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B. Tech. in Metallurgical and Materials Engineering
III Semester Syllabus.
MM301PC: Iron Making

Course objectives:

1. Discuss the evolution of Iron making in chronological order.
2. Illustrate the applications of thermodynamics and kinetics in production of pig iron and refining it.
3. Outline the techniques for production and primary processing in Blast furnace.
4. Differentiate between past and present production methods and examine the modern trends in iron production.
5. Identify consists of and effect for blast furnace irregularities and their remedial measures.

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

CO1. Describe the developments of Iron making and recognize the importance of processing raw materials for Iron making keeping in view of economics, safety, and efficiency.
CO2. Identify the required parameters and design of a blast furnace and illustrate ancillary equipment and measures to be taken for starting and troubleshooting of the Blast furnace process.
CO3. Predict the physio-chemical phenomena taking place in blast furnace. Able to perform simple mass balance and complex problems.
CO4. Identify and explain the modernization techniques to improve quantity, quality, and minimize waste.
CO5. Able to predict the possible alternative processes to be followed suitable to the local conditions in view of energy, environmental and efficiency considerations.
CO6. Able to undertake any technical assignment in R&D and production units with professionalresponsibility towards profession and society.

UNIT – I: Raw materials for Iron making. Occurrence and distribution of iron ores, fuels, and fluxes.Preparation of iron ores.
UNIT – II: Blast Furnace profile and design considerations. Furnace lining. Furnace cooling system. Blast Furnace stoves, BF gas cleaning system. Blast furnace operation and irregularities.
UNIT – III: Systems of importance in iron making blast furnace reactions. Thermodynamics of iron oxidereduction by CO + CO_2 and H_2 and H_2O mixtures. Control of C, Si, S, P in metals and slags. Blast furnace slags. Burden calculations.
UNIT – IV: Modern trends in blast furnace: High top pressure, humidification of blast, Oxygen enrichment,hot blast temperature, BF additives, and top charging systems.

UNIT – V: Alternative routes of iron making: Sponge iron making: HYL, Rotary Kiln, Midrex process.Smelting and reduction methods such as Corex process.

Suggested Readings:

1. Iron making and steel making – Theory and practice Ahindra and Ghosh.
2. Beyond the B.F – Amit Chatterjee
3. Sponge Iron production by direct reduction of Iron ores - Amit Chatterjee, P & H. publications, 2010
4. Hot metal production by smelting reduction of Iron ore - Amit Chatterjee. P & H publications, 2010

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B. Tech. in Metallurgical and Materials Engineering
III Semester Syllabus
MM302PC: Mineral Processing

Course Objectives:

1. The prime objective of the mineral processing course is to build the solid foundation on principles and equipment of various unit operations such as Liberation done by size reduction process.
2. To determine the mineral sizes by Screening and Classification process and finally the Separation of metal bearing minerals from rocky mass that would facilitate metal extraction.

Course Outcomes: The student will be able to

CO1. Recognize the importance of mineral processing from economic front and sampling process.
CO2. Appraise the comminution operations - principles, types and equipment and industrial practice.
CO3. Categorize laboratory sizing and industrial screening and classification methods.
CO4. Propose the concentration operation such as Heavy Media Separation, Magnetic Separation and Electrostatic Separation based on nature of minerals.
CO5. Justify the Gravity Concentration and Froth Flotation for economic recovery of valuable minerals.

UNIT I: Scope and Objectives of Ore Dressing; Sampling of ores by different methods; Theory of liberation of minerals; Crushing - Jaw, Gyratory, Cone, Rolls and Toothed Roll crushers. Grinding - Types of grinding operations like Batch and Continuous grinding, Dry and Wet grinding, Open circuit and Closed-circuit grinding, Grinding Mills - Ball mills, Theory of ball mill operation, Rod and Tube mills; Comminution laws - Rittinger's laws, Kick's law and Bond's law.

UNIT II: Sizing– Study of laboratory sizing techniques and reporting of sizing data, Industrial sizing units – Types of screen surfaces, Grizzlies, Trommels, Vibrating and Shaking screens; **Classification** – Types of classifiers, Study of Settling Cones, Rake Classifier, Spiral Classifier and Cyclones. **Movement of solids in fluids** – Stokes' and Newton's laws, Terminal velocity and its relationship with size, Relation between time and velocity, Relation between distance travelled and velocity; Equal settling ratio, Free and hindered settling ratios; **Quantifying concentrating operations**– Ratio of concentration, Recovery, Selectivity Index and Economic Recovery.

UNIT III: Heavy Media Separation - Principles, flow chart, different media used, Heavy Media Separation using heavy liquids and heavy suspensions, Washability curves for easy, normal and difficult coal; Magnetic separation processes and Electrostatic separation processes.

UNIT IV: Jigging: - Theory of jigging, Jigging machines – Harz jig, Denver jig Baum jig, Hancock jig, James coal jig and Halkyln jig, Design considerations in a jig. Tabling - Study of stratification on a table. Shaking tables, Wilfley table.

UNIT V: Flotation - Principles of flotation, Factors affecting flotation, Classification of Collectors and Frothers, Regulators, and Factors affecting their efficiency, Application of flotation process for Cu, Pb and Zn ores.

Suggested Readings:

1. Mineral Processing Technology - Barry A. Wills, Tim Napier-Munn, Elsevier Science and Technology Books, ISBN:0750644508, October 2006.
2. Principles of Mineral Dressing - A.M. Gaudin, McGraw Hill Book Company, 1940

Reference Books:

1. Mineral Processing - S. K. Jain, CBS Publishers & Distributors, ISBN: 9788123907536,
2. Elements of Ore Dressing - A. F. Taggart, New York, John Wiley and Sons, Inc. London Chapman and Hall, Ltd.1951

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B. Tech. in Metallurgical and Materials Engineering
III Semester Syllabus
MM303PC: Metallurgical Thermodynamics and Kinetics

Course Objectives:

1. The course is primarily intended to give the students a fundamental insight into the Science and Engineering of Thermodynamics.
2. The Course is instructed to get the students know about the inter-conversion of work and heat in various thermodynamic processes.
3. The Course also focuses on significant applications of Thermodynamics and Kinetics in metallurgical concerned processes viz., extraction, refining, and diffusion.

