JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B.TECH. METALLURGICAL AND MATERIALS ENGINEERING

COURSE STRUCTURE & SYLLABUS (2016-17)

II YEAR I SEMESTER

S. No	Course Code	Course Title	L	T	P	Credits
1	MA301BS	Mathematics – IV	4	1	0	4
2	MM302ES	Physical Metallurgy	4	1	0	4
3	MM303ES	Thermodynamics & Kinetics	4	1	0	4
4	MM304ES	Mechanics of Solids and Mechanics of Fluids	3	1	0	3
5	MM305ES	Fuels, Furnaces and Refractories	3	1	0	3
6	MM306ES	Physical Metallurgy Lab	0	0	3	2
7	MM307ES	Fuels, Furnaces and Refractories Lab	0	0	3	2
8	MM308ES	Metallurgical Analysis Lab	0	0	3	2
9	*MC300HS	Gender Sensitization Lab	0	0	3	0
		Total Credits	**18**	**5**	**9**	**24**

II YEAR II SEMESTER

S. No	Course Code	Course Title	L	T	P	Credits
1	MM401ES	Thermodynamics of Materials	4	1	0	4
2	MM402ES	Mineral Processing	4	1	0	4
3	MM403ES	Mechanical Metallurgy	4	1	0	4
4	MM404ES	Principles of Extractive Metallurgy	3	1	0	3
5	SM405MS	Business Economics and Financial Analysis	3	0	0	3
6	MM406ES	Mineral Processing Lab	0	0	3	2
7	MM407ES	Mechanical Metallurgy Lab	0	0	3	2
8	MM408ES	Principles of Extractive Metallurgy Lab	0	0	3	2
9	*MC400ES	Environmental Science and Technology	3	0	0	0
		Total Credits	**18**	**4**	**9**	**24**

MA301BS: MATHEMATICS - IV

B.Tech. II Year I Sem.

L	T	P	C
4	1	0	4

Prerequisites: Foundation course (No Prerequisites)**.**

Course Objectives: To learn

- differentiation and integration of complex valued functions
- evaluation of integrals using Cauchy's integral formula
- Laurent's series expansion of complex functions
- evaluation of integrals using Residue theorem
- express a periodic function by Fourier series and a non-periodic function by Fourier transform
- to analyze the displacements of one dimensional wave and distribution of one dimensional heat equation

Course Outcomes: After learning the contents of this paper the student must be able to

- analyze the complex functions with reference to their analyticity, integration using Cauchy's integral theorem
- find the Taylor's and Laurent's series expansion of complex functions
- the bilinear transformation
- express any periodic function in term of sines and cosines
- express a non-periodic function as integral representation
- analyze one dimensional wave and heat equation

UNIT–I

Functions of a complex variable: Introduction, Continuity, Differentiability, Analyticity, properties, Cauchy, Riemann equations in Cartesian and polar coordinates**.** Harmonic and conjugate harmonic functions-Milne-Thompson method

UNIT-II

Complex integration: Line integral, Cauchy's integral theorem, Cauchy's integral formula, and Generalized Cauchy's integral formula, Power series: Taylor's series- Laurent series, Singular points, isolated singular points, pole of order m – essential singularity, Residue, Cauchy Residue theorem (Without proof).

UNIT–III

Evaluation of Integrals: Types of real integrals:

(a) Improper real integrals $\int_{-\infty}^{\infty} f(x)dx$ (b) $\int_{c}^{c+2\pi} f(\cos\theta, \sin\theta)d\theta$

Bilinear transformation- fixed point- cross ratio- properties- invariance of circles.

UNIT–IV

Fourier series and Transforms: Introduction, Periodic functions, Fourier series of periodic function, Dirichlet's conditions, Even and odd functions, Change of interval, Half range sine and cosine series.

Fourier integral theorem (without proof), Fourier sine and cosine integrals, sine and cosine, transforms, properties, inverse transforms, Finite Fourier transforms.

UNIT–V

Applications of PDE: Classification of second order partial differential equations, method of separation of variables, Solution of one dimensional wave and heat equations.

TEXT BOOKS:

1. A first course in complex analysis with applications by Dennis G. Zill and Patrick Shanahan, Johns and Bartlett Publishers.
2. Higher Engineering Mathematics by Dr. B. S. Grewal, Khanna Publishers.
3. Advanced engineering Mathematics with MATLAB by Dean G. Duffy

REFERENCES:

1. Fundamentals of Complex Analysis by Saff, E. B. and A. D. Snider, Pearson.
2. Advanced Engineering Mathematics by Louis C. Barrett, McGraw Hill.

