ANDHRA UNIVERSITY

DEPARTMENT OF METALLURGICAL ENGINEERING

PROGRAM : B.Tech. (Metallurgical Engineering)
REGULATIONS AND SYLLABUS EFFECTIVE FROM
2021-2022 BATCH

ANDHRA UNIVERSITY
DEPARTMENT OF METALLURGICAL ENGINEERING

Program Outcomes:

At the end of the Programme the student will be able to:

PO1. Design processes for concentrating ores and minerals.

PO2. Select processes for extraction of ferrous and non-ferrous metals.

PO3. Assess performance of metallurgical processes.

PO4. Identify processes to produce products as per specifications.

PO5. Produce defect free products using metal forming and metal joining processes.

PO6. Design thermo-mechanical treatment processes to modify the properties of metals and alloys for specific engineering applications.

PO7. Analyze processes for protecting materials from mechanical and environmental degradation

Program Specific Outcomes:

PSO1. Design material systems, components, processes for specific applications considering environmental sustainability.

PSO2. Apply modern science, engineering and project management principles to address the specific needs of metallurgical industries.

PSO3. Function in multi-disciplinary teams using tools and environment to achieve project objectives

PSO4. Practice professional ethics for improved moral and human values.

PSO5. Engage in lifelong learning for professional advancement.

SCHEME AND SYLLABI
(with effect from 2021-2022)

B.Tech I Year - I Semester

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
MT1101	BS	Maths – I	4	0	30	70	100	3
MT1102	BS	Physics	4	0	30	70	100	3
MT1103	ES	Engg. Graphics	2	3	30	70	100	3
MT1104	ES	Principles of Extractive Metallurgy	4	0	30	70	100	3
MT1105	ES	Fuels, Refractories & Furnaces	4	0	30	70	100	3
MT1106	ES	Workshop	0	3	50	50	100	1.5
MT1107	BS	Physics Lab	0	3	50	50	100	1.5
MT1108	ES	Fuels Lab	0	3	50	50	100	1.5
Total Credits								**19.5**

B.Tech I Year - II Semester

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
MT1201	BS	Maths – II	4	0	30	70	100	3
MT1202	BS	Chemistry	4	0	30	70	100	3
MT1203	HSS	English	4	0	30	70	100	3
MT1204	ES	CPNM	4	0	30	70	100	3
MT1205	ES	Elements of Materials Science	4	0	30	70	100	3
MT1206	HSS	English Language Lab	0	3	50	50	100	1.5
MT1207	BS	Chemistry Lab	0	3	50	50	100	1.5
MT1208	ES	CPNM Lab	0	3	50	50	100	1.5
Total Credits								**19.5**

B. Tech -II Year- I Semester

Course Code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
MT2101	BS	Metallurgical Thermodynamics I	4	0	30	70	100	3
MT2102	PC	Mineral Beneficiation	4	0	30	70	100	3
MT2103	PC	Iron Making	4	0	30	70	100	3
MT2104	PC	Physical Metallurgy	4	0	30	70	100	3
MT2105	HSS	Managerial Economics	4	0	30	70	100	3
MT2106	PC	Non Metallic Materials	4	0	30	70	100	3
MT2107	PC	Mineral Beneficiation Lab	0	3	50	50	100	1.5
MT2108	SC	Moulding and Casting practice	1	2	50	50	100	2
MT2109	MC	Professional Ethics &Universal human values	0	0	0	100	100	0
MT2110	MC	NCC/NSS	0	2	-	-	-	0
Total Credits								**21.5**

B. Tech -II Year- II Semester

Course Code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
MT2201	ES	Heat Treatment	4	0	30	70	100	3
MT2202	PC	Metallurgical Thermodynamics II	4	0	30	70	100	3
MT2203	PC	Non Destructive Testing	4	0	30	70	100	3
MT2204	PC	Non-Ferrous Extractive Metallurgy - I	4	0	30	70	100	3
MT2205	PC	Mechanical properties of Materials	4	0	30	70	100	3
MT2206	PC	Metallography Lab	0	3	50	50	100	1.5
MT2207	PC	Mechanical Metallurgy Lab	0	3	50	50	100	1.5
MT2208	SC	Welding Practice	1	2	50	50	100	2
MT2209	MC	Environmental Science	0	0	0	100	100	0
Total credits								**20**
Internship -I								

B. Tech -III Year- I Semester

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
MT3101	PC	Foundry Technology	4	0	30	70	100	3
MT3102	PC	Advances in Iron making	4	0	30	70	100	3
MT3103	PC	Non-Ferrous Extractive	4	0	30	70	100	3
		Metallurgy - II						
MT3104	PE	Professional Elective I	4	0	30	70	100	3
MT3105	OE	Open Elective I	4	0	30	70	100	3
MT3106	PC	Heat Treatment Lab	0	3	50	50	100	1.5
MT3107	PC	Metal Casting Lab	0	3	50	50	100	1.5
MT3108	SC	Foundry Practice	1	2	50	50	100	2
MT3109	INT	Internship I			50	50	100	2
Total credits								**22**

B. Tech -III Year- II Semester

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
MT3201	PC	Metal Forming	4	0	30	70	100	3
MT3202	PC	Environmental degradation of Materials	4	0	30	70	100	3
MT3203	PC	Advances in Steel Making & Production of Ferro Alloys	4	0	30	70	100	3
MT3204	PE	Professional Elective II	4	0	30	70	100	3
MT3205	OE	Open Elective II	4	0	30	70	100	3
MT3206	PC	Electro-Metallurgy lab	0	3	50	50	100	1.5
MT3207	PC	Materials processing lab	0	3	50	50	100	1.5
MT3208	PC	NDT Lab	0	3	50	50	100	1.5
MT3209	SC	Soft Skills	1	2	50	50	100	2
Total credits								**21.5**
Internship I I								

B. Tech -IV Year- I Semester

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
MT4101	PE	Professional Elective III	4	0	30	70	100	3
MT4102	PE	Professional Elective IV	4	0	30	70	100	3
MT4103	PE	Professional Elective V	4	0	30	70	100	3
MT4104	OE	Open Elective III	4	0	30	70	100	3
MT4105	OE	Open Elective IV	4	0	30	70	100	3
MT4106	HSSE	HSS Elective	4	0	30	70	100	3
MT4107	SC	Advanced Materials processing	1	2	50	50	100	2
MT4108	INT	Internship II			50	50	100	2
Total credits								**22**

B. Tech -IV Year- II Semester

Course code	Category	Course Title	Internal Marks	External Marks	Total Marks	Credits
MT4201	PROJ	Project work,	100	100	200	14
					Total credits	**14**

List of Professional Electives

1.	Steel Making
2.	Composite materials
3.	Strengthening mechanisms
4.	Engineering Materials
5.	Nano materials
6.	Functional materials
7.	Energy materials
8.	Bio materials
9.	Electronic materials
10.	Fatigue and fracture mechanics
11.	Computational Materials engineering
12.	Surface Engineering
13.	Phase transformations
14.	Introduction to transport phenomenon
15.	Physics of Materials

List of Open Electives

1.	Materials Characterization
2.	Metal Joining processes
3.	Powder Metallurgy
4.	Failure Analysis
5.	Introduction to materials Engineering
6.	Materials Thermodynamics
7.	Iron making and Steel making Technology
8.	Materials processing
9.	Introduction to Instrumentation
10.	Fluid Mechanics and Heat Transfer
11.	Engineering Mechanics& Strength of Materials
12.	Electrical Technology

List of HSS Electives

1	Organizational Behaviour
2	Industrial Management and Entrepreneurship
3	Operations Research

MT 1101 MATHEMATICS-I

Course Objectives:

- To transmit the knowledge of Partial differentiation.
- To know of getting maxima and minima of function of two variables and finding errors and approximations.
- To evaluate double and triple integrals, volumes of solids and area of curved surfaces.
- To expand a periodical function as Fourier series and half-range Fourier series.

Course Outcomes:

- Find the partial derivatives of functions of two or more variables.
- Evaluate maxima and minima, errors and approximations.
- Evaluate double and triple integrals, volumes of solids and area of curved surfaces.
- To expand a periodical function as Fourier series and half-range Fourier series.
- Have a fundamental understanding of Fourier series and be able to give Fourier expansions of a given function.

SYLLABUS

Partial Differentiation: Introduction - Functions of two or more variables - Partial derivatives - Homogeneous functions – Euler's theorem - Total derivative - Change of variables – Jacobins. Mean value Theorems (without proofs)

Applications of Partial Differentiation: Geometrical interpretation -Tangent plane and Normal to a surface -Taylor's theorem for functions of two variables - Errors and approximations -Total differential. Maxima and Minima of functions of two variables - Lagrange's method of undeterminedmultipliers - Differentiation under the integral Sign - Leibnitz's rule.

Multiple Integrals: Introduction - Double Integrals - Change of Order of Integration - Double Integrals in Polar Coordinates - Triple Integrals - Change of Variables.

Multiple Integrals-Applications: Area enclosed by plane curves - Volumes of solids - Area of a curved surface - Calculation of Mass - Center of gravity - Moment of inertia - product of inertia – principal axes- Beta Function - Gamma Function - Relation between Beta and Gamma Functions. Error Function or Probability Integral.

Fourier Series: Introduction - Euler's Formulae - Conditions for a Fourier Expansion - Functions having points of discontinuity - Change of Interval - Odd and Even Functions - Expansions of Odd or Even Periodic Functions, Half-Range Series - Parseval's Formula. Practical Harmonic analysis.

Text Book:

1. Scope and Treatment as in "Higher Engineering Mathematics", by Dr. B.S. Grewal, 43rd Edition, Khanna publishers.

Reference Books:

1. Graduate Engineering Mathematics by V B Kumar Vatti., I.K.International publishing house Pvt. Ltd.
2. Advanced Engineering Mathematics by Erwin Kreyszig.
3. A text book of Engineering Mathematics, by N.P. Bali and Dr. Manish Goyal, Lakshmi Publications.
4. Advanced Engineering Mathematics by H.K. Dass. S. Chand Company.
5. Higher Engineering Mathematics by B.V. Ramana, Tata McGraw Hill Company.
6. Higher Engineering Mathematics by Dr. M.K.Venkataraman.

MT 1102 PHYSICS

Course Objectives:

- To impart knowledge in basic concept of physics of Thermodynamics relevant to engineering applications.
- To grasp the concepts of physics for electromagnetism and its application to engineering. Learn production of Ultrasonics and their applications in engineering.
- To Develop understanding of interference, diffraction and polarization: connect it to a few engineering applications.
- To Learn basics of lasers and optical fibers and their use in some applications.
- To Understand concepts and principles in quantum mechanics and Nanopahse Materials. Relate them to some applications.

Course Outcomes:

- Understand the fundamentals of Thermodynamics and Laws of thermodynamics. Understand the working of Carnot cycle and concept of entropy.
- Gain Knowledge on the basic concepts of electric and magnetic fields. Understand the concept of the nature of magnetic materials. Gain knowledge on electromagnetic induction and its applications .
- Understand the Theory of Superposition of waves. Understand the formation of Newton's rings and the working of Michelson's interferometer. Remember the basics of diffraction, Evaluate the path difference. Analysis of Fraunhofer Diffraction due to a single slit
- Understand the interaction of matter with radiation, Characteristics of Lasers, Principle, working schemes of Laser and Principle of Optical Fiber. Realize their role in optical fiber communication.
- Understand the intuitive ideas of the Quantum physics and understand dual nature of matter. Compute Eigen values, Eigen functions, momentum of Atomic and subatomic particles using Time independent one Dimensional Schrodinger'swave equation. Understand the fundamentals and synthesis processes of Nanophase materials.

SYLLABUS

Thermodynamics: