II Semester

L	T	P	C
3	0	0	3

Course objectives:

1. To explain the phenomenon of heat transfer by conduction, convection, radiation and to study the working of various types of furnaces.
2. To study the principles of temperature measurement by various methods.

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

1. Apply the various methods of heat transfer and solve problems.
2. Can apply /select a suitable pyrometer for high temperature measurements under various conditions.
3. Will be able to select / have knowledge about a particular furnace details and applications.

UNIT -I

Steady State Heat Transfer: Importance of heat transfer, conduction through plane, cylindrical, spherical and compound walls, shape factor and effect of variable thermal conductivity. Unsteady state conduction: Thermal diffusivity equation for uni-directional heat flow. Sudden change of surface temperature of a thick plane wall, cylinder and sphere. Graphical Solutions.

UNIT-II

Dimensional groups. Free and Forced convection. Heat Transfer by combined effect of conduction and convection between two fluids separated by a plane wall and cylindrical wall. Types of Heat exchangers on mode of travel. Log mean temperature difference for both parallel and counter flow exchangers. Radiation - emissivity-luminous and non-luminous flames. Radiant exchange between parallel surfaces enclosed body and enclosure. Combined effect of conduction, convection and radiation. Thermal efficiency of insulation.

UNIT-III

Furnaces: Characteristic features of vertical shaft furnaces, reverberatory furnaces, Electric Arc and Induction furnaces. Tube and muffle type resistance furnaces, continuous furnaces. Sources of heat losses in furnaces and heat balance.

UNIT-IV

Pyrometry: Thermo electric pyrometer- Peltier and Thomas e.m.f's. Thermo-electric power of thermocouples. Required properties of thermocouples. Noble and base metal thermocouples. Thermo-pile. Measurement of e.m.f by Milli-voltmeters and potentiometers. Cold junction correction. Resistance thermometers – Calendars correction. Principle, construction of resistance thermometers. Measurement of resistance compensation for connection wires.

UNIT- V

Optical pyrometers-principle involved in optical pyrometers, Black body conditions. Wiens and Plancks laws of monochromatic radiation. Principle and construction of disappearing filament optical pyrometer (morse type). F and F optical pyrometer (Wedge type) and Pyro optical pyrometer. The effect of the distance between pyrometer and source, Emissivity of materials. Absorbing media and reflection of optical pyrometer readings. Total radiation pyrometer: Principles, construction of ferry radiation pyrometer, ferry metal spiral radiation pyrometer, fixed focus radiation pyrometer (foster Pyrometer) and pyrometer.

TEXT BOOKS:

1. Elements of heat transfer- Jakob & Hawikns.

2. Pyrometry - W.P. wood & J. M. Corck

REFERENCE BOOKS:

1. Furnaces-J. D. Gilchrist, First edition, Published by Pergamon press.
2. Elements of thermodynamics& heat transfer- Obert & Young.
3. Control systems & Instrumentation – S. Bhasker.

MM604PC: MATERIAL PROCESSING LAB (CASTING & WELDING)

III B.Tech.(MME) II Semester

L	T	P	C
0	0	3	1.5

Course objectives: This lab course is designed to provide hands on experience on various foundry testing methods for evaluation of moulding sand properties, also designed to make the student to understand and demonstrate the various types of welding processes and its variables.

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Determine moulding sand dry, hot and green strength
2. Understand the preparation of moulding sand
3. Determine moulding sand properties by varying additives
4. Understand the Melting of Al alloys
5. Gain hands on experience in various methods of welding and joining of metals and understand the mechanical behavior of the joint with respect to microstructure and mechanical properties.