MM302ES: PHYSICAL METALLURGY

B.Tech. II Year I Sem.

L	T	P	C
4	0	0	4

Course Objective: This theory course will help the students get introduced to various metals and alloys that are industrially applied, their crystal, microstructures and phase transformation that take place with temperature and compositional changes

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

- Appreciate the wide range of characteristics of metals due to crystal structure variation
- Understand the phase transformations taking place in Fe-C binary phase diagram
- Construct the T-T-T diagrams for particular steel
- Suggest the heat treatment process for a particular metallic system

UNIT – 1

Crystal Structure: Crystallography: space lattice, unit cell, lattice parameter, coordination number, atomic radius, packing factor, density calculations. Miller's indices. Relation between crystal structure and ductility. Solidification; homogenous and heterogeneous nucleation. Polymorphism

UNIT-II

Binary Phase Diagrams: Construction. Isomorphous and eutectic systems-Specific examples: Cu-Ni, Pb-Sn, Al-Cu. Structure evolution. Phase rule. Lever rule. Hume-Rothery rules. Importance of electron-to-atom ratio. Binary Phase Diagrams. Intermediate phases. Intermetallic compounds. Application of phase diagrams. Precipitation hardening, Dispersion strengthening, ordering and clustering tendencies of solution phases, ordered phase, miscibility gaps, spinodal boundaries and spinodal dicomposition

UNIT – III

Microstructures: Grains and grain boundaries. ASTM Grain Size. Grain size dependence of strength. Strain hardening, Recovery, Recrystallization, and grain growth. Solid solutions-substitutional and interstitial solid solutions.

UNIT-IV

Iron-Carbon Phase Diagram: Phase transformations. Microstructures and quantitative phase evaluation of the Fe-C Alloys. Effect of Alloying Elements on the phase diagram, Time Temperature Transformation Curves, CCT curves, Effect of alloying elements on TTT and CCT curves.

UNIT -V

Isothermal Transformation Diagrams: Construction and interpretation. Effect of alloying elements on kinetics of transformation. Peralitic, Bainitic and Martensitic transformations.

TEXT BOOKS:

1. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007
2. Introduction to Physical Metallurgy – SH Avner, TATA Mc GRAW HILL,1997

REFERENCES:

1. Essentials of Materials Science Engineering, Donald R. Askeland, Pradeep P. Phule, Cengage learning (INDIA).
2. Engineering Physical Metallurgy and Heat treatment – Y Lakhtin

MM303ES: THERMODYNAMICS AND KINETICS

B.Tech. II Year I Sem.

L	T	P	C
4	0	0	4

Course Objective:
The course will develop an understanding of three laws of thermodynamics and kinetics.

Course Outcome:
The objectives of this course are to: Introduce the laws of thermodynamics, understand their implications, and become familiar with their use and applications and Understand physical transformations in materials

UNIT-I
Objectives and Limitations of Thermodynamics, concepts of system and state, heterogeneous and homogeneous systems, extensive and intensive properties of system, thermodynamic variables, thermodynamic equilibrium. Reversible and irreversible processes.

UNIT-II
First Law of Thermodynamics: Nature of first law, relationship between heat and work, internal energy and the first law of thermodynamics, calculations of work, constant capacity, reversible adiabatic processes, reversible isothermal pressure or volume changes of an ideal gas, enthalpy change with temperature, Kirchhoff's equation.

UNIT-III
Second Law of Thermodynamics: Efficiency of a cyclic process, Carnot cycle, Carnot therom, 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 ΔS^0 for a reaction.

UNIT-IV
Energy Functions: Purposes of the new functions, definition of Helmholtz and Gibbs energy change, meaning of thermodynamically possible process, determination of ΔG 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.

UNIT-V

Kinetics: Kinetics of chemical processes, Molecularity and order of a reaction, zero order reactions, first order and second order reactions, Determination of order of reaction, collision theory, theory of absolute reaction rates, consecutives and simultaneous reactions, catalysis in chemical reactions.