Course Outcomes: At the conclusion of the course, the student will be able to…….

CO1. Apply the knowledge of thermodynamics in the real engineering world.

CO2. Interpret and apply the data of thermodynamics in the Metallurgical Engineering processes.

CO3. Conclude the most appropriate correlations of thermodynamic functions with the thermodynamic variables.

CO4. Identify and recommend the optimum operational parameters to be employed in significant Metallurgical Engineering processes.

UNIT I: Fundamental Thermodynamics: Conceptual outlook on Thermodynamics: Scope, prime objectives, merits, and limitations. Thorough understanding on some of the significant thermodynamic quantities viz., system, state, process, path, reversibility, irreversibility, intensive property and extensive property, heat capacity, and enthalpy. The Laws of Thermodynamics (Zeroth, First, Second). Heat and Work Calculations. Calculation of Thermodynamic efficiency: Carnot's theorem and concerned case studies. Third Law of Thermodynamics.

UNIT II: The Thermodynamic functions: Free Energy-purpose, significance, and applications. Temperature's influence on Free Energy, Determination of Free Energy Change. Maxwell's Equations. Concepts of Fugacity, Activity, and Equilibrium Constant. Clausius-Clapeyron Equation.

UNIT III: Phase Equilibrium Diagrams-Thermodynamics Application: Concepts of Chemical Potential, Gibbs Phase Rule. Free Energy-Composition curves. Determination of liquidus and solidus lines. Construction of distinct phase equilibrium diagrams with thermodynamics viewpoint.

UNIT IV: Solution Thermodynamics: Applications in Metallurgy: An Overview of the concept of solutions applied for metallurgy. Classification of solutions based on Raoult's Law and Henry's Law. Concept of partial molar thermodynamic quantities. Gibbs-Duhem Equation-Derivation, applications, and significance. Excess Thermodynamic functions. Application of Sievert's Law in process metallurgy.

UNIT V: Metallurgical Kinetics: Fundamental understanding on Chemical Kinetics and its related terms and Laws. Concept of Diffusion-a significant case study of Kinetics applied to metallurgical processes. Diffusion along the grain boundaries. Fick's Laws of Diffusion-Applications in Processes related to Metallurgical Industries.

Suggested Readings:

1. Problems in Metallurgical Thermodynamics: G.S Upadhyaya, R.K. Dubey, Elsevier Science, 2013.
2. Introduction to the Thermodynamics of Materials, David R Gaskell, 4th Edition, Taylor & Francis pub., 2009.

Reference Books:

3. Physical Chemistry of Metals- L.S. Darken & Gurry, CBS publishers & Distributors 2002.

B. Tech. in Metallurgical and Materials Engineering
III Semester Syllabus
ME331PC: Mechanics of Solids and Fluids

L	T	P	C
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Course Objectives:

The objective is to learn the fundamental concepts of stress, strain, and deformation of solids with applications to bars and beams. To learn a number of potentially useful phenomena involving movement of solids and fluids. This course will advance the students' development of the following broad capabilities:

1. Students will be able to understand basic concepts of stress, strain and their relations based on linear elasticity.
2. Material behaviors due to different types of loading will be discussed.
3. To understand how to develop shear-moment diagrams of a beam.
4. To understand how to find the maximum moment/shear and their locations.
5. To understand the basic principles of fluid mechanics.

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

CO1. Analyse the behaviour of the solid bodies subjected to various types of loading.
CO2. Apply knowledge of materials and structural elements to the analysis of simple structures.
CO3. Undertake problem identification, formulation and solution using a range of analytical methods.
CO4. Able to explain the effect of fluid properties on a flow system.

UNIT – I: Simple Stresses &Strains: Elasticity and plasticity – Types of stresses & strains–Hooke's law– stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio & volumetric strain – Elastic moduli & the relationship between them – Temperature stresses.

UNIT – II: Shear Force and Bending Moment: Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, uniformly distributed loads, and uniformly varying loads – Point of contra flexure.

UNIT – III: Flexural Stresses: Theory of simple bending – Assumptions – Derivation of bending equation: $M/I = f/y = E/R$; Neutral axis – Determination of bending stresses; section modulus of rectangular and circular sections (Solid). Torsion of Circular Shafts: Theory of pure torsion – Derivation of Torsion equations: $T/J = q/r = N\theta/L$ – Assumptions made in the theory of pure torsion– Polar section modulus.

UNIT – IV: Fluid Properties: Dimensions and Units: Physical properties of Fluids -density, specific weight, specific gravity, viscosity vapour pressure -atmospheric gauge and vacuum pressure - measurement of pressure – manometers – Piezometer, U-tube, and Differential Manometers.

UNIT – V: Fluid Kinematics: Basic definition of Streamline, path line, streak lines, and classification of flows: steady, unsteady, uniform, non-uniform, laminar, turbulent, rotational and irrotational flows. Equation of continuity for 1-dimensional flow.
Fluid Dynamics: Surface and body forces- Euler's and Bernoulli's equations for flow along a streamline, Measurement of Flow: Venturi meter, Orifice meter.

Suggested Readings:

1. Strength of Materials by S. S. Rattan, Tata McGraw Hill Education Pvt. Ltd
2. Strength of Materials by Bhanikatti
3. Hydraulics, Fluid mechanics and Hydraulic Machinery - MODI and SETH.
4. Fluid Mechanics and Hydraulic Machines by Rajput.

Reference Books:

1. U. C. Jindal, “Strength of Materials”, Pearson Education India,2012
2. Strength of Materials by R.K.Bansal
3. Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, Kotaria & Sons.

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B. Tech. in Metallurgical and Materials Engineering
III Semester Syllabus
MM304PC: Physical Metallurgy

Course Objectives:

1. The prime objective of this course is to make the student gain an understanding of the relation between microstructural characteristics and properties of metals and alloys.
2. The course also critically focuses on the crystallography, phase transformations that occur in several ferrous and nonferrous metallurgical systems as a function of temperature and composition through phase equilibrium diagrams.

