**B.Tech. in Metallurgical and Materials Engineering**
Scheme of Instruction and Examination
**(Choice Based Credit System)**

## III Semester

| S.No | Course Code | Course Title | Instruction | | | Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | Hours Per Week | | | Max. Marks | | Duration of SEE in Hours | |
| | | | L | T | P/D | CIE | SEE | | |
| 1 | MM301PC | Materials Thermodynamics | 3 | 1 | 0 | 30 | 70 | 3 | **4** |
| 2 | MM302PC | Physical Metallurgy | 3 | 1 | 0 | 30 | 70 | 3 | **4** |
| 3 | MM303PC | Mineral Processing | 3 | 0 | 0 | 30 | 70 | 3 | **3** |
| 4 | MM304PC | Introduction to Engineering Materials & applications | 3 | 0 | 0 | 30 | 70 | 3 | 3 |
| 5 | MM305PC | Mechanical Metallurgy | 3 | 0 | 0 | 30 | 70 | 3 | 3 |
| 6 | MC301HS | Constitution of India | 3 | 0 | 0 | 30 | 70 | 3 | **0** |
| 7 | MM351PC | Metallography Lab | 0 | 0 | 2 | 30 | 70 | 3 | **1** |
| 8 | MM352PC | Mineral Processing Lab | 0 | 0 | 2 | 30 | 70 | 3 | **1** |
| **9** | MM352PC | Mechanical Metallurgy | 0 | 0 | 2 | 30 | 70 | 3 | **1** |
| **10** | EN351HS | **Finishing School – I** | **0** | **0** | **2** | 30 | 70 | 3 | **1** |
| | | **Total Hours/Marks/Credits** | **18** | **2** | **8** | **300** | **700** | | **21** |

## IV-Semester

| S.No | Course Code | Course Title | Instruction | | | Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | Hours Per Week | | | Max. Marks | | Duration of SEE in Hours | |
| | | | L | T | P/D | CIE | SEE | | |
| 1 | MH407BS | Probability Distributions& Complex variables | 3 | 1 | 0 | 30 | 70 | 3 | **4** |
| 2 | EE431ES | Basic Electrical and Electronics Engg. | 3 | 0 | 0 | 30 | 70 | 3 | **3** |
| 3 | MM401PC | Heat Treatment and Phase Transformations | 3 | 1 | 0 | 30 | 70 | 3 | **4** |
| 4 | MM402PC | Iron Making | 3 | 0 | 0 | 30 | 70 | 3 | 3 |
| 5 | MM403PC | Non-Ferrous Extractive Metallurgy | 3 | 0 | 0 | 30 | 70 | 3 | **3** |
| 6 | EE461ES | Basic Electrical and Electronics Engg. Lab | 0 | 0 | 2 | 30 | 70 | 3 | **1** |
| 7 | MM451PC | Heat Treatment and Phase Transformation Lab | 0 | 0 | 2 | 30 | 70 | 3 | **1** |
| 8 | MM452PC | Extractive Metallurgy Lab | 0 | 0 | 2 | 30 | 70 | 3 | **1** |
| 9 | EN452HS | Finishing School – II | 0 | 0 | 2 | 30 | 70 | 3 | **1** |
| 10 | MC45IHS | Gender Sensitization Lab | 0 | 0 | 2 | 30 | 70 | 3 | **0** |
| | | **Total Hours/Marks/Credits** | **15** | **2** | **10** | **300** | **700** | | **21** |

**Department of Metallurgical and Materials Engineering**

B.Tech. III Semester Syllabus

**U21MM301PC: MATERIALS THERMODYNAMICS**

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**Course Objectives**:

- To emphasize the fundamental role of Thermodynamics in evolution of metallurgical and materials related processes.
- To understand the Laws of Thermodynamics and their applications
- To develop thorough knowledge on various thermodynamic functions and their interpretation into appropriate plots.
- To learn about applications of thermodynamic quantities in solutions
- To learn about the construction of Ellingham diagrams

**Course Outcomes**:

- Use various thermodynamic functions appropriately under different experimental situations
- Apply Gibbs Phase Rule to account for the attainment of equilibria of some of the significant metallurgical reactions
- Recommend the set of thermodynamic quantities required for facilitating an efficient process
- Adopt the thermodynamic quantities in decision making activity of extraction techniques

**Unit- I: Objectives and Limitations of Thermodynamics, concepts of system and state, heterogeneous and homogeneous systems, gases (12 hours)**

deal gas, Real gas, Van-der Waals; extensive and intensive properties, of system, thermodynamic variables, thermodynamic equilibrium. Reversible and irreversible processes. First Law of Thermodynamics: Nature of first law, relationship between heat and work, internal energy and the first law of thermodynamics, calculations of work, enthalpy change with temperature, Kirchhoff's equation.

**Unit-II: Second Law of Thermodynamics (12 hours)**

Efficiency of a cyclic process, Carnot cycle, Carnot theorem, second law of thermodynamics, concept of entropy, entropy and quantification of irreversibility, reversible processes. Third law of thermodynamics: Background of third law, deductions from third law, applications of third law, and other methods of obtaining $\Delta S^o$ for a reaction. Statistical interpretation of entropy, Boltzmann equation.

**Unit-III: Energy Functions (12 hours)**

Purposes of the new functions, definition of Helmholtz and Gibbs energy change, meaning of thermodynamically possible process, determination of $\Delta G$ from thermal data useful relationships among thermodynamic functions, Maxwell's equations and Gibbs-Helmholtz equation. Fugacity, activity and equilibrium constant: Concepts of fugacity, activity and equilibrium constant variation of the equilibrium constant with temperature. Application of the Clausius – Clapeyron equation for single substance, Integration of Clausius – Clapeyron equation.

**Unit-IV: Solutions (12 hours)**

Composition, Concept of chemical potential, partial molal quantities, Gibb's – Duhem equation, integration of Gibbs' - Duhem equation, ideal dilute solutions, ideal solutions, Raoults Law, actual (Non-ideal) solutions (Henry's Law), Sieverts law, Excess thermodynamics quantities. Free Energy – Composition Diagrams; Construction of Phase Diagrams

**Unit-V: Application of Ellingham diagrams to process metallurgy (12 hours)**

Introduction, calculation of equilibrium constants from standard energy changes, general description of Ellingham diagrams, Interpretation of two or more free energy change vs. temperature lines taken together, derivation and uses of the oxygen, nomographic scale in Richardson's diagrams.