TEXT BOOK:

1. Introduction to Thermodynamics of Materials – D.R. Gaskell
2. Text Book of Materials and Metallurgical Thermodynamics: Ahindra Ghosh (PHI)
3. Principles of Metallurgical Thermodynamics, SK Bose and SK Roy, University Pres – IIM Series in Metallurgy and Materials Science

REFERENCES:

1. Physical Chemistry for Metallurgists – J. Mackowick
2. Physical Metallurgy Principles – RH Reed hill
3. An Introduction to Thermodynamics-Y. V. C. Rao

MM304ES: MECHANICS OF SOLIDS AND MECHANICS OF FLUIDS

B.Tech. II Year I Sem.

L	T	P	C
3	1	0	3

Pre-requisite: Nil

Course Objectives:
The student will gain insight into a number of potentially useful phenomena involving movement of solids and fluids. He/she will learn to do elementary calculations for engineering application of fluid motion. This course also prepares the student for more advanced courses such as Aerodynamics- I & -II.

Course Outcomes:
It makes the student ready to understand advance Aero dynamics.

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. Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

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, u.d.l., uniformly varying loads and combination of these loads – Point of contra flexure – Relation between S.F., B.M and rate of loading at a section of a beam.
Flexural Stresses : Theory of simple bending – Assumptions – Derivation of bending equation: $M/I = f/y = E/R$ Neutral axis – Determination bending stresses – section modulus of rectangular and circular sections (Solid and hollow).

UNIT – III
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 – Torsional moment of resistance – Polar section modulus – Power transmitted by shafts – Combined bending and torsion and end thrust.

UNIT - IV
Fluid Properties: Density, specific weight, specific gravity, surface tension & capillarity, Newton's law of viscosity, incompressible & compressible fluid, numerical problems.
Hydrostatic forces on submerged bodies: Pressure at a point, Pascal's law, pressure variation with temperature and height, Center of pressure on vertical, inclined and curved surfaces.
Manometers- simple and differential manometers, inverted manometers, micro manometers, Pressure gauges and numerical problems. **Buoyancy**- Archimedes's Principle, Metacenter, meta centric height calculations.

UNIT - V

Fluid Kinematics: Stream line, path line, streak line, stream surface, stream tube, and classification of flows: steady, unsteady, uniform, non uniform, laminar, turbulent flows. One dimensional approximation, examples of real 1-D flows, two dimensional approximations.

Fluid Dynamics: Surface & body forces, substantive derivative, local derivative and convective derivative, momentum equation, Euler equation, Bernoulli's equation, Phenomenological basis of Navier-Stokes equation, simple problems.

TEXT BOOKS:

1. Solid Mechanics, by Popov
2. Strength of Materials by Bhanikatti.
3. Strength of Materials by S.S.Rattan, Tata McGraw Hill Education Pvt. Ltd.
4. Engineering Fluid mechanics – K.L . Kumar, S. Chand & Co.
5. Fluid Mechanics – Frank M and White, Mc-Grawhill.

REFERENCES:

1. Strength of Materials -By Jindal, Umesh Publications.
2. Strength of Materials by D.S Prakash Rao, Universities Press Pvt. Ltd.
3. Fundamentals of Solid Mechancis by M.L.Gambhir, PHI Learning Pvt. Ltd
4. Strength of Materials by R.K Rajput, S.Chand & Company Ltd.
5. Fluid Mechanics - Fox and Mc Donald
6. Fluid Mechanics – E. Rathakrishnan.

MM305ES: FUELS, FURNACES AND REFRACTORIES

B.Tech. II Year I Sem.

L	T	P	C
3	0	0	3

Course Objective:

This course is mainly intended to describe the importance and characterization of conventional and unconventional fuels that are employed in metallurgical processes; construction, salient features and heat transfer of various furnaces; measurement of temperature through pyrometers. The characterization, manufacture testing and applications of refractories are also dealt as an integral part of the course.

Course Outcome:

On understanding the technology of fuels, furnaces and Refractories, the student will be able to select suitable furnace/refractories to meet the industrial requirements.

UNIT I

Introduction to Fuels, Classification of fuels. Principle of Carbonization, Manufacture of Metallurgical coke Properties of Metallurgical Coke Testing of Coke.

Principles of production of fuel oils from crude. Manufacture, properties and uses of Producer gas, Water gas, Blast furnace gas and coke oven gas.

Nuclear fuels: Introduction; comparison between conventional fuels and nuclear fuels;

Classification – Fissile and Fertile fuels; Fission and Fusion, Energy release and chain reaction.