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

CO1. Apply the concepts of strengthening mechanisms to alloy systems.
CO2. Construct the binary alloy phase diagrams.
CO3. Apply the Kinetics of phase transformations in alloy systems.
CO4. Analyse the microstructure-property correlation of alloy systems.
CO5. Select the materials required for engineering applications.
CO6. Learn the physical metallurgy concepts of non-ferrous alloy systems.

UNIT-I: Introduction: Importance of alloying, Constitution of Alloys. Grain size measurement methods–ASTM grain size measurement, Linear intercept method, Jeffrey's planimetric method, microstructures of pure metals, microstructure of different alloys; Dislocation strengthening mechanisms and slip systems, strengthening mechanisms: Grain boundary strengthening, work hardening, solid solution strengthening, precipitation hardening and dispersion strengthening.

UNIT-II: Equilibrium Diagrams: Experimental methods for construction of equilibrium diagrams, Unary phase diagram, Isomorphous systems, Phase rule and its applications, Lever rule and its applications, Equilibrium heating and cooling of an isomorphous alloy, Coring, Miscibility gaps, Eutectic systems, Congruent melting intermediate phases, Eutectoid, Peritectic, Peritectoid, Monotectic and Syntectic reactions. Study of important binary systems of Cu-Zn, Cu-Sn, Pb-Sn.

UNIT-III: Study of Fe-Fe_3C phase diagram. Interpretation of solidification behaviour and microstructure of different alloys belonging to different systems. Introduction to TTT diagrams of Steels, Effect of alloying elements on Fe-Fe_3C phase diagram and TTT diagrams; CCT diagrams, Austempering and Martempering.

UNIT-IV: Types of Cast Irons; Classification of Stainless steels; Maraging steels, Hadfield Mn steels, Electrical steel, Introduction to Dual phase steels, Twinning induced plasticity (TWIP) steels and Transformation induced plasticity (TRIP) steels.

UNIT-V: Introduction to Al alloys, classification, properties, and applications. Physical metallurgy of Al-Cu, Al-Mg, Al-Mn systems. Introduction to ternary phase diagrams, Study of Al-Mg-Si Al-Zn-Mg Systems. Introduction to Ti alloys: Commercially pure Ti, its properties, and applications. Classification of Ti alloys. Alpha Ti alloys, Beta Ti alloys and alpha plus beta Ti alloys, Ti–5Al–2.5Sn, Ti-5553 alloy and Ti-6Al-4V alloys.

Textbooks:

1. Introduction to Physical Metallurgy - Sidney H Avner - Mc Graw Hill Publications
2. Physical Metallurgy Principles - Robert E. Reed-Hill – Cengage Learning 4th Ed.
3. Physical Metallurgy: Principles and Practice - V. Raghavan – PHI Publications.

B. Tech. in Metallurgical and Materials Engineering
III Semester Syllabus
MM351PC: Physical Metallurgy Lab

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Course Objectives:

The laboratory course helps to:
1. Gain skills of preparation of samples for metallographic examinations.
2. Find and analyze the microstructures of various ferrous and non-ferrous materials.
3. Use the suitable metallurgical microscope with suitable magnification.

Course Outcomes: By completing this laboratory course, students:

CO1. Can describe the sample preparation, mounting and use/choosing of different etching reagents.
CO2. Can identify and report the microstructural features of ferrous and non-ferrous samples observed.
CO3. Can operate optical microscope with an ease.
CO4. Characterize microstructures of engineering alloys using optical microscopy and image analyzer.

List of Experiments

1. Understanding of Constructional features and principle of Optical microscope.
2. Cold and Hot mounting of miniature samples
3. Metallographic preparation and microstructure evaluation of steels.
4. Metallographic preparation and microstructure evaluation of Non-ferrous metals and alloys.
5. Metallographic preparation and microstructure evaluation of different cast irons (grey cast iron, white cast iron, malleable cast iron, spheroidal graphite iron).
6. Measurement of Grain size by ASTM method, Heyn's Intercept Method, Jeffery's Planimetric method
7. Determination of phase fraction and grain size using Image analyser.
8. Identification of various zones in welded structures
9. Compare and evaluate the microstructures of stainless steels using chemical etching and electrolytic etching.
10. Determination of type of inclusions in steels, using ASTM Standard charts
11. Drawing of the Binary phase diagrams of (Cu-Ni), Eutectic (Pb-Sn, Al-Si) and partial solubility diagram (Al-Cu) with interpretation.
12. Study of sample preparation for electron microscopy

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B. Tech. in Metallurgical and Materials Engineering
III Semester Syllabus
MM352PC: Mineral Processing Lab

Course Objectives:

This laboratory course is designed to make the student to recognize and demonstrate the process variables in mineral processing operations. The students also gain hands-on laboratory experience by performing mineral liberation, sizing and finally concentration processes.

Course Outcomes: The student would gain hands on experience to

CO1. Recognize the sampling process and movement of the mineral particle in fluid by justified by Stoke's Law.
CO2. Identify the Particle Size and its distribution of a given material using Sieve Analysis Data.
CO3. Differentiate the reduction ratio, capacities of Jaw crusher and Roll crusher.
CO4. Appraise the ability of the minerals to be grounded using Grinding mill and Hard groove Grindability Tester.
CO5. Analyze the concentration operation such as Magnetic separation, Jigging, Wilfley Table for economic recovery of minerals.

1. Sampling of an ore from the bulk by
   (a) Coning and quartering method and (b) Riffle sampler methods
2. Sizing of material by Sieve analysis.
3. Verification of Stokes' Law.
4. Determining the reduction ratio of a Jaw crusher.
5. To determine the variation of reduction ratio with process variables in Rolls crusher.
6. Effect of process variables on reduction ratio and particle size distribution in Ball mill.
7. To find the grindability index of coal.
8. Study the Laws of Comminution and their verification.
9. Determination of the efficiency of a magnetic separator.
10. Study the working principle of a jig.
11. Study the particle separation by fluid flow using Wilfley table.