**Text Books**:

1. Introduction to Thermodynamics of Materials, 5th Edition, David R Gaskell, Taylor and Francis,2016.
2. Principles of Metallurgical Thermodynamics/ SK Bose and SK Roy; Editor-in- Chief, Baldev Raj, Published by Universities Press (India) Private Limited, 2014.
3. Problems in Metallurgical Thermodynamics and Kinetics by G S Upadhyaya R.K. Dube, Pergamon Press.

**Reference Books**:

1. Thermodynamics in Materials Science, Robert De-Hoff, CRC Press, 2006.
2. Materials Thermodynamics with Emphasis on Chemical Approach, Hae-Geon Lee, World Scientific Publishing, 2012.

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B.Tech. III Semester Syllabus

**U21MM302PC: PHYSICAL METALLURGY**

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**Course Objectives**:

- To learn about the principles of alloy design, phase diagram and strengthening mechanisms in different metals and alloys
- To obtain knowledge about the physical metallurgy of specific and important engineering materials such as ferrous and non-ferrous alloys
- To develop a fundamental understanding of the relationships between material composition, structure, and properties resulting from synthesis, processing or service.
- To develop an understanding of the processes occurring in metals during heating that influence the microstructure and properties.
- To develop an understanding of the effects of alloying of metals upon the microstructure and properties

**Course Outcomes**:

- The ability to identify the concepts of alloy design, phase diagrams and strengthening mechanisms and apply them to materials systems
- The knowledge of heat treatment and the resulting microstructure in materials
- The knowledge of physical metallurgical aspects of important engineering alloys
- Ability to apply and integrate knowledge of structure, properties, processing, and performance to solve materials selection and design problems

**Unit-I: Metallic Crystal Structures: (9 hours)**

Space lattice, unit cell, packing factor, density calculations. Miller's indices, Planes and directions. Crystal defects, plastic deformation, Relation between crystal structure and ductility. Introduction to Grains, grain boundaries and microstructure, ASTM grain size. ASTM Grain Size. Strengthening mechanisms: solid solution hardening, work hardening, precipitation hardening, dispersion strengthening, and Grain boundary strengthening. Effect of grain size on mechanical properties.

**Unit II: Phase Diagrams: (9 hours)**

Binary Phase Diagrams, solid solutions, types of solid solutions, Intermediate phases, Intermetallic compounds, Hume-Rothery rules. Construction of phase diagrams: Isomorphous and eutectic systems-Specific examples: Cu-Ni, Pb-Sn, Al-Cu, Lever rule application to phase diagrams. Application of phase rule to phase diagrams.

**Unit-III: Iron-Carbon Phase Diagram: (9 hours)**

Iron Iron-carbide phase diagram and microstructural aspects of ledeburite, austenite, ferrite and cementite, cast iron. Annealing, Normalizing, Hardening, Tempering and Spheroidising. Isothermal transformation diagrams for Fe-C alloys, Construction and interpretation and microstructures developments. Austempering and Martempering.

**Unit-IV: Transformation Diagrams and Cast Irons: (9 hours)**

CCT Diagrams, Alloying of steel, Effect of alloying elements on Fe-C diagram TTT and CCT curves. Properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons

**Unit-V: Non-Ferrous Metals and Alloys: (9 hours)**

Copper and copper alloys (Brass, bronze and cupro-nickel)-Aluminum and Al-Cu alloys- Titanium alloys, Shape memory alloys.

Ordering and clustering tendencies of solution phases, ordered phase, miscibility gaps, and spinodal decomposition

**Text Books**:

1. Introduction to Physical Metallurgy by Sidney H Avner McGraw Hill
2. Physical Metallurgy: Principles and Practice, V. Raghavan, PHI Learning, Delhi, 2008.
3. William D. Callister , “Materials Science and Engineering”, John Wiley & Sons Inc2010.

**Reference Books**:

1. B.K.Agarwal, “Introduction to Engineering Materials”, Tata McGraw Hill-1stEdition.
2. V. Raghavan, “Material Science and Engineering”,-PHI Learning - 5th Edition.
3. R.K.Rajput, “Engineering Materials and Metallurgy”, - S.Chand - 1st Edition-2011
4. Physical Metallurgy Vols. I, II, III, R.W. Cahn and P. Haasen, North Holland, 1996.
5. Light Metals, I.J. Polmear, Elsevier, 2005

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B.Tech. III Semester Syllabus

**U21MM303PC: MINERAL PROCESSING**

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**Course Objectives:**

- To build the solid foundation on principles and working equipment for various size reduction operation known as Comminution.
- To impart fundamental understanding of various unit operations pertaining to identification of size both from qualitative and quantitative scale using Laboratory and Industrial Sizing.
- To describe the concepts of concentration (separation) as applied to the processing of minerals.
- To describe the range of activities for the production of a mineral concentrate

**Course Outcomes:**

- At the end of the course, the students would have understanding of the various unit operations, equipment and beneficiation techniques for processing of coal and minerals.
- Explain the principles governing a range of processes applied in the minerals industry.
- Describe typical unit processes and flow-sheets for production of a number of metals.
- Apply basic engineering principles to the design of minerals processes.
- Produce conceptual designs for simple extraction processes.
- Work proficiently and effectively in small teams.

**UNIT-I : Grinding: (9 hours)**

Scope and objectives of ore dressing, Sampling of ores by different methods, Theory of liberation of minerals, Crushers: - Jaw, Gyratory, Cone, Rolls and Toothed Roll Crushers,

Grinding: - Types of grinding operations like batch and continuous 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 : (9 hours)**

Study of laboratory sizing techniques and reporting of sizing data. Industrial sizing units: Types of screen surfaces. Grizzlies, Trommels, Vibrating and Shaking screens. Movement of solids in fluids: Stokes and Newton's laws. Terminal velocity and its relation 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, Classification of classifiers, Study of Settling Cones, Rake Classifier, Spiral Classifier and Cyclones.

**UNIT-III: Heavy media separation : (9 hours)**

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 - Design of Magnetic Separators, Low-intensity Drum Magnetic Separation, High-intensity Magnetic Separator – Induced Roll Separator and Jones Separator, Cryogenic Magnetic Separator and

Demagnetizer. Electrostatic separation process – Step – wise procedure for the separation. High-Tension Roll Separator and Plate & Screen Electrostatic separator.

**UNIT-IV: Jigging: (9 hours)**

Theory of jigging – Mechanism of stratification of jig. Jigging method – Jigging on the screen and Jigging through the screen. Jigging machines: Hand jig, 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. Theory and operation of shaking tables, Wilfley table.