UNIT II

Steady State Heat Transfer: Importance of Heat transfer, conduction through plane, cylindrical, Spherical and compound walls, shape factor and effect of variable thermal conductivity.

UNIT III

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

UNIT-IV

Pyrometry: Thermo electric pyrometry- peltier and Thomas EMF's. Thermo-electric power of thermocouples. Required properties of thermocouples. Noble and base metal thermocouples. Thermopiles. Measurement of emf by Milli-voltmeters and potentiometers. Thermometer; optical and radiation pyrometer.

UNIT V

Refractories: Desirable properties of Refractories. Methods of classification. Modes of failure of refractories in service and their prevention. Manufacturing methods and properties of Fireclay, Silica Magnesite and Chrome-Refractories. Testing of Refractories. Applications of refractories in the metallurgical industries.

TEXT BOOKS:

1. Furnaces, Fuels and Refractories - O. P. Gupta, Khanna Publishers.
2. Fuels, Furnaces, Refractories & Pyrometry-A. V. K. Surya Narayana.

REFERENCES:

1. Elements of Fuel Technology -HIMUS
2. Refractories - Norton
3. Furnaces - J. D. Gilchrist
4. Pyrometry-W. P. Wood& J. M. Corck

MM306ES: PHYSICAL METALLURGY LAB

B.Tech. II Year I Sem.

L	T	P	C
0	0	3	2

Course Objective: This laboratory course is mainly intended to make the students understand the microstructure of various ferrous, nonferrous metals and their alloys through microscopic observation and also correlate the microstructure with their mechanical characteristics.

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

- Prepare the ferrous and nonferrous metals and alloys for microscopic examination
- Determine the grain sizes and phase analysis of ferrous and nonferrous alloys
- Construct the phase equilibrium diagrams graphically
- Operate the optical microscope to observe fine microstructure for the given metal/alloy

LIST OF EXPERIMENTS

1. Preparation of precise crystal structure models and study of their structural parameters, calculation of packing factor.
2. Study of the required equipment of specimen preparation for metallographic examination.
3. Study of principle, construction and salient features of different classes of metallurgical microscopes.
4. Calculation of Grain Size and inclusion content in the given materials and study of ASTM charts.

Microstructural analysis of ferrous alloys

5. Identification and analysis of microstructure of hypoeutectoid, eutectoid, and hypereutectoid steels.
6. Identification and analysis of microstructure of Alloy steels.
7. Identification and analysis of microstructure of different classes of cast irons.

Microstructural analysis of nonferrous alloys

8. Identification and analysis of microstructure of various nonferrous alloys viz.,
    - Aluminum base
    - Copper base and
    - Titanium base alloys

Construction of phase equilibrium diagrams

9. Construction of graphical representation of isomorphous phase equilibrium diagram and study of phases, invariant points, and invariant reactions.
10. Construction of graphical representation of eutectic phase equilibrium diagrams and study of phases, invariant points, and invariant reactions.
11. Construction of graphical representation of Iron-Iron Carbide phase equilibrium diagram and study of phases, invariant points, and invariant reactions.

MM307ES: FUELS, FURNACES AND REFRACTORIES LAB

B.Tech. II Year I Sem.

L	T	P	C
0	0	3	2

Course Objective:

The laboratory course critically deals with the characterization of fuels, refractories and measurement of temperature. Apart from this it also concerns the flow properties of lubricants and their variation with temperature.

Course Outcome:

The student will gain hands-on experience on the equipment that facilitates property evaluation of fuels, lubricants and Refractories. This would provide the student to choose the fuels and refractories for specific use in construction of different furnaces.

LIST OF EXPERIMENTS

1. To find the Flash and Fire points of fuel oil by "PENSKY MARTINS" open and closed cup apparatus.
2. To find the flash and points of fuel oil by ABEL's Flash point apparatus
3. To find the viscosity of lubricant oil by using
    a. Red-wood-I Viscometer
    b. Red-wood-II Viscometer
    c. Saybolt Viscometer
4. To find the calorific value of solid and liquid fuels by using "Bomb Calorimeter"
5. To find the calorific value of gaseous fuels by using "Junker's Gas Calorimeter"
6. To study proximate analysis of Coal
7. To study ultimate analysis of Coal
8. To study various types of refractories and find their densities, Hardness.
9. To study Calibration of thermocouple.
10. Measurement of temperature using radiation pyrometer.
11. Measurement of temperature using optical pyrometer

EQUIPMENT:

1. Muffle Furnace (1000^0 c) – 2 No's	2. Pensky Martins Apparatus
3. Abels Flash Point Apparatus	4. Red – wood – I Viscometer
5. Red – wood – II Viscometer	6. Say bolt Viscometer
7. Bomb Calorimeter	8. Junkers Gas Calorimeter
9. Compression testing Machine	10. Digital Electronic Balance

MM308ES: METALLURGICAL ANALYSIS LAB

B.Tech. II Year I Sem.