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B. Tech. in Metallurgical and Materials Engineering
III Semester Syllabus
MM353PC: Basic Metallurgical Computations Lab

Course Objectives:

1. This course is designed to make the student to demonstrate simple programming skills.
2. To provide practice on the computational methods for evaluation of metallurgical and materials engineering problems**.**

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

CO1. For phase rule, ASTM grain size number and packing factor in cubic crystals.
CO2. For calculation of ultimate tensile strength (UTS), yield strength (YS), % elongation and % reduction in area and Hall Petch relation.
CO3. For determination of heat transfer
CO4. For determination of free energy, entropy, and enthalpy
CO5. For determination of electrochemical properties

List of Experiments: Programming of

1. Estimation of proportion of phases using Lever rule, ASTM grain size and packing factor for BCC, FCC, and HCP cubic crystals.
2. Determination of ΔH using Kirchhoff's equation, ΔG° from enthalpy and entropy data.
3. To solve the problems on heat conductions
4. Calculation of ultimate tensile strength (UTS), yield strength (YS), and Hall Petch relation
5. Functions in computing free energy of common metallurgical systems from enthalpy, entropy and/or heat capacity and determination of temperature of reduction of metal oxides.
6. Computation of % CO/CO_2 with a given temperature profile along the height of blast furnace and reduction reactions.
7. Write a program to simulate mechanical properties of pure metal/ simple binary isomorphous/ eutectic system from given composition, heat treatment condition, % cold working etc.
8. Write a program to design sacrificial anode for cathodic protection of underground pipeline with given pipe dimensions and electrochemical properties.

Suggested Readings:

1. Computer oriented Numerical methods – V. Rajaraman (PHI Publications)
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)

B. Tech. III Semester Syllabus

MC301HS: Constitution of India
(CE, ME, ECE, MCT & MME)

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Course Objectives

- Students will get to know about the history of Indian Constitution.
- Students will get to know about President Election and his Power.
- Students will get to know about Council of Ministers and their election procedureand their powers and responsibilities.
- Students will get to know about Judicial System in India.
- Students will get to know about Panchayat-raj System in India.

Course Outcomes

CO1. This enables the Students to know about the Rights of Citizen.
CO2. This enables the Students to know about Fundamental Duties of People.
CO3. This enables the Students to Know the Directive principles of State Policy.
CO4. This enables the Students to know about Functioning of Parliament and its Powers.
CO5. This enables the Students to know about various Constitutional bodies in India.

Course content

1. Meaning of the constitution, law and constitutionalism
2. Historical perspective of the Constitution of India
   - Drafting Committee
3. Salient features and characteristics of the Constitution of India
   - Preamble
   - Salient Features
   - Major Sources of Indian Constitution
4. Scheme of the fundamental rights
   - Article 13 to 32
   - Scheme of the Fundamental Right to Equality
   - Scheme of the Fundamental Right to certain Freedom
   - Scope of the Right to Life and Personal Liberty
5. The scheme of the Fundamental Duties and its legal status
   - List of Fundamental Duties
   - Justifiability of Fundamental Duties
6. The Directive Principles of State Policy – Its importance and implementation
   - Categories - Gandhian, Socialist and Liberal Principles
   - Significance of Directive Principles of State Policy
   - Relation between Fundamental rights and Directive Principles of State Policy
7. Federal structure and distribution of legislative and financial powers between theUnion and the States
   - Union List

- State List
- Concurrent List
- Residuary Powers

8. Parliamentary Form of Government in India.
9. The constitutional powers and status of the President of India vs the constitutionalpowers and status of the Council of ministers headed by the Prime Minister
10. Amendment of the Constitution and its Procedure
    - Procedure of Amendment to Constitution of India
    - Important Amendments
11. Emergency Provisions: National Emergency, President Rule, Financial Emergency
12. Local Self Government – Constitutional Scheme in India
    - Urban local Self Government
    - Rural local Self Government
13. Important Constitutional Bodies
    - Election Commission of India
    - Finance Commission of India
    - Union Public Service Commission
    - C-AG

Suggested Readings:

1. Subhash Kashyap, Our Constitution, National Book Trust, 5th Edition, Reprint- 2017.
2. V. N Shukla, The Constitution of India, Law literature Publication, 11th Edition, 2020.

Reference Books:

1. M P Jain, Indian Constitutional Law, Lexis Nexis, 8th Edition, 2018.
2. Samar Aditya Pal, Indian Constitution-Origin& Evolution, Lexis Nexis, 1st Edition,2019.

MAHATMA GANDHI INSTITUTE OF TECHNOLOGY (Autonomous)
IV Semester Syllabus
EE431ES: BASIC ELECTRICAL AND ELECTRONICS ENGINEERING
(Common for CE, ME and MME)

L	T	P	C
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Prerequisite: Mathematics and Physics

Course Objectives:

1. To understand magnetic circuits, DC circuits and AC single phase & three phase circuits
2. To impart the knowledge of various electrical installations
3. To study and understand the different types of DC/AC machines and Transformers.
4. To introduce the concepts of diodes & filters
5. To impart the knowledge of various configurations, characteristics and applications in transistors and field effect transistors.

Course Outcomes: After completion of the course, students will be able to:

CO1. To analyze and solve electrical circuits using network laws and theorems.
CO2. To introduce components of Low Voltage Electrical Installations
CO3. To study the working principles of Electrical Machines
CO4. To understand and analyze basic diode and rectifier configurations
CO5. To identify and characterize various types of transistors.

UNIT-I: ELECTRICAL CIRCUITS

DC Circuits: Electrical circuit elements (Resistor, Inductor & Capacitor), Ohm's Law, voltage and current sources (Independent and Dependent), Kirchhoff's Laws, Mesh Analysis, Nodal Analysis, Delta-Star & Star Delta Conversion

AC Circuits: Representation of sinusoidal waveforms, peak value and rms values, phasor representation, Analysis of single-phase ac circuits with phasor diagrams, Three-phase balanced circuits, voltage and current relations in star and delta connections

UNIT-II: ELECTRICAL INSTALLATION

Miniature Circuit Breaker (MCB), Types of Wires and Cables, Earthing, Types of earthing, Batteries, Elementary calculations for energy consumption.