LIST OF EXPERIMENTS:

1. Preparation of gating system using green sand moulding.
2. Study of permeability of green sand with clay and water.
3. Determination of sand properties: green and dry strength, green and dry hardness, hot shear strength with variation in sand additives.
4. Determination of clay content in sand.
5. Determination of the shatter index of green sand
6. Melting of Al alloys in a pit furnace and casting into light components
7. Preparation of a shell by shell moulding process
8. Study and observe the identification of flames using gas welding techniques and prepare a Butt joint with gas welding.
9. Preparation of a butt joint with mild steel plates using Arc welding process and study the comparison of the bead geometry with DCSP, DCRP and A.C.
10. Demonstration and practice of resistance spot welding process and plot the variation of spot area with time and current variation
11. Preparation of a butt joint with mild steel strip using tungsten inert gas (TIG) welding process.
12. Preparation of a butt joint with mild steel plate using submerged arc welding (SAW) process.
13. Preparation of a butt joint with mild steel plate using MIG welding process.
14. Evaluation of microstructure of welded joint and observe the structural difference in weld zone, heat affected zone (HAZ) and base metal

LIST OF EQUIPMENT:

1. Mould Boxes, Patterns, Core Boxes, Tool Boxes. 2. Sieve Shaker 3. Permeability Apparatus. 4. Universal Sand testing Machine with Accessories. 5. Sand Hardness tester. 6. Clay Content Apparatus 7. Shatter Index test apparatus. 8. Pit Furnace/ Electric Furnace 9. Shell Moulding Machine 10. Centrifugal Casting Machine 11. Ultrasonic Tester. 12. Ladles, Crucibles and other Accessories. 13. Muffle Furnace 1000^0c 14. Centrifugal Casting Machine 15. Gas welding equipment. 16. Spot welding Machine 17. TIG Welding Machine 18. Arc welding Machine. 19. MIG welding Machine 20. Submerged Arc Welding machine

MM605PC: MODELING AND SIMULATION LAB FOR METALLURGICAL AND MATERIALS ENGINEERING

III B.Tech.(MME) II Semester

L	T	P	C
0	0	3	1.5

Course objectives: This course is designed to impart hands-on experience on the various modelling and simulation techniques used in metallurgical and materials engineering.

Course outcomes: Students will acquire a hands-on training on

1. Different computational, modelling and simulation techniques.
2. Students will know the importance of Metallurgical Computations, modelling and simulation techniques for supplementing experiments for understanding of materials behaviour.

List of experiments:

1. Computing heat and mass calculations of chemical reactions
2. Determination of Crystal structures using computer principles
3. Programming of pressurized and non-pressurized Gating system
4. Programming on calculation of electrode potential at nonstandard conditions
5. Programming of Riser system
6. Programming to determine the charge input to get the required output of pig iron in a blast furnace.
7. Computation of binary phase diagrams
8. Computation of Pour-baix diagrams

TEXT BOOKS:

1. Computer oriented Numerical methods – V. Rajaraman (PHI Publicatons)
2. Computer programming and Numerical methods – S. Saran
3. Numerical methods in engineering – Mario G. Salvadori and Melvin L. Baron
4. Matrix operation on Computer – L.L. Brirud (LCUE Publication)

EN608HS: ADVANCED COMMUNICATION SKILLS LAB

III B.Tech.(MME) II Semester

L	T	P	C
0	0	2	1

1. INTRODUCTION:

The introduction of the Advanced Communication Skills Lab is considered essential at 3rd year level. At this stage, the students need to prepare themselves for their careers which may require them to listen to, read, speak and write in English both for their professional and interpersonal communication in the globalized context.

The proposed course should be a laboratory course to enable students to use 'good' English and perform the following:

- Gathering ideas and information to organize ideas relevantly and coherently.
- Engaging in debates.
- Participating in group discussions.
- Facing interviews.
- Writing project/research reports/technical reports.
- Making oral presentations.
- Writing formal letters.
- Transferring information from non-verbal to verbal texts and vice-versa.
- Taking part in social and professional communication.