**UNIT-V**: **Flotation: (9 hours)**

Principles of flotation. Physico-Chemical Factors affecting flotation – surface energy and surface tension, surface condition and surface reactivity, angle of contact, Natural floatability and acquired floatability, particle size, adsorption. Classification of collectors and frothers, Regulators – Activators, Depressants and pH Modifier, Factors affecting the efficiency of Chemical reagents, Flotation Machines: - Pneumatic and Mechanical Flotation cells, Application of flotation process for Cu, Pb and Zn ores.

**TEXT BOOK:**

1. Principles of Mineral Dressing by A.M. Gaudin

**REFERENCES:**

1. Elements of Ore Dressing - A. F. Taggart
2. Mineral processing technology - B. A. Wills
3. Ore dressing Practices - S. K. Jain

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B.Tech. III Semester Syllabus

**U21MM304PC: INTRODUCTION TO ENGINEERING MATERIALS AND APPLICATIONS**

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**Course Objectives** :

- To provide the students with basic knowledge of materials science, so that they would be able to understand and distinguish between variety of materials based on their structure and properties

**Course outcomes**:

- Students will get to know the different classes of materials used in engineering applications. Should be able to choose the right materials for specific applications

**Unit-I: Nature and Properties of Materials: (9 hours)**

Introduction to engineering materials, Classification of materials, Crystalline structures, structure property relationships, Crystal geometry, lattices, symmetry, points &pace groups, structure determination. Effect of processing ,structure and composition on material properties.

**Unit-II: Materials for high temperature applications: (9 hours)**

Superalloys, Titanium alloys, High entropy alloys; Refractory metals alloys, Electrical , Electronic and magnetic materials. Composition , properties and applications.

**Unit-III: Non-Metallic Materials : (9 hours)**

Introduction to Ceramics, Composites, Nano materials, Polymers and elastomers. Metallic glasses Nuclear materials: Composition , properties and applications,.

**Unit- IV: Smart Materials: (9 hours)**

Smart materials, lasers and optical fibers, photoconductivity and superconductivity, thermal materials, shape memory alloys. Composition, properties and applications

**Unit-V: Energy Materials: (9 hours)**

Supramolecular energy materials- biomaterials, Fuel cells- thin films, carbon fibers, graphene, foams, gels. Composition , properties and applications

**Text Books**:

1. Materials Science and Engineering, V. Raghavan, PHI Learning, Delhi, 2008.
2. William D. Callister , “Materials Science and Engineering”, John Wiley & Sons Inc2010.

**Reference Books**:

1 B.K.Agarwal, “Introduction to Engineering Materials”, Tata McGraw Hill-1stEdition.
2. V. Raghavan, “Material Science and Engineering”,-PHI Learning - 5th Edition.
3. R.K.Rajput, “Engineering Materials and Metallurgy”, - S.Chand - 1st Edition-2011

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B.Tech. III Semester Syllabus

**U21MM305PC: MECHANICAL METALLURGY**

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| 3 | 1 | 0 | 4 |

**Course Objectives**:

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

**Course Outcomes**:

- To extract and interpret sensible information from mechanical test data.
- To give an explanation on relationships between metallurgy of the metals and their mechanical properties.
- To perform mechanical testing of metals (Hardness, tension and Impact)
- To select metals for engineering applications.
- To design metals for engineering applications.

**UNIT- I: Plastic Deformation in Metals and Alloys: (12 hours)**

Introduction: Theoretical Shear Strength, Critical resolved shear stress. Stacking faults and Energy considerations. Defects in crystalline materials Point defects and line defects. The concept of dislocation - Edge dislocation and screw dislocation. Burgers vector, Energy of Dislocations, Force Required to Bow a Dislocation, Intersection of Dislocations, Dislocation Pileups, Deformation Produced by Motion of Dislocations (Orowan's Equation) The Peierls-Nabarro Stress, Interaction between dislocations, extended dislocations, sessile dislocation, glissile dislocation, dislocation climb, Jogs, Forces on dislocations. Tilt and Twist Boundaries Sources of Dislocations, Frank Reed source, slip and twinning. Strengthening by grain boundaries, yield point phenomenon, strain ageing, strengthening by solutes, precipitates

**UNIT- II: Fracture: (12 hours)**

Introduction :Types of fracture in metals, Theoretical cohesive Strength of metals, Stress Concentration and Stress Concentration factor, Notch effects, Griffith theory of brittle fracture, Fractography, Concept of fracture curve, Effect of hydrostatic stress on fracture Ductile Fracture, Notch sensitivity. Hardness Test: Introduction, Classification of hardness test. Principle, Advantages and disadvantages of Brinells, Vickers, Rockwell, Rockwell superficial, Shore and Poldi methods, Geometrically similar indentations produced by spherical indenters of different diameters Microhardness test, Knoop Hardness Test, Relationship between hardness and other mechanical properties.

**UNIT- III: Tension Test: (12 hours)**

Engineering stress and Engineering strain, True stress-strain curve. Tension Test and tensile properties, conditions for necking, effect of temperature and strain rate on tensile properties. Compression Test-

Comparison with tension, buckling &barreling. Impact Test: Notched bar impact test and its significance, Charpy and Izod Tests, significance of transition temperature curve, Metallurgical factors affecting the transition temperature, temper embrittlement. DBTT curve and its importance. Fracture toughness testing- Plane-Strain Fracture Toughness Test, Crack Opening Displacement Testing, Role of microstructure on fracture toughness.

**UNIT- IV: Fatigue Test: (12 hours)**

Introduction, Stress cycles, Fatigue Parameters and S--N (Wohler) Curves , Fatigue Strength or Fatigue Life, Effect of Mean Stress on Fatigue Life . Low cycle fatigue - High cycle fatigue, cyclic stress strain curve, strain life equation, Cumulative Damage and Life Exhaustion, Mechanism of fatigue failure, effect of stress concentration, size, surface condition and environments on fatigue. Effect of metallurgical variables on fatigue. Effect of temperature on fatigue. Corrosion fatigue, design for fatigue.

**UNIT- V: Creep and Stress Rupture: (12 hours)**

Introduction, The high temperature materials problem, Time dependent mechanical behavior, 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. Fracture at elevated temperature, Effect of Metallurgical variables on creep, presentation of engineering creep data, prediction of long-time properties.