UNIT-III: ELECTRICAL MACHINES

Working principle of Single-phase transformer, equivalent circuit, phasor diagram of transformer at no load and load, losses in transformers, efficiency & regulation calculation. Construction and working principle of DC generators, Types of DC generators: Separately excited, Self-Excited (Shunt, Series, Compound), EMF equation. Working principle of DC motors, Types of DC motors,

Torque equations Construction and working principle of Three-phase Induction motor, Slip, Torque equations, Construction and working principle of synchronous generators.

UNIT-IV: ELECTRONIC DEVICES

Diodes : Principle of Operation, Forward bias, Reverse bias, Static Volt-Ampere characteristics, Static and dynamic resistances, Operation of Zener diode, Characteristics of zener diode and applications.

Rectifiers and Filters: P-N junction as a rectifier - Half Wave Rectifier, Full Wave Rectifier, Bridge Rectifier, Filters – Inductor Filters, Capacitor Filters

UNIT-V: TRANSISTORS

Bipolar Junction Transistor (BJT) - Construction, Principle of Operation, Common Emitter, configurations, Input and Output Characteristics. Transistor Application: Transistor as Amplifier & Transistor as Switch.

Field Effect Transistor (FET): Construction, Principle of Operation of JFET, Output Characteristics, Transfer Characteristics, JFET applications: JFET as Amplifier & JFET as a Switch, Comparison of Bipolar Junction Transistor and Field Effect Transistor, Biasing of FET.

Suggested Readings:

1. Sukija, TK Nagasarkar Basic Electrical and Electronics Engineering – Oxford University.
2. D.P. Kothari, I J Nagrath, Basic Electrical and Electronics Engineering - McGraw Hill Education.

Reference Books:

1. R. L. Boylestad and Louis Nashelsky, Electronic Devices and Circuits, PEI/PHI, 9th Ed, 2006.
2. Millman and C. C. Halkias, Satyabrata Jit, Millman's Electronic Devices and Circuits, TMH, 2/e, 1998.
3. William Hayt and Jack E. Kemmerly, Engineering circuit analysis, McGraw Hill Company, 6th edition.

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B. Tech. in Metallurgical and Materials Engineering
IV Semester Syllabus

MA403BS: Probability, Statistics and Complex Variables

(ME, MCT and MME)

Course Objectives

- The ideas of random variables and various discrete and continuous probability distributions and their properties.
- The concept of theoretical distributions
- The testing of hypothesis and making statistical inferences
- Differentiation of complex valued functions.
- Evaluation of integrals using Cauchy's integral formula and Cauchy's residue theorem.
  Expansion of complex functions using Taylor's and Laurent's series.

Course Outcomes: After completion of the course the students will be able to:

CO1. Formulate and solve problems involving random variables and probability distributions
CO2. Understand the theoretical distributions
CO3. Apply concept of testing of hypothesis to case studies
CO4. Analyze the complex function with reference to their analyticity
CO5. Evaluating integrals using Cauchy's integral and residue theorems. Taylor's and Laurent's series expansions of complex function

UNIT-I: Random Variables and Probability Distributions **8 L**

Concept of a Random variables - Discrete and Continuous random variables and their distribution functions – Expectation, Variance and standard deviation of random variables.

UNIT-II: Theoretical Distributions **10 L**

Binomial, Poisson distributions and their properties, Poisson approximation to the binomial distribution, Uniform distribution, Normal distributions and its properties. Normal approximation to Binomial distribution

UNIT-III: Tests of Hypotheses:
10 L

Test of significance- Basics of testing of hypothesis, Null and Alternate hypothesis, types of errors, level of significance, Critical region, Large sample test - single mean, single proportion, difference of means, difference of proportions; Small sample tests- Student's t-distribution, single mean, difference of means.

UNIT-IV: Complex Differentiation **10 L**

Limit, Continuity and Differentiation of Complex functions, Analyticity, Cauchy-Riemann equations in Cartesian and Polar co-ordinates (without proof), finding harmonic conjugate, Mobius transformation.

UNIT-V: Complex Integration **10 L**

Line integral, Cauchy's theorem, Cauchy's Integral formula, Zeros of analytic functions, Singularities, Taylor's series, Laurent's series, Residues, Cauchy Residue theorem (All theorems without Proof).

Text Books:

1. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition,2010.
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, keying Ye, Probability and statistics for engineers and scientists, 9th Edition, Pearson Publications.
3.

Reference Books:

1. Fundamentals of Mathematical Statistics, Khanna Publications, S.C.Guptha and V.K.Kapoor.
2. Miller and Freund's, Probability and Statistics for Engineers, 8th Edition, Pearson Educations.
3. N.P.Bali and Manish Goyal, A textbook of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
4. J. W. Brown and R.V.Churchill, ComplexVariables and Applications, 7th Edition, Mc-GrawHill,2004.

B. Tech. in Metallurgical and Materials Engineering
IV Semester Syllabus
MM401PC: Mechanical Metallurgy

L	T	P	C
3	0	0	3

Course Objectives:

1. To develop a fundamental understanding of stress-strain behaviour, fracture mechanism
2. To provide practical skills on mechanical testing of metals
3. To learn issues related to high temperature such as creep.
4. To gain knowledge in strengthening mechanisms of metals
5. To understand the failure mechanism

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

CO1. Describe the basics of elastic and plastic deformation behaviour in metals and analyse the role of dislocations in plastic deformation of metals (PO 1,2)
CO2. Recognise the types of fracture in metals and demonstrate the hardness testing practices. (PO 1,2)
CO3. Analyse the tensile behaviour of metals and other mechanical testing practices. (PO 1,2)
CO4. Explain fatigue and creep behaviour of metals. (PO 1,2)
CO5. Evaluate &design metals for better Fatigue &creep resistance (PO 1,2,3,4)

UNIT – I: Plastic Deformation in Metals and Alloys: Introduction. Defects in crystalline materials Point defects and line defects. The concept of dislocation - Theoretical Shear Strength, Edge dislocation and screw dislocation. Burger's vector, Critical resolved shear stress. Energy of Dislocations, Force Required to Bow a Dislocation, Intersection of Dislocations, Dislocation Pileups, The Peierls--Nabarro Stress, extended dislocations, sessile dislocation, glissile dislocation, dislocation climb, Jogs, Forces on dislocations. Frank Reed source, slip and twinning.