L	T	P	C
0	0	3	2

LIST OF EXPERIMENTS

1. Estimation of Iron in Iron ore. - To determine the percentage of Iron in Iron Ore by $KMnO_4$ method and $K_2Cr_2O_7$ method.
2. Estimation of Silicon in Cast Iron.
3. Estimation of Manganese in cast iron.
4. Estimation of Sodium and Potassium in Chloride Salts by Flame Photometry.
5. Estimation of lime in Limestone.
6. Estimation of the concentration of $KMnO_4$ in the solution using Digital Spectrophotometer.
7. Estimation of Mn, Cr and Si in Ferro-Alloys

EQUIPMENT

1. Flame Photometer
2. Spectrophotometer

MC300HS: GENDER SENSITIZATION LAB

B.Tech. II Year I Sem.

L	T	P	C
0	0	3	0

Course Objectives:

- 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.

UNIT-I

UNDERSTANDING GENDER

Gender: Why Should We Study It? (*Towards a World of Equals*: Unit -1)

Socialization: Making Women, Making Men (*Towards a World of Equals*: Unit -2)

Introduction. Preparing for Womanhood. Growing up Male. First lessons in Caste. Different Masculinities.

UNIT-II

GENDER AND BIOLOGY

Missing Women: Sex Selection and Its Consequences (*Towards a World of Equals*: Unit -4)

Declining Sex Ratio. Demographic Consequences.

Gender Spectrum: Beyond the Binary (*Towards a World of Equals*: Unit -10)

Two or Many? Struggles with Discrimination.

UNIT-III

GENDER AND LABOUR

Housework: the Invisible Labour (*Towards a World of Equals*: Unit -3)

"My Mother doesn't Work." "Share the Load."

Women's Work: Its Politics and Economics (*Towards a World of Equals*: Unit -7)

Fact and Fiction. Unrecognized and Unaccounted work. Additional Reading: Wages and Conditions of Work.

UNIT-IV

ISSUES OF VIOLENCE

Sexual Harassment: Say No! (*Towards a World of Equals*: Unit -6)

Sexual Harassment, not Eve-teasing- Coping with Everyday Harassment- Further Reading: "*Chupulu"*.

Domestic Violence: Speaking Out (*Towards a World of Equals*: Unit -8)

Is Home a Safe Place? -When Women Unite [Film]. Rebuilding Lives. Additional Reading: New Forums for Justice.

Thinking about Sexual Violence (*Towards a World of Equals*: Unit -11)

Blaming the Victim-"I Fought for my Life…." - Additional Reading: The Caste Face of Violence.

UNIT-V

GENDER: CO - EXISTENCE

Just Relationships: Being Together as Equals (*Towards a World of Equals*: Unit -12)

Mary Kom and Onler. Love and Acid just do not Mix. Love Letters. Mothers and Fathers. Additional Reading: Rosa Parks-The Brave Heart.

TEXTBOOK

All the five Units in the Textbook***, "Towards a World of Equals: A Bilingual Textbook on Gender"*** written by A. Suneetha, Uma Bhrugubanda, Duggirala Vasanta, Rama Melkote, Vasudha Nagaraj, Asma Rasheed, Gogu Shyamala, Deepa Sreenivas and Susie Tharu and published by **Telugu Akademi, Hyderabad**,Telangana State in the year **2015**.

Note: Since it is an 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.

REFERENCE BOOKS:

1. Menon, Nivedita. Seeing like a Feminist. New Delhi: Zubaan-Penguin Books, 2012
2. Abdulali Sohaila. "*I Fought For My Life…and Won.*"Available online at: http://www.thealternative.in/lifestyle/i-fought-for-my-lifeand-won-sohaila-abdulal/

MM401ES: THERMODYNAMICS OF MATERIALS

B.Tech. II Year II Sem.