**Text Books**:

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

**Reference Books**:

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

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**III Semester Syllabus**
**MC301HS: Constitution of India**
*(Common to CE, EEE, ME, ECE, MCT & MME)*

## Course Objectives

- **Students will get to know about the history of Indian Constitution**
- **Students will get to know about President election and his Powers**
- **Students will get to know about Council of Ministers and their election Procedure and their Powers and Responsibilities.**
- **Students will get know about Judicial System in India**
- **Students will get know about Panchayat-raj System in India**

## Course Outcomes

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

## Course content

### Meaning of the constitution, law and constitutionalism

1. Historical perspective of the Constitution of India
   - Drafting Committee
2. Salient features and characteristics of the Constitution of India
   - Preamble
   - Salient Features
   - Major Sources of Indian Constitution
3. 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
4. The scheme of the Fundamental Duties and its legal status

- List of Fundamental Duties
- Justifiability of Fundamental Duties

5. 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
6. Federal structure and distribution of legislative and financial powers between the Union and the States
   - Union List
   - State List
   - Concurrent List
   - Residuary Powers
7. Parliamentary Form of Government in India.
8. The constitutional powers and status of the President of India Vs the constitutional powers and status of the Council of ministers headed by The Prime Minister
9. Amendment of the Constitution and its Procedure
   - Procedure of Amendment to Constitution of India
   - Important Amendments
10. Emergency Provisions: National Emergency, President Rule, Financial Emergency
11. Local Self Government – Constitutional Scheme in India
    - Urban local Self Government
    - Rural local Self Government
12. 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. Samaraditya Pal, Indian Constitution-Origin & Evolution, Lexis Nexis, 1st Edition, 2019.

**Department of Metallurgical and Materials Engineering**

B.Tech. III Semester Syllabus

**U21MM351PC: METALLOGRAPHY LAB**

| L | T | P | C |
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| 0 | 0 | 2 | 1 |

**Course Objectives**:

- To provide hands on experience to prepare the samples for metallographic analysis and understand the basic constituents of microstructures
- To understand the principles microscopy and microstructure inferences

**Course Outcomes**:

- The knowledge of heat treatment and the resulting microstructure in materials
- By completing this laboratory course, students will : Get to know and gain hands on experience with various techniques of sample
- Preparation for metallographic analysis of metals and alloys. Be able to analyze the hardness of different constituents of microstructure using
- Different hardness testers Obtain knowledge of quantitative analysis, such as grain size, volume fraction of second phases .

**List of experiments**

1. Study of metallurgical microscope
2. Metallographic preparation of metals and alloys
3. Microscopic examination and microstructure interpretation of steels
4. Microscopic examination and microstructure interpretation of nonferrous metals
5. Microscopic examination and microstructure interpretation of heat treated steels
6. Microscopic examination and microstructure interpretation of cast structures
7. Microscopic examination and microstructure interpretation of wrought structures
8. Microscopic examination and microstructure interpretation of welded structures
9. Microscopic examination of defects and failures in components
10. Conduct of Hardness testing of metals on Vickers scale

**List of equipment:**

1. Metallurgical microscopes,
2. Belt grinders,
3. Disc polishers,
4 Vickers Hardness tester
5. Metallographic Samples (Ferrous and Non-Ferrous).

**Text Books**:

1. V. Raghavan, “Material Science and Engineering”,-PHI Learning - 5th Edition.
2. R.K.Rajput, “Engineering Materials and Metallurgy”, - S.Chand - 1st Edition-2011
William D. Callister , “Materials Science and Engineering”, John Wiley & Sons Inc2010

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B.Tech. III Semester Syllabus

**U21MM352PC: MINERAL PROCESSING LAB**

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**Course Objective:** This Laboratory course is designed to make the student to understand and demonstrate

- The process variables in mineral processing techniques employed.
- The mineral characteristics like size
- Size distribution etc. also evaluated

**Course Outcome:** The student would gain hands on experience

- About different ore characteristics and
- Various industrial mineral processing operations for beneficiation

**List of Experiments**

1. Sampling of an ore from the bulk by
   i) Coning and quartering method
   ii) Riffle sampler methods
2. Sizing by Sieve analysis of crushed ore
3. Verification of Stoke's Law.
4. Determining the reduction ratio of a jaw crusher.
5. Study of the variation of reduction ratio with process variables in Rolls crusher.
6. Study of the process variables on reduction ratio and particle size distribution in ball mill.
7. To find the grindability index of ores.
8. Verification of Laws of Commination (Study)
9. Determination of the efficiency of a magnetic separator.
10. Determination of the efficiency of a jig. (Study)
11. Study of the particle separation by fluid flow using Wilfley table.
12. To study the concentration of metallic and non-metallic ores by Froth-Flotation process

**Equipment:**

1. Riffle Sampler
2. Sieve Shaker with Sieves
3. Stokes' Apparatus
4. Jaw Crusher
5. Roll Crusher
6. Ball Mill
7. Grindability Index Apparatus
8. Magnetic Separator
9. Laboratory Jig
10. Wilfly's Table
11. Froth – Floatation Equipment
12. Balances

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**U21MM353PC: MECHANICAL METALLURGY LAB**

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**Course objectives:**

- To obtain knowledge on various mechanical testing machines, and mechanical testing methodology.

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

- To extract and interpret sensible information from mechanical test data.
- To give explanation on relationships between metallurgy of the metals and their mechanical properties.
- To perform mechanical testing of metals (Hardness, tension and Impact)
- To select metals for engineering applications.
- To design metals for engineering applications.

**List of experiments:**

1. To determine the Brinell Hardness of ferrous and non-ferrous samples.
2. To determine the Rockwell hardness of ferrous and non-ferrous samples.
3. To determine the hardness of ferrous and non-ferrous samples by using Vickers hardness tester.
4. To Determination of hardness profile across weldments
5. To determine the elastic modulus, ultimate tensile strength, breaking stress, percentage
6. Elongation percentage reduction in area of the given specimen by tensile test.
7. To plot True stress Vs True stain and compare with engineering stress strain curve by tensile test.
8. To determine the modulus of rigidity of given material by torsion test
9. To determine the Charpy and Izod (V & U Groove notch) impact strength of a given material at room temperature.
10. To determine the fatigue strength of given material at a given stress

**List of equipment:**

1. Brinell Hardness Machine
2. Vickers Hardness Machine 3. Rockwell Hardness Machine 4.UTM,
5. Torsion Testing Machine 6.Impact Testing Machine 7. Fatigue Testing Machine

**TEXT Books:**

1. Appropriate ASTM standards to be followed to understand associated theory.
2. Mechanical Metallurgy by George E Dieter, McGraw-Hill Education; 3rdedition June 1986

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## III Semester Syllabus
## EN351HS: Finishing School-I
*(Common to all Branches)*

*Course Overview*

*In view of the growing importance of English as a tool for global Communication and the consequent emphasis on training students to acquire language skills, this syllabus has been designed to develop linguistic, communicative and critical thinking competencies of Engineering students.*

*Course Objectives*

The main objective of this finishing school curriculum is to provide content for developing the LSRW skills of language learning and to facilitate proficiency in both receptive and productive skills, among students.