UNIT -II: Hardness Test: Brinell, Vickers, Rockwell, Microhardness test, relationship between hardness and other mechanical properties, Nanoindentation. **The Tension Test:** Engineering stress-strain and True stress-strain curve. Tensile properties, conditions for necking, effect of temperature and strain rate on tensile properties. Elastic and in-elastic action and properties in compression test. **The Impact Test:** Notched bar impact test and its significance, Charpy and Izod Tests, fracture toughness testing - COD and CTOD tests, significance of DBTT, metallurgical factors affecting on transition temperature, temper embrittlement.

UNIT - III Fracture: Types of fracture in Metals, Elementary theories of fracture, Griffith's theory of brittle fracture, Theoretical cohesive Strength of metals, ductile fracture, notch sensitivity. Strain-Energy release rate, Stress Intensity Factor, Fracture Toughness, and design, K_{IC} Plane-Strain Toughness testing, plasticity corrections, J-Integral.

UNIT - IV Fatigue Test: Introduction, Stress cycles, S-N Curve, mechanism of fatigue failure, effect of mean stress, stress concentration, size, surface condition and environments on fatigue. Effect of metallurgical variables on fatigue. Low-cycle fatigue. High-cycle fatigue and thermal fatigue, Corrosion fatigue.

UNIT - V Creep and Stress Rupture: Introduction, The high temperature materials problem, Time dependent mechanical behaviour, The creep curve, Stress-rupture test, Structural changes during creep, Mechanism of creep deformation, Deformation mechanism maps, Activation energy for steady state

creep, superplasticity, fracture at elevated temperature, High temperature alloys. Effect of Metallurgical variables on creep.

Suggested Readings:

1. Mechanical Metallurgy, McGraw Hill Book Company, – G. E. Dieter.
2. Mechanical Behaviour Materials, McGraw Hill, – Thomas H. Courtney
3. Mechanical behaviour of materials, Meyers, and Chawla

Reference Books:

1. Derek Hull and D.J. Bacon: Introduction to Dislocations, Pergamon Press,
2. K. Bowman: Mechanical Behaviour of Materials, Wiley,

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B. Tech. in Metallurgical and Materials Engineering
IV Semester Syllabus
MM402PC: Heat Treatment and Phase Transformations

Course Objectives:

1. To introduce the student to key concepts in Phase transformations and enable an understanding of the steps involved in several important phase transformations like Pearlitic, Bainitic, Martensitic, Order and Disorder Transformations.
2. Introduce the concepts of heat treatments, Surface treatments and Thermo-mechanical treatments.

Course Outcomes:

CO1. Apply the fundamental concepts of diffusion and derive solutions to real time industrial problems.
CO2. Co-relate the microstructure and mechanical properties of alloys, by learning the fundamental concepts of phase transformations.
CO3. Design of heat treatment cycles to ferrous and non-ferrous alloys to achieve the desired properties required by the industry.
CO4. Determination the hardenability of steels
CO5. Apply the concepts of surface treatments in producing the automobile components
CO6. Learn and apply the concepts of thermomechanical treatment of steels.

Unit-I: Diffusion in Solids: Atomic model of diffusion and role of crystal defects, Fick's laws of diffusion, solution of Fick's second law and its applications, temperature dependence of diffusion coefficient, Kirkendall effect.

Unit-II: Phase transformations with diffusion: Diffusional transformation in solids, Nucleation and growth, energy considerations; homogeneous nucleation, heterogeneous nucleation, growth kinetics, overall transformation rates. Mechanisms of Pearlitic and Bainitic transformations. Order-disorder transformation, examples of ordered structures, long and short range order, detection of super lattices, influence of ordering on properties. Residual stresses and their evaluation.

Unit-III: Diffusion less phase transformation in solids: Martensitic Transformations, General characteristics of martensitic reactions, similarity to deformation twinning, Bain distortion, crystallography and kinetics of martensitic transformations, examples from ferrous and non-ferrous alloy systems.

UNIT-IV: Heat treatment: Annealing, Normalizing, Hardening, and tempering. Mechanism of heat removal during quenching, quenching media, size effect and mass effect. Tempering and its stages, Heat Treatment of tool steels (double tempering and triple tempering, Subzero treatment, Patenting. Phase transformations in low alloys steels (bainitic transformations), Hardenability of steels, Factors affecting and its determination.

UNIT-V: Surface treatments and Thermo mechanical treatments: Surface Hardening: Principles and Applications of Carburizing, Nitriding, Carbonitriding, Nitrocarburizing, Boronizing and Aluminizing; Flame, Induction and Laser surface hardening. Thermo mechanical treatments: HTMT, LTMT, Ausforming, Isoforming, Cryoforming.

Suggested Readings:

1. Heat Treatment Principle and Techniques – T.V. Rajan, C.P. Sharma, Ashok Sharma, 2nd edition, 2011.

2. Phase Transformations in Metals and Alloys - David A. Porter, Kenneth E. Easterling, and Mohamed Y. Sherif, 4th edition, CRC Press, Taylor & Francis Group, 2021

Reference Books:

1. Heat Treatment of Metals - Vijendra Singh, Standard Publishers Distributors, 2020.
2. Engineering Physical Metallurgy –Y. Lakhtin, CBS Publishers & Distributors, 2009.
3. Physical Metallurgy for Engineers - R. Varney Wilbur Donald S. Clark, published by Affiliated East-West Press (Pvt.) Ltd, 2018.
4. Physical Metallurgy Principles - Robert E. Reed-Hill, published by Affiliated East-West Press, 2008.

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B. Tech. in Metallurgical and Materials Engineering
IV Semester Syllabus
MM403PC: Steel Making

Course Objective: This course is primarily of industrial oriented and designed to make the student to understand and demonstrate the

1. Principles of steel making processes
2. Various primary steel making processes, Hot metal route and scrap route,
3. Casting pit side practice, Continuous casting of steel.
4. Secondary steel making process to produce quality steels for critical applications.

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

CO1. To apply the principles in steel making processes.
CO2. To suggest the steel making process based on the available sources.
CO3. To know the importance of secondary steel making processes and apply the same to produce steels for critical applications.
CO4. To get the knowledge of producing quality steels with more efficiency.