2. OBJECTIVES:

This Lab focuses on using multi-media instruction for language development to meet the following targets:

- To improve the students' fluency in English, through a well-developed vocabulary and enable them to listen to English spoken at normal conversational speed by educated English speakers and respond appropriately in different socio-cultural and professional contexts.
- Further, they would be required to communicate their ideas relevantly and coherently in writing.
- To prepare all the students for their placements.

3. SYLLABUS:

The following course content to conduct the activities is prescribed for the Advanced English Communication Skills (AECS) Lab:

1. **Activities on Fundamentals of Inter-personal Communication and Building Vocabulary** - Starting a conversation – responding appropriately and relevantly – using the right body language – Role Play in different situations & Discourse Skills- using visuals - Synonyms and antonyms, word roots, one-word substitutes, prefixes and suffixes, study of word origin, business vocabulary, analogy, idioms and phrases, collocations & usage of vocabulary.
2. **Activities on Reading Comprehension** –General Vs Local comprehension, reading for facts, guessing meanings from context, scanning, skimming, inferring meaning, critical reading& effective googling.
3. **Activities on Writing Skills** – Structure and presentation of different types of writing – *letter writing/Resume writing/ e-correspondence/Technical report writing/* – planning for writing – improving one's writing.
4. **Activities on Presentation Skills** – Oral presentations (individual and group) through JAM sessions/seminars/**PPTs** and written presentations through posters/projects/reports/ e-mails/assignments etc.
5. **Activities on Group Discussion and Interview Skills** – Dynamics of group discussion, intervention, summarizing, modulation of voice, body language, relevance, fluency and organization of ideas and rubrics for evaluation- Concept and process, pre-interview planning, opening strategies, answering strategies, interview through tele-conference & video-conference and Mock Interviews.

4. MINIMUM REQUIREMENT:

The Advanced English Communication Skills (AECS) Laboratory shall have the following infrastructural facilities to accommodate at least 35 students in the lab:

- Spacious room with appropriate acoustics.
- Round Tables with movable chairs
- Audio-visual aids
- LCD Projector
- Public Address system
- P – IV Processor, Hard Disk – 80 GB, RAM–512 MB Minimum, Speed – 2.8 GHZ
- T. V, a digital stereo & Camcorder
- Headphones of High quality

5. SUGGESTED SOFTWARE:

The software consisting of the prescribed topics elaborated above should be procured and used.

- Oxford Advanced Learner's Compass, 7th Edition
- DELTA's key to the Next Generation TOEFL Test: Advanced Skill Practice.
- Lingua TOEFL CBT Insider, by Dream tech
- TOEFL & GRE (KAPLAN, AARCO & BARRONS, USA, Cracking GRE by CLIFFS)

TEXT BOOKS:

1. Effective Technical Communication by M Asharaf Rizvi. McGraw Hill Education (India) Pvt. Ltd. 2nd Edition
2. Academic Writing: A Handbook for International Students by Stephen Bailey, Routledge, 5th Edition.

REFERENCES:

1. Learn Correct English – A Book of Grammar, Usage and Composition by Shiv K. Kumar and Hemalatha Nagarajan. Pearson 2007
2. Professional Communication by Aruna Koneru, McGraw Hill Education (India) Pvt. Ltd, 2016.
3. Technical Communication by Meenakshi Raman & Sangeeta Sharma, Oxford University Press 2009.
4. Technical Communication by Paul V. Anderson. 2007. Cengage Learning pvt. Ltd. New Delhi.
5. English Vocabulary in Use series, Cambridge University Press 2008.
6. Handbook for Technical Communication by David A. McMurrey & Joanne Buckley. 2012. Cengage Learning.
7. Communication Skills by Leena Sen, PHI Learning Pvt Ltd., New Delhi, 2009.
8. Job Hunting by Colm Downes, Cambridge University Press 2008.
9. English for Technical Communication for Engineering Students, Aysha Vishwamohan, Tata Mc Graw-Hill 2009.