*Methodology:*

- Every Session will have activities on all the four skills-Listening, Speaking, Reading and Writing.
- To personalize the learning, a variety of case studies and structured problem solving activities will be given to small groups and the teachers will facilitate peer reviews.
- Continuous grading, peer review and positive reinforcement will be emphasized.
- Vocabulary exercises will also be a part of every session.
- All sessions are designed to be student-centric and interactive.

## Unit-I: Fundamentals of Communication

**Unit Overview:**

This is an introductory module that covers the fundamentals of communication. This module is intended to enable the students to communicate using greetings and small sentences/queries.

*Learning Outcomes:*

The students should be able to:

- Respond to questions
- Engage in informal conversations
- Speak appropriately in formal situations
- Write formal and informal emails/letters

*Competencies:*

- Greeting appropriately
- Introducing themselves, a friend
- Situational Dialogue writing
- Responding to simple statements and questions both verbally and in writing.

- Writing an email with appropriate salutation, subject lines, introduction and purpose of mail.
- Using appropriate vocabulary for both formal and informal situations.
- JAM sessions.

*Sessions:*

1. Introduction to Formal and Informal Conversations (Listening Activity)
2. Informal Conversations
3. Informal Conversations - Writing
4. Formal Conversations
5. Formal Conversations -Writing
6. Grammar-Prepositions
7. Adjectives and Degrees of Comparison
8. Word formation: Prefixes and Suffixes

## *Unit–II: Rational Recap*

*Unit Overview:*

The module enables the participants to organize their communication, structure their speaking and writing, explain their thoughts/ideas, and summarize the given information.

*Learning Outcomes:*

*The students should be able to:*

- Classify content and describe in a coherent form
- Recognize and list the key points in a topic/message/article.
- Compare and contrast using appropriate structure
- Explain cause and effect
- Use appropriate transitions in their presentations and written assignments

*Competencies:*

- Organizing the communication based on the context and audience
- Structuring the content based on the type of information.
- Explaining a technical/general topic in detail.
- Writing a detailed explanation/process
- Recapitulating

*Sessions:*

1. Introduction to Mind maps
2. Classification
3. Sequencing
4. Description and Enumeration

## *Unit-III: Narrations and Dialogues*

*Unit Overview:*

The Module is intended to develop the desired level of language competence that enables them to narrate and participate in casual dialogues.

*Learning Outcomes:*

The students should be able to

- Narrate a message/story/incident, both verbally and in writing.
- Describe an event/a session/a movie/an object/image
- Understand Vocabulary in context

*Competencies:*

- Framing proper phrases and sentences to describe in context
- Reading Stories and articles and summarizing.
- Speaking fluently with clarity
- Listening for main ideas and reformulating information in his/her own words
- Drawing and write appropriate conclusions, post reading a passage.
- Speaking Reading and Writing descriptive sentences and paragraphs
- Using appropriate tenses, adjectives and adverbs in conversations and written tasks

*Sessions:*

*Grammar: Verb, Tenses*

1. Recalling and Paraphrasing
2. Describing Events
3. Describing Objects/ Places
4. Story Telling
5. Describing Hypothetical events

## *Unit-IV: Technical Expositions and Discussions*

*Unit Overview:*

The module enables the students to build strategies for effective interaction and help them in developing decisive awareness and personality, maintaining emotional balance.

*Learning Outcomes:*

The students should be able to:

- Participate in Professional discussions by providing factual information, possible solutions, and examples.

**Competencies:**

- Comprehending key points of a topic and identifying main points including supporting details.
- Construct a logical chain of arguments and decisive points.
- Writing a review about a product by providing reasons, causes and effects.

*Sessions:*

*Based on Case Studies*

1. Compare and Contrast
2. Cause and Effect
3. Problem and Solution

## *Unit-V: Drawing Conclusions*

*Unit Overview:*

This module is intended to provide necessary inputs that enable the studentsto draw conclusions out of a discussion and provide reports.

*Learning Outcomes:*

Students should be able to:

- Provide logical conclusions to the topics under discussion.
- Prepare, present, and analyze reports.

*Competencies:*

- Reasoning skills - Coherent and logical thinking
- Reporting and Analyzing skills.
- Analyzing the points discussed.
- Connecting all points without gaps.
- Connectives
- Communicating the decisions

*Sessions:*

1. *Report Writing*
2. Reasoning
3. Analyzing
4. Generalization and Prediction
5. Précis writing

## Reference Books:


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. Mc Murrey & 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.
10. Effective Technical Communication by M Asharaf Rizvi. McGraw Hill Education (India) Pvt. Ltd. 2nd Edition.

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## IV Semester Syllabus
## MA407BS: Probability Distributions and Complex Variables
*(Common to ME, MCT & MME)*

### Course Objectives

At the end of this course, students are expected to

- The ideas of probability and random variables and various discrete and continuous probability distributions and their properties.
- The statistical methods of studying data samples.
- Differentiation and integration 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 successful completion of the course, students should be able to

- Formulate and solve problems involving random variables
- Apply statistical methods for analyzing experimental data.
- Analyse the complex function with reference to their analyticity, integration using Cauchy's integral and residue theorems.
- Taylor's and Laurent's series expansions of complex function.

### Unit-I: Basic Probability

Probability spaces, conditional probability, independent events, and Bayes' theorem. Random variables: Discrete and continuous random variables and their distribution functions, Expectation of random variables, Variance of random variables.

### Unit-II: Probability Distributions

Binomial and Poisson distributions with their Mean, Mode and Variance, Poisson approximation to the binomial distribution. Normal and exponential distribution with their Mean, Mode and Variance. Binomial approximation to normal distribution.

### Unit-III: Testing of Hypothesis

Test of significance: Basics of testing of Hypothesis. Null and alternate Hypothesis, types of errors, level of significance, critical region. Large sample test of hypothesis for single proportion, difference of proportions, single mean, difference of means; small sample tests: Test for single mean, difference of means.

### Unit-IV: Complex Variables (Differentiation)

Limit, Continuity and Differentiation of Complex functions, Analyticity, Cauchy-Riemann equations (Cartesian and polar forms without proof), Harmonic conjugate and its evaluation using CR equations and Milne-Thomson Method.