UNIT I: Introduction to Steel Making: Current scenario of steel making in India and world, Raw materials of steel making. Factors affecting the efficiency of steel making. **Principles of Steel making**; Removal of Carbon, Silicon, Manganese, phosphorous and sulphur. Role of slag, types, and properties of slags. Molecular and ionic theory of slags. Principles of deoxidation. Precipitation and diffusion deoxidation.

UNIT II: Primary Steel Making (Hot Metal): Steel making by Acid and Basic Bessemer Processes, Construction and lining details, sequence of elimination of impurities, Steel Making by LD process, Construction, lining and process details in LD, LD-AC or OLP, Kaldo, LD-Kaldo, Rotor oxygen steel making, Oxygen bottom blowing (OBM), Hybrid process of steel making, Improvements and modification of the above steel making process.

UNIT III: Primary Steel Making (From Scrap): Open Hearth Steel Making: Construction and process details; Electric Arc Furnace (EAF); Construction and Process details: Induction furnace. Stainless steel making.

UNIT IV: Secondary Steel Making: Secondary steel making processes. Electro Slag Remelting (ESR), Vacuum Arc Remelting (VAR). Brief outline of manufacture of alloy steels. Vacuum treatment of steels. AOD, VOD, Synthetic slag treatments, De-carburization techniques de-gassing of steel Powder injection etc. methods

UNIT V: Solidification of steels: Ingot defects and remedies; Casting pit side practice: Types of Moulds, Teeming Methods, Killed, Semi Killed, capped, and rimmed Steels, Continuous casting of steels.

Suggested Readings:

1. Steel Making – V. Kudrin
2. Modern Steelmaking – Dr. R.H. Tupkary and V.H. Tupkary
3. Steel Making – A. K. Chakravarthy (PHI) 2007

References:

1. Iron Making & Steel Making Theory and Practice - Ahindra Ghosh & Amit Chatterjee
2. Secondary Steel Making; Principles and applications – Ahindra Ghosh
3. Physical Chemistry of Iron & Steel by Bodsworth.
4.

B. Tech. in Metallurgical and Materials Engineering
IV Semester Syllabus
EE461ES: BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY
(Common for CE, ME and MME)

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Prerequisite: Basics of Electrical and Electronics Engineering

Course Objectives:

1. To study a given network by applying various electrical laws
2. To understand the performance characteristics of DC and AC machines
3. To understand the characteristics of PN junction and Zener Diode
4. To understand the applications of diode as rectifiers
5. To understand the characteristics of BJT and FET

Course Outcomes:

After completion of the course, students will be able to:

1. Analyze network by applying various electrical laws
2. Analyze performance characteristics of DC and AC machines
3. Analyze the characteristics of PN junction and Zener Diode
4. Acquire the knowledge of various rectifier configurations
5. Analyze the characteristics of BJT and FET

LIST OF EXPERIMENTS/ DEMONSTRATIONS:

PART A: ELECTRICAL

1. Verification of KVL and KCL
2. Measurement of Voltage, Current and Real Power in primary and Secondary Circuits of a Single-Phase Transformer
3. Measurement of Active and Reactive Power in a balanced Three-phase circuit
4. Performance Characteristics of a DC Shunt Motor
5. Performance Characteristics of a Three-phase Induction Motor
6. No-Load Characteristics of a Three-phase Alternator

PART B: ELECTRONICS

1. Study and operation of
    a. Multi-meter (ii) Function Generator (iii) Regulated Power Supply (iv) Cathode Ray Oscilloscope.
2. PN Junction diode characteristics
3. Zener diode characteristics and Zener as voltage Regulator
4. Input & Output characteristics of Transistor in CE configuration
5. Full Wave Rectifier with & without filters
6. Input and Output characteristics of FET in CS configuration

Any 5 experiments from PART-A and 5 experiments from PART-B are to be conducted.

Suggested Readings:

1. Basic Electrical and electronics Engineering –M S Sukija TK Nagasarkar Oxford University
2. Basic Electrical and electronics Engineering-D P Kothari. I J Nagarath, McGraw Hill Education

Reference Books:

1. Electronic Devices and Circuits – R. L. Boylestead and Louis Nashelsky, PEI/PHI, 9th Ed, 2006.
2. Engineering circuit analysis- by William Hayt and Jack E. Kemmerly, McGraw Hill Company, 6th edition.
3. Network Theory by N. C. Jagan& C. Lakshminarayana, B.S. Publications.
4. L. S. Bobrow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2011.
5. E. Hughes, “Electrical and Electronics Technology”, Pearson, 2010.
6. V. D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989

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B. Tech. in Metallurgical and Materials Engineering
IV Semester Syllabus
MM451PC: Mechanical Metallurgy Lab

Course Objectives:

To gain knowledge of various mechanical tests and working principle of different mechanical testing machines.

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

CO1. Analyse, interpret and present the observation from the tests conducted.
CO2. Understand and conduct hardness, tension, and impact tests
CO3. Explain the relationships between metallurgy of the metals and their mechanical properties.
CO4. Prepare formal laboratory reports describing the experimental and the results obtained.

List of Experiments:

1. Determine the hardness of ferrous and non-ferrous samples using Brinell hardness Testing Machine.
2. Determine the hardness of ferrous and non-ferrous samples using Rockwell hardness Testing machine
3. Determine the hardness of ferrous and non-ferrous samples using Vickers hardness Testing machine
4. To determine the tensile properties of ductile ferrous materials.
5. To determine the tensile properties of ductile non-ferrous materials.
6. To determine the impact toughness of a given material by Charpy and Izod tests.
7. Torsion Test: -To determine the modulus of rigidity of a given material
8. Compare engineering stress-strain curve and true stress true-strain curve of ferrous/nonferrous metal.

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B. Tech. in Metallurgical and Materials Engineering
IV Semester Syllabus
MM452PC: Heat Treatment and Phase Transformations Lab

Course Objectives:

This course is designed to.
1. To conduct various heat treatment processes, surface hardening techniques and age hardening processes on different materials.
2. Gain knowledge of phase transformations taking place under various conditions of heat treatment.

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

CO1. Conduct heat treatment in furnaces under suitable/ required time, temperature and atmospheric conditions.
CO2. Modify the microstructures of metals and alloys through heat treatment practice for obtaining desired properties in present and future.
CO3. To modify the surface properties of steels.
CO4. To determine hardenability by performing Jominy end quench test
CO5. Analyze, correlate, and interpret the results obtained in the tests conducted.
CO6. Report the observations in a formal manner

List of Experiments:

1. Annealing of plain carbon steel and observation of microstructure.
2. Normalizing of plain carbon steel and observation of microstructure.
3. Hardening of plain carbon steel with quenching in water and brine solution and observation of microstructures.
4. Hardening of plain carbon steel with quenching in oil and observation of microstructure.
5. Effect of tempering temperature on plain carbon steel.
6. Effect of tempering time on plain carbon steel.
7. Age hardening of Aluminum - Copper alloys.
8. Spheroidizing of a given high carbon steel.
9. Recrystallization studies of nonferrous metals and alloys.
10. Determination of hardenability of medium carbon steel by Jominy end quench test.
11. Determination of phase fraction and grain size of heat treated samples using Image analyzer

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B. Tech. in Metallurgical and Materials Engineering
B. Tech. IV Semester Syllabus
MC451HS: GENDER SENSITIZATION LABORATORY
(CE, ME, ECE, MCT & MME)

Course Objectives

This course aims:

- To develop students' sensibility with regard to issues of gender in contemporary India.
- To provide a critical perspective on the socialization of men and women.
- To introduce students to information about some key biological aspects of genders.
- To expose the students to debates on the politics and economics of work.
- To help students reflect critically on gender violence.
- To expose students to more egalitarian interactions between men and women.

Course Outcomes

CO1. Students will have developed a better understanding of important issues related to gender in contemporary India.
CO2. Students will be sensitized to basic dimensions of the biological, sociological, psychological and legal aspects of gender. This will be achieved through discussion of materials derived from research, facts, everyday life, literature and film.
CO3. Students will attain a finer grasp of how gender discrimination works in our society and how to counter it.
CO4. Students will acquire insight into the gendered division of labour and its relation to politics and economics.
CO5. Men and women students and professionals will be better equipped to work and live together as equals.
CO6. Students will develop a sense of appreciation of women in all walks of life.
CO7. Through providing accounts of studies and movements as well as the new laws that provide protection andrelief to women, the textbook will empower students to understand and respond to gender violence.

Course Description

This course offers an introduction to Gender Studies, an interdisciplinary field that asks critical questions about the meanings of sex and gender in society. The primary goal of this course is to familiarize students with key issues, questions and debates in Gender Studies, both historical and contemporary. It draws on multiple disciplines – such as literature, history, economics, psychology, sociology, philosophy, political science, anthropology and media studies – to examine cultural assumptions about sex, gender, and sexuality. This course integrates analysis of current events through student presentations, aiming to increase awareness of contemporary and historical experiences of women, and of the multiple ways that sex and gender interact with race, class, caste, nationality and other social identities. This course also seeks to build an understanding and initiate and strengthen programmes combating gender-based violence and discrimination. The course also features several exercises and reflective activities designed to examine the concepts of gender, gender-based violence, sexuality, and rights. It will further explore the impact of gender- based violence on education, health and development.

Unit-I: Understanding Gender

Introduction: Definition of Gender-Basic Gender Concepts and Terminology-Exploring Attitudes towards Gender- Construction of Gender-Socialization: Making Women, Making Men - Preparing for Womanhood. Growing up Male.

Unit-II: Gender Roles and Relations

Two or Many? -Struggles with Discrimination-Gender Roles and Relations-Types of Gender Roles-Gender Roles and Relationships Matrix-Missing Women-Sex Selection and Its Consequences-Declining Sex Ratio. Demographic Consequences-Gender Spectrum: Beyond the Binary

Unit-III: Gender and Labour

Division and Valuation of Labour-Housework: The Invisible Labor- "My Mother doesn't Work." "Share the Load."-Work: Its Politics and Economics -Fact and Fiction. Unrecognized and Unaccounted work. -Gender Development Issues-Gender, Governance and Sustainable Development-Gender and Human Rights-Gender and Mainstreaming

Unit–IV: Gender - Based Violence

The Concept of Violence- Types of Gender-based Violence-Gender-based Violence from a Human Rights Perspective-Sexual Harassment: Say No! -Sexual Harassment, not Eve-teasing-Coping with Everyday Harassment- Further Reading: "Chupulu".

Domestic Violence: Speaking Out -Is Home a Safe Place? -When Women Unite [Film]. Rebuilding Lives. Thinking about Sexual Violence Blaming the Victim-"I Fought for my Life…."

Unit – V: Gender and Culture

Gender and Film-Gender and Electronic Media-Gender and Advertisement-Gender and Popular Literature- Gender Development Issues-Gender Issues-Gender Sensitive Language-Gender and Popular Literature - Just Relationships: Being Together as Equals Mary Kom and Onler. Love and Acid just do not Mix. Love Letters. Mothers and Fathers. Rosa Parks-The Brave Heart.

Note: Since it is Interdisciplinary Course, Resource Persons can be drawn from the fields of **English Literature** or Sociology or Political Science or **any other qualified faculty who has expertise in this field from engineering departments.**

- Classes will consist of a combination of activities: dialogue-based lectures, discussions, collaborative learning activities, group work and in-class assignments. Apart from the above prescribed book, Teachers can make use of any authentic materials related to the topics given in the syllabus on "Gender".

Suggested Readings:

- The Textbook, "Towards a World of Equals: A Bilingual Text Book on Gender" written by A. Suneetha, Uma Bhrugubanda, DuggiralaVasanta, Rama Melkote, Vasudha Nagaraj, Asma Rasheed, Gogu Shyamala, Deepa Sreenivas and Susie Tharu published by Telugu Akademi, Telangana Government in 2015.

Assessment and Grading:

- Discussion & Classroom Participation: 20%
- Project/Assignment: 30%
- End Term Exam: 50%.