*MC609: ENVIRONMENTAL SCIENCE

III B.Tech.(MME) II Semester

L	T	P	C
3	0	0	0

Course Objectives:

- Understanding the importance of ecological balance for sustainable development.
- Understanding the impacts of developmental activities and mitigation measures
- Understanding the environmental policies and regulations

Course Outcomes:

Based on this course, the Engineering graduate will understand /evaluate / develop technologies on the basis of ecological principles and environmental regulations which in turn helps in sustainable development

UNIT - I

Ecosystems: Definition, Scope and Importance of ecosystem. Classification, structure, and function of an ecosystem, Food chains, food webs, and ecological pyramids. Flow of energy, Biogeochemical cycles, Bioaccumulation, Biomagnification, ecosystem value, services and carrying capacity, Field visits.

UNIT - II

Natural Resources: Classification of Resources: Living and Non-Living resources, **water resources:** use and over utilization of surface and ground water, floods and droughts, Dams: benefits and problems. **Mineral resources:** use and exploitation, environmental effects of extracting and using mineral resources, **Land resources:** Forest resources, **Energy resources:** growing energy needs, renewable and non-renewable energy sources, use of alternate energy source, case studies.

UNIT - III

Biodiversity And Biotic Resources: Introduction, Definition, genetic, species and ecosystem diversity. Value of biodiversity; consumptive use, productive use, social, ethical, aesthetic and optional values. India as a mega diversity nation, Hot spots of biodiversity. Field visit. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; conservation of biodiversity: In-Situ and Ex-situ conservation. National Biodiversity act.

UNIT - IV

Environmental Pollution and Control Technologies: Environmental Pollution: Classification of pollution, **Air Pollution:** Primary and secondary pollutants, Automobile and Industrial pollution, Ambient air quality standards. **Water pollution:** Sources and types of pollution, drinking water quality standards. **Soil Pollution:** Sources and types, Impacts of modern agriculture, degradation of soil. **Noise Pollution:** Sources and Health hazards, standards, **Solid waste:** Municipal Solid Waste management, composition and characteristics of e-Waste and its management. **Pollution control technologies:** Wastewater Treatment methods: Primary, secondary and Tertiary.

Overview of air pollution control technologies, Concepts of bioremediation. **Global Environmental Problems and Global Efforts: C**limate change and impacts on human environment. Ozone depletion and Ozone depleting substances (ODS). Deforestation and desertification. International conventions / Protocols: Earth summit, Kyoto protocol, and Montréal Protocol.

UNIT - V

Environmental Policy, Legislation & EIA: Environmental Protection act, Legal aspects Air Act- 1981, Water Act, Forest Act, Wild life Act, Municipal solid waste management and handling rules, biomedical waste management and handling rules, hazardous waste management and handling rules. EIA: EIA structure, methods of baseline data acquisition. Overview on Impacts of air, water, biological and Socio-

economical aspects. Strategies for risk assessment, Concepts of Environmental Management Plan (EMP). **Towards Sustainable Future:** Concept of Sustainable Development, Population and its explosion, Crazy Consumerism, Environmental Education, Urban Sprawl, Human health, Environmental Ethics, Concept of Green Building, Ecological Foot Print, Life Cycle assessment (LCA), Low carbon life style.

TEXT BOOKS:

1. Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission.
2. Environmental Studies by R. Rajagopalan, Oxford University Press.

REFERENCE BOOKS:

1. Environmental Science: towards a sustainable future by Richard T. Wright. 2008 PHL Learning Private Ltd. New Delhi.
2. Environmental Engineering and science by Gilbert M. Masters and Wendell P. Ela. 2008 PHI Learning Pvt. Ltd.
3. Environmental Science by Daniel B. Botkin & Edward A. Keller, Wiley INDIA edition.
4. Environmental Studies by Anubha Kaushik, 4th Edition, New age international publishers.
5. Text book of Environmental Science and Technology - Dr. M. Anji Reddy 2007, BS Publications.