## Unit-V: Complex Variables (Integration)

Line integral, Cauchy's theorem, Cauchy's Integral formula, Zeros of analytic functions, Singularities, Taylor's series, Laurent's series; Residues, Cauchy Residue theorem.

## Suggested Readings:

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. J.W.Brown and R.V. Churchill, Complex Variables and Applications, 7th Ed., Mc-Graw Hill, 2004.

## Reference Books:

1. S.C. Gupta and V. K. Kapoor. Fundamentals of Mathematical Statistics, Khanna Publications.
2. Miller and Freund's, Probability and Statistics for Engineers, 8th Edition, Pearson Educations.
3. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.
4. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
5. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.

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**IV Semester Syllabus**
**EE431ES: Basic Electrical and Electronics Engineering**
*(Common to CE, ME & MME)*

## Course Objectives

- **To introduce the concepts of electrical circuits and its components.**
- **To understand magnetic circuits, DC circuits and AC single phase & three phase circuits.**
- **To study and understand the different types of DC/AC machines and Transformers.**
- **To impart the knowledge of various electrical installations.**
- **To introduce the concept of power, power factor and its improvement.**
- **To introduce the concepts of diodes & transistors.**
- **To impart the knowledge of various configurations, characteristics and applications.**

## Course Outcomes

- **To analyze and solve electrical circuits using network laws and theorems.**
- **To understand and analyze basic Electric and Magnetic circuits.**
- **To study the working principles of Electrical Machines.**
- **To introduce components of Low Voltage Electrical Installations.**
- **To identify and characterize diodes and various types of transistors.**

## Unit–I: DC Circuits & AC Circuits

**DC Circuits**: The SI System of Units, Electrical circuit elements (Resistor, Inductor & Capacitor), V-I Characteristics of circuit elements, Colour Coding of Resistors, Ohm's Law, voltage and current sources (Independent and Dependent), Power, Energy, Kirchhoff's Voltage Law & Kirchhoff's Current Law, Voltage Division Rule, Current Division Rule, Analysis of Series - Parallel Circuits with DC excitation - Mesh (Loop) Analysis, Nodal Analysis, Delta-Star & Star Delta Conversion.

**A.C. Circuits:** Representation of sinusoidal waveforms, peak value and rms values, phasor representation, real power, reactive power, apparent power, power factor, 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 Installations

Components of LT Switchgear: Switch Fuse Unit (SFU), Miniature Circuit Breaker (MCB), Earth leakage Circuit Breaker (ELCB), Moulded Case Circuit Breaker (MCCB), Residual Current Circuit Breaker (RCCB), Residual Current Circuit Breaker (RCCB), Residual Current Circuit Breaker with Over current Protection (RCBO), Types of Wires and Cables: PVC, XLPE, Rubber, cable sizing. Earthing: Necessity of Earthing, Types of earthing, Batteries: Working Principle, Types of Batteries, Important Characteristics for 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, open circuit and short circuit test on transformer, efficiency & regulation calculation. Three-phase transformer connections. 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 and Speed control of DC motors, Construction and working principle of Three-phase Induction motor, Slip, Torque equations, Torque Slip Characteristics and Speed control of Three-phase induction motor. Construction and working principle of synchronous generators.

## Unit - IV: Diodes, Rectifiers and Filters

**Diodes :** Principle of Operation, Forward bias, Reverse bias, Diode equation, Static Volt-Ampere characteristics, Temperature dependence, Ideal versus practical, Static and dynamic resistances, Equivalent circuit, Operation of Zener diode, Characteristics of Zener diode and applications.

**Rectifiers and Filters:** P-N junction as a rectifier - Half Wave Rectifier, Ripple Factor, Peak Inverse Voltage, Efficiency – Full Wave Rectifier, Bridge Rectifier, Mid Point Rectifier, Ripple Factor, Peak Inverse Voltage, Efficiency, Harmonic components in Rectifier Circuits, Filters – Inductor Filters, Capacitor Filters, L-section Filters, π-section Filters.

## Unit-V: Transistors

**Bipolar Junction Transistor (BJT) -** Construction, Principle of Operation, NPN and PNP Transistor, Amplifying Action, Common Emitter, Common Base and Common Collector configurations, Input and Output Characteristics, Comparison of CE, CB and CC configurations. 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. M S 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. J. 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.
4. Raymond A. De Carlo and Pen-Min-Lin, Linear circuit analysis (time domain phasor and Laplace transform approaches) - 2 nd edition, Oxford University Press, 2004.
5. N. C. Jagan & C. Lakshminarayana, Network Theory, B.S. Publications.
6. Sudhakar, Shyam Mohan Palli, Network Theory, TMH.
7. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
8. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
9. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

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B.Tech. IV Semester Syllabus

**U21MM401PC: HEAT TREATMENT AND PHASE TRANSFORMATIONS**

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**Course objectives:**

- 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 and Martensitic transformations
- Order Disorder Transformations

**Course outcomes:**

- After completing this course, the student should be able to:
- Classify phase transformations
- Indicate important steps in different types of phase transformations
- Explain phase transformations from the perspective of thermodynamics and kinetics
- Describe a few well known and studied phase transformations

**Unit-I: Heat treatment Processes: (12 hours)**

Heat treatment processes of steels: annealing, Types of annealing and its applications, normalizing, hardening and tempering, stages of tempering, Surface hardening methods; Carburizing, Cyaniding, Nitriding, Carbonitiriding, Induction , Flame Hardening and plasma hardening.

**Unit-II: Hardenability and thermomechanical treatments: (12 hours)**

Introduction to Hardenability, Mechanism of heat removal during quenching, quenching media, size and mass effect, Factors affecting hardenability, methods to determine hardenability. Case studies of hardenability of few plain carbon steels and alloy steels. Thermo-mechanical treatments: Ausforming, Isoforming, Cryoforming., Heat treatment of tool steels, Secondary hardening

**UNIT-III: Diffusion: (12 hours)**

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, Kirkendal effect.

**UNIT-IV: Phase transformations with diffusion: (12 hours)**

Diffusional transformation in solids, Nucleation and growth, energy considerations; homogeneous nucleation, heterogeneous nucleation, growth kinetics, overall transformation rates. Mechanisms of Pearlitic transformations 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-V: Diffusion less transformation in solids: (12 hours)**

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.

**Text Books:**

1. Heat Treatment of Metals by Vijendra Singh, Standard Publishers and Distributers
2. Heat Treatment of Steels by Zakharov, Mir publications
3. Phase Transformations in Metals and Alloys by Porter and Easterling, PHI
4. Introduction to Physical Metallurgy by Sidney H Avner

**Reference Books:**

1. Heat Treatment by Rajan, Sharma and Sharma
2. Phase Transformations in Materials by J W Christian, Wiley Publications

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**U21MM402PC: IRON MAKING**

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**Course Objective:**

- Understanding the raw materials required for Iron making and their preparation
- Understanding the significance of Blast Furnace design
- Application of knowledge of thermodynamics to understand the Physico-chemical reactions of Blast furnace
- Understanding the significance of latest trends in Blast Furnace operations.
- Understanding the importance and methods Alternate routes of Iron making

**Course Outcomes**

- Able to suggest the raw materials for Iron making
- Able to understand the blast furnace reaction by applying the thermodynamics
- Understanding the process variables to enhance the productivity and efficiency of the Blast Furnace
- Able to understand the alternative routes of Iron Making.

**UNIT-I: Principles of Iron Making: (9 hours)**

Reduction, Smelting, Direct Reduction, Smelt Reduction. Calcination and its significance Raw materials for Iron making and their properties -Iron Ore, Coke, Flux. Agglomeration Techniques of Iron ore fines, Sintering; Principles, Factors affecting sintering, sintering bonds, sintering machines. Pelletisation; Significance of Palletization, Theory of Palletization, Water-particles system. Production of green pellets; disk and drum pelletizes, Induration of pellets, Shaft, traveling grate, Coke Making: Principles of Coke manufacturing from Coal

**UNIT-II: Blast Furnace profile and its design: (9 hours)**

Blast Furnace profile and its design, Refractory lining. Water cooling system. Raw materials handling and charging, Burden distribution, Construction and operation of Hot blast Stoves. Gas cleaning system and its utilization.

**UNIT-III: Physio-Chemical Reactions of Blast furnace: (9 hours)**

Physical chemistry of Iron making, Blast furnace reactions, Physical and chemical factors affecting reduction of ores; Thermodynamics of iron oxide reduction by CO + CO2 and H2 and H2O mixtures. Control of C, Si, S, P in pig iron. Types of Pig Irons & Blast furnace Slags and its properties. Blast furnace operations and difficulties, Modern Trends in Blast furnace; Burden calculations.

**UNIT-IV Alternate Routes of Iron Making: (9 hours)**

Limitations of Blast furnace Iron production; Alternate Routes of Iron Making, Principles of Sponge Iron Making, Degree of Metallization, Percentage Reduction, Classification of Sponge Iron making methods. Using gases reducing agent, Midrex process, HY process, Krupp-Renn process.

**UNIT-V: (9 hours)**

Sponge Iron making using solid reducing agent process such as SL/RN process, Smelt Reduction Methods; COREX, INRED, ELRED, Plasma Smelting; Sponge Iron making in India.

**TEXT BOOK:**

1. Principles of Blast furnace Iron making – A.K Biswas
2. Beyond Blast furnace – Amit Chaterjee – CRC Press
3. Production of Iron – Dr. R. Tupkary

**REFERENCES:**

1. Iron making and Steel making – Ahindra Ghosh & Amit Chatterjee PMI Pvt. Ltd. 2008
2. Hand Book of Extractive Metallurgy – Fathi Habhashi Vol. 1 Metals Industry Ferrous Metals
3. Hot metal Production by Smelting Reduction of Iron Oxides – Amit Chatterjee, PHI Publications 2010

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**U21MM403PC: NON-FERROUS EXTRACTIVE METALLURGY**

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**Course objectives:**

- To explain the various methods of extraction of non-ferrous metals.
- 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

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

**UNIT -I: Principal Ore and Minerals: (9 hours)**

Copper 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 and Lead Extraction : (9 hours)**

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: Aluminum Extraction: (9 hours)**

Aluminum: Bayer process: Hall - Heroult process: Anode effect: Efficiency of the process: Refining, Alternative processes of aluminum production. Recovery and Recycling of Aluminum

**UNIT – IV: Magnesium and Titanium: (9 hours)**

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: Extraction of Nuclear Material : (9 hours)**

Extraction of Uranium, Zr, Th, and Be.

**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 & Sons1980

**REFERENCE BOOKS:**

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

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**IV Semester Syllabus**

## EE461ES: Basic Electrical and Electronics Engineering Lab

*(Common to CE, ME & MME)*

### Course Objectives

- **To introduce the concepts of electrical circuits and its components**
- **To understand magnetic circuits, DC circuits and AC single phase & three phase circuits**
- **To study and understand the different types of DC/AC machines and Transformers.**
- **To introduce the concepts of diodes & transistors, and**
- **To impart the knowledge of various configurations, characteristics and applications**

### Course Outcomes

- **To analyze and solve electrical circuits using network laws and theorems.**
- **To understand and analyze basic Electric and Magnetic circuits**
- **To study the working principles of Electrical Machines**
- **To identify and characterize diodes and various types of transistors.**

### List of Experiments/Demonstrations:

### Part A: Electrical

1. Verification of KVL and KCL
2. (i) Measurement of Voltage, Current and Real Power in primary and Secondary Circuits of a Single Phase Transformer
   (ii) Verification of Relationship between Voltages and Currents in a Three Phase Transformer
3. Measurement of Active and Reactive Power in a balanced Three-phase circuit
4. Performance Characteristics of a Separately Excited 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 (i) Multi-meters (ii) Function Generator (iii) RPS (iv) CRO.
2. PN Junction diode characteristics
3. Zener diode characteristics and Zener as voltage Regulator

4. Input & Output characteristics of Transistor in CB/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.**

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**U21MM451PC: HEAT TREATMENT AND PHASE TRANSFORMATION LAB**

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**Course Objective:**

- This Laboratory course is designed to make the student understand and demonstrate the various
- types of heat treatment processes, process variables and surface hardening treatments for ferrous
- and non-ferrous metals and alloys.

**Course outcomes:** The student would gain hands on experience

- To define heat treatment cycles for ferrous and non-ferrous metals and alloys with proper understanding of different heat treatment process variables.
- To evaluate the microstructure and hardness after successful heat treatment.

**List of Experiments:**

1. Annealing of plain carbon steel and observation of hardness and microstructure
2. Normalizing of plain carbon steel and observation of hardness and microstructure
3. Hardening of plain carbon steel and observation of hardness and microstructure
4. Study of tempering characteristics of hardened steel.
5. Study of age hardening phenomenon in an Al-Cu alloy or Cu-Be alloy
6. Spheroidising of high carbon steel
7. Determination of hardenability of a steel using Jominy End Quench Test
8. Re-crystallization studies on cold worked Cu or Cu alloys

**Equipment:**

1. Muffle Furnaces 1200 0C, 2. Jominy End Quench Apparatus, 3. Microscopes,
4. Rockwell Hardness Tester

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**U21MM452PC: EXTRACTIVE METALLURGY LAB**

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**Course objectives:**

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

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

- Understand pyro-metallurgical extraction concepts like roasting, calcination
- Realize Hydrometallurgical extraction fundamentals
- Understand the electrometallurgical extraction concepts

**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

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## IV Semester Syllabus
## EN452HS: Finishing School- II
*(Common to all Branches)*

*Course Overview*

In view of the growing importance of English as a tool for global Communication and the consequent emphasis on training students to acquire language skills, this syllabus has been designed to develop linguistic, communicative and critical thinking competencies of Engineering students.

*Course Objectives*

The main objective of this finishing school curriculum is to provide content for developing the LSRW skills of language learning and to facilitate proficiency in both receptive and productive skills, among students.

*Methodology:*

- Students will be given Reading/Listening exercises that they would have to do as a prerequisite for the class room intervention.
- Every Session will have activities on all the four skills. Listening, Speaking, Reading and Writing.
- Vocabulary exercises will also be a part of every session.
- Students will be asked to summarize their takeaways in every class in three sentences.
- The students will be given a self study plan for language enhancement and will be given extra reading and writing exercises as and when necessary.
- To personalize learning, a variety of case studies and structured problem solving activities will be given in small groups and the trainers will facilitate peer reviews.

### Unit-I: Discussions and Debates

**Module Overview:**

The module enables the students to build strategies for effective group interaction. It focuses on developing decisive awareness and positive personality while maintaining emotional balance.

*Learning Outcomes:*

The students should be able to:

- Participate in group discussions by providing factual information, real time solutions, and examples.
- Debate on a topic by picking up the key points from the arguments

offered.

*Competencies:*

- Analytical and Probing Skills
- Interpersonal Skills
- Identifying key points of the debate.
- Problem solving ability
- Constructing a logical chain of arguments and presenting winning viewpoints.

**Sessions:**

1. Six Thinking Hats
2. Initiation Techniques
3. Generating points
4. Summarization Techniques

## Unit-II: Powerful Presentations

**Unit Overview:**

Presentations need to be clear and logical. This Module is designed to introduce students to an ideal structure for a presentation

*Learning Outcomes:*

Students should be able to:

- Prepare, present, and analyze reports
- Analyze the points discussed
- Connect all points logically with coherence
- Connectives
- Communicate the decisions
- Provide logical conclusions

*Sessions:*

1. Persuasion skills
2. Cultivate appropriate body language and group dynamics
3. Debating Structure and Content
4. Case Study based Group Discussions

## *Unit-III: Effective Technical Writing*

*Unit Overview:*

Organizing the writing in a logical order, using headings, linkers and sequence markers. This module is designed to give the students inputs on how to organize using Information Mapping. The students are also given inputs to correct spelling, language and Punctuation errors, as part of editing.

*Learning Outcomes:*

*The Students should be able to choose appropriate words and tone to present accurate, specific, and factual written documents*

*Competencies:*

- Reporting an incident
- Writing/Presenting an essay

- Language and Vocabulary

*Sessions:*

1. Information Mapping
2. Report writing
3. Memos
4. SoP (Statement of Purpose)
5. MoM (Minutes of the Meeting)

## Unit-IV: Reading for Content and Context

**Unit Overview:**

This course is designed to develop and improve reading and study skills needed for employability. Topics include identifying main idea and supporting details, determining author's purpose and tone, distinguishing between fact and opinion, identifying patterns of organization in a paragraph or passage and the transition words associated with each pattern. Also recognizing the relationship between sentences, puzzling out meanings in context, identifying logical inferences and conclusions.

*Learning Outcomes:*

Upon completion of the course, students should be able to:

1. Compose a summary of a given text.
2. Apply reading skills appropriate to different genres.

**Competencies**

- Distinguish facts from opinions.
- Make inferences
- Identify author's purpose, point of view, tone, and perspective.
- Comprehend the use of figurative language.
- Synthesize information gathered from reading in order to give informed opinion.

*Sessions:*

1. Skimming and Scanning Techniques
2. Recognition of author's purpose
3. Awareness of stylistic differences
4. Evaluation and Discernment of fact and opinion

## *Unit-V: Critical Reading Skills*

*Unit Overview:*

Research shows that good reading skills can lead to well written assignments. In this unit, students will learn reading strategies to understand and retain information, organization of reading passages, and strategies for learning and retaining vocabulary. Building on these basic strategies, students will develop skills to critically analyze texts. In addition, students will practice and develop paraphrasing and summarizing skills. Students' feedback is integral to the learning process.

*Learning Outcomes:*

- Recognition of propaganda techniques
- Present vocabulary building methods

- Use comprehension and vocabulary strategies to improve reading skills.

*Competencies:*

The students will develop enhanced ability to apply the following critical thinking skills when reading:

a. Understand the meaning of new vocabulary through:
1. Context clues, e.g., synonyms, antonyms, examples, definitions, and restatements, etc.
2. Roots and affixes

b. Analyze text (simple outlining and note taking) summarize, draw conclusions, and apply information to personal experiences.

*Sessions*

1. Contextual Vocabulary-One-word substitutes
2. Homophones, Homonyms and Homographs
3. Idioms and Phrases
4. Synonyms, Antonyms and Phrasal verbs
5. Note making and Inference
6. Main idea identification
7. Précis Writing.

## Reference Books:


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. Mc Murrey & 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.
10. Effective Technical Communication by M Asharaf Rizvi. McGraw Hill Education (India) Pvt. Ltd. 2nd Edition.

**MAHATMA GANDHI INSTITUTE OF TECHNOLOGY (Autonomous)**
**B.Tech. in Metallurgical and Materials Engineering**

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**IV Semester Syllabus**
**MC451HS: Gender Sensitization Lab**
(An Activity-based Course)
*(Common to CE, EEE, ECE, ME, 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

- **Students will have developed a better understanding of important issues related to gender in contemporary India.**
- **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.**
- **Students will attain a finer grasp of how gender discrimination works in our society and how to counter it.**
- **Students will acquire insight into the gendered division of labour and its relation to politics and economics.**
- **Men and women students and professionals will be better equipped to work and live together as equals.**
- **Students will develop a sense of appreciation of women in all walks of life.**
- **Through providing accounts of studies and movements as well as the new laws that provide protection and relief 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, GoguShyamala, 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%.