L	T	P	C
4	0	0	4

Course Objective: The prime aim of the course is to apply thermodynamics to various metallurgical aspects like Solution, Phase Diagrams, Diffusion, and Ellingham Diagrams. The course is also intended to correlate electrochemical principles with thermodynamics

Course Outcome: The student will be able to establish a thermodynamic perception with Metallurgical Processes and slove the Problems associated with the same.

UNIT-I

DIFFUSION: Fick's law of diffusion and its application, Kirkendal effect, Darken's equations, the Metano Method, determination of intrinsic diffusivities, Diffusion mechanisms in metals, self diffusion in pure metals, diffusion along grain boundaries and surfaces, Temperature dependence of the diffusion coefficient

UNIT-II

ELLINGHAM DIAGRAMS: 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.

UNIT-III

SOLUTIONS: Composition, 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.

UNIT-IV

APPLICATION TO PHASE DIAGRAMS: Concept of chemical potential, equality of chemical potentials in equilibrated phases, calculations of solidus and liquidus lines for ideal solutions, calculation of liquidus line for eutectic systems.

UNIT-V

REVERSIBLE CELLS: Electro- Chemical cells, galvanic cells, chemical and electrical energy, thermodynamics of Electro-chemical cells, standard electrode potentials, application of Gibbs - Helmholtz equation to galvanic cells. Concentration Cells.

TEXT BOOKS:

1. Physical Chemistry for Metallurgist - J. Mackowick
2. M. L. KAPOOR, Chemical and Metallurgical Thermodynamics, Vol. 1 & 2, Nemchand & Bros; Roorkee

3. N. A. Gokcen and R. G. Reddy, Thermodynamics-Second Edition, Plenum Press – New York & London

REFERENCE:

1. Physical Chemistry of Metals - LS Darken and R.W Gurry
2. Physical Metallurgy Principles – R E Reed –Hill, R.A. Abbasihian and Lara Abbaschian
3. Text book of Materials and Metallurgical Thermodynamics – A Ghosh

MM402ES: MINERAL PROCESSING

B.Tech. II Year II Sem.

L	T	P	C
4	0	0	4

Course Objectives: The prime objective of this course is to build the solid foundation on principals and equipment of various mineral beneficiations procedures that would facilitate metal extraction. It also focuses on mathematical derivations that are associated with concentration processes.

Course Outcome: The student will be able to understand the concentration process for a particular mineral. He will also have complete understanding on principles, constructions, and working of equipment for concentration and classification.

UNIT I

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 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; 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 – Types of classifiers, Study of Settling Cones, Rake Classifier, Spiral Classifier and Cyclones.

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 process.

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.

TEXT BOOK:

1. Mineral processing technology - B. A. Wills
2. Principles of Mineral Dressing - A.M. Gaudin

REFERENCES:

1. Ore dressing Practices - S. K. Jain
2. Elements of Ore Dressing - A. F. Taggart

MM403ES: MECHANICAL METALLURGY

B.Tech. II Year II Sem.

L	T	P	C
4	0	0	4

Course Objective: This course is primarily designed to develop the fundamental aspects of mechanics of deformation and fracture of materials by destructive testing**.**

Course Outcome: At the end of the course, the student will be able to identify and analyze the deformation mechanisms that occur in metals and alloys so that the metal forming operations can be easily understood.

UNIT- I

Plastic Deformation in Metals and Alloys: Critical resolved shear stress. Defects in crystalline materials Point defects and line defects. The concept of dislocation - Edge dislocation and screw dislocation. Interaction between dislocations, sessile dislocation, glissile dislocation, dislocation climb, Jogs, Forces on dislocations Energy of a dislocation. Frank Reed source, slip and twinning.

UNIT II

Fracture: Elementary theories of fracture, Griffith's theory of brittle fracture, Ductile Fracture, Notch sensitivity.

Hardness Test: Methods of hardness testing Brinells, Vickers, Rockwell, Rockwell superficial, Shore and Poldi methods, Microhardness test, relationship between hardness and other mechanical properties.

UNIT III

Tension Test: Mechanism of elastic action, linear elastic properties. 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: Elastic and in elastic action in compression, compression Test.

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 - COD and CTOD tests.

UNIT- IV

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

UNIT -V

Creep and Stress Rupture: Introduction, The creep curve, Stress-rupture test, Structural changes during creep, Mechanism of creep deformation, theories of creep. Fracture at elevated temperature, Effect of Metallurgical variables on creep.

TEXT BOOKS:

1. Mechanical Metallurgy - GE Dieter
2. Mechanical Behavior of Material - A. H. Courtney

REFERENCES:

1. Engineering Materials Science - CW Richards
2. Mechanical Metallurgy - White & Le May.

MM404ES: PRINCIPLES OF EXTRACTIVE METALLURGY

B.Tech. II Year II Sem.

L	T	P	C
3	0	0	3

Course Objective: The basic objective of the course is to introduce principles of various types of unit process used for extracting industrially important metals

Course Outcome: Student will be in a position to ascertain the method of extraction of a particular metal and also understands the importance of recovery of byproducts during extraction.

UNIT I

Classification of ores, basics of pyrometallurgy, calcination, roasting, and type of roasting, thermodynamics of extraction

UNIT II

Sintering Pelletisation and Smelting, basic principles with examples, Slags, classification, properties and uses

UNIT III

Hydrometallurgy: advantages, and disadvantages, principles and types of leaching, solution purification by ion exchange and solvent extraction, cementation

UNIT IV

Principles of electrometallurgy, electro winning and electro refining with typical examples

UNIT V

Principles of fire refining, distillation, liquqation, zone refining with examples

TEXT BOOKS:

1. Extraction of Non-Ferrous Metals - HS Ray, KP Abraham and R. Sridhar
2. Principles of Extractive Metallurgy – Ghosh

REFEREMCES:

1. Metallurgy – A R Bailey
2. Principles Of Extractive Metallurgy - J W Christian

SM405MS: BUSINESS ECONOMICS AND FINANCIAL ANALYSIS

B.Tech. II Year II Sem.

L	T	P	C
3	0	0	3

Course Objective: To learn the basic Business types, impact of the Economy on Business and Firms specifically. To analyze the Business from the Financial Perspective.

Course Outcome: The students will understand the various Forms of Business and the impact of economic variables on the Business. The Demand, Supply, Production, Cost, Market Structure, Pricing aspects are learnt. The Students can study the firm's financial position by analysing the Financial Statements of a Company.

UNIT – I

Introduction to Business and Economics:

Business: Structure of Business Firm, Theory of Firm, Types of Business Entities, Limited Liability Companies, Sources of Capital for a Company, Non-Conventional Sources of Finance.

Economics: Significance of Economics, Micro and Macro Economic Concepts, Concepts and Importance of National Income, Inflation, Money Supply in Inflation, Business Cycle, Features and Phases of Business Cycle. Nature and Scope of Business Economics, Role of Business Economist, Multidisciplinary nature of Business Economics.

UNIT – II

Demand and Supply Analysis:

Elasticity of Demand: Elasticity, Types of Elasticity, Law of Demand, Measurement and Significance of Elasticity of Demand, Factors affecting Elasticity of Demand, Elasticity of Demand in decision making, Demand Forecasting: Characteristics of Good Demand Forecasting, Steps in Demand Forecasting, Methods of Demand Forecasting.

Supply Analysis: Determinants of Supply, Supply Function & Law of Supply.

UNIT- III

Production, Cost, Market Structures & Pricing:

Production Analysis: Factors of Production, Production Function, Production Function with one variable input, two variable inputs, Returns to Scale, Different Types of Production Functions.

Cost analysis: Types of Costs, Short run and Long run Cost Functions.

Market Structures: Nature of Competition, Features of Perfect competition, Monopoly, Oligopoly, and Monopolistic Competition.

Pricing: Types of Pricing, Product Life Cycle based Pricing, Break Even Analysis, and Cost Volume Profit Analysis.

UNIT-IV

Financial Accounting: Accounting concepts and Conventions, Accounting Equation, Double-Entry system of Accounting, Rules for maintaining Books of Accounts, Journal, Posting to Ledger, Preparation of Trial Balance, Elements of Financial Statements, Preparation of Final Accounts.

UNIT -V

Financial Analysis through Ratios:

Concept of Ratio Analysis, Liquidity Ratios, Turnover Ratios, Profitability Ratios, Proprietary Ratios, Solvency, Leverage Ratios (simple problems).

Introduction to Fund Flow and Cash Flow Analysis (simple problems).

TEXT BOOKS:

1. D. D. Chaturvedi, S. L. Gupta, Business Economics - Theory and Applications, International Book House Pvt. Ltd. 2013.
2. Dhanesh K Khatri, Financial Accounting, Tata Mc –Graw Hill, 2011.
3. Geethika Ghosh, Piyali Gosh, Purba Roy Choudhury, Managerial Economics, 2e, Tata Mc Graw Hill Education Pvt. Ltd. 2012.

REFERENCES:

1. Paresh Shah, Financial Accounting for Management 2e, Oxford Press, 2015.
2. S. N. Maheshwari, Sunil K Maheshwari, Sharad K Maheshwari, Financial Accounting, 5e, Vikas Publications, 2013.

MM406ES: MINERAL PROCESSING LAB

B.Tech. II Year II Sem.

L	T	P	C
0	0	3	2

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 and 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 Communition.(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. Jig	10. Wilfly's Table
11. Froth – Floatation Equipment	12. Balances

MM407ES: MECHANICAL METALLURGY LAB

B.Tech. II Year II Sem.

L	T	P	C
0	0	3	2

Course Objective: This lab course is mainly designed to impart knowledge of the various testing methods for evaluation of mechanical properties of metals

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

1. Operate instruments for measuring hardness and impact strength of ferrous and non-ferrous alloys.
2. Determine the Stress vs Strain curve using UTM
3. Interpret hardness and strength of the materials.
4. Determine the torsion curve using Torsion Testing Machine

LIST OF EXPERIMENT:

1. Hardness Test: To determine the Brinell Hardness Values of ferrous and non-ferrous samples.
2. To determine the Rockwell hardness values of heat treated steels
3. To find the microhardness of phases by using micro hardness tester
4. Determination of hardness profile across weldments
5. Tension Test: - To determine the elastic modulus, ultimate tensile strength, breaking stress, percentage elongation percentage reduction in area of the given specimen. - To determine the strain distribution along the gauge length
6. Torsion Test: -To determine the modulus of rigidity of given material
7. Impact Testing: - To determine the Charpy and Izod (V & U Groove notch) values of a given material at room temperature. - To establish the ductile - brittle transition temperature of the given material
8. Fatigue Test: - To determine the number of cycles to failure of a given material at a given stress

EQUIPMENT:

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

MM408ES: PRINCIPLES OF EXTRACTIVE METALLURGY LAB

B.Tech. II Year II Sem.

L	T	P	C
0	0	3	2

Course Objective

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

Course Outcome:

Upon successful completion of this course, the student will:

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

LIST OF EXPERIMENTS

1. To find the efficiency of electrolytic cell for Cu refining
2. To study the effect of time and temperature on leaching of Copper oxide
3. To conduct cementation of Copper ore
4. Electro wining of a non ferrous metal
5. To conduct calcination of lime stone
6. Study of roasting of Zinc sulphide
7. Study the effect of time and temperature on roasting of Zinc sulphide

EQUIPMENT

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

MC300ES: ENVIRONMENTAL SCIENCE AND TECHNOLOGY

B.Tech. II Year II Sem.

L	T	P	C
3	0	0	0

Course Objectives:

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

Course Outcomes:

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

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

of e-Waste and its management. **Pollution control technologies:** Wastewater Treatment methods: Primary, secondary and Tertiary.
Overview of air pollution control technologies, Concepts of bioremediation. **Global Environmental Problems and Global Efforts: C**limate change and impacts on human environment. Ozone depletion and Ozone depleting substances (ODS). Deforestation and desertification. International conventions / Protocols: Earth summit, Kyoto protocol and Montréal Protocol.

UNIT-V

Environmental Policy, Legislation & EIA: Environmental Protection act, Legal aspects Air Act- 1981, Water Act, Forest Act, Wild life Act, Municipal solid waste management and handling rules, biomedical waste management and handling rules, hazardous waste management and handling rules. EIA: EIA structure, methods of baseline data acquisition. Overview on Impacts of air, water, biological and Socio-economical aspects. Strategies for risk assessment, Concepts of Environmental Management Plan (EMP). **Towards Sustainable Future:** Concept of Sustainable Development, Population and its explosion, Crazy Consumerism, Environmental Education, Urban Sprawl, Human health, Environmental Ethics, Concept of Green Building, Ecological Foot Print, Life Cycle assessment (LCA), Low carbon life style.

TEXT BOOKS:

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

REFERENCE BOOKS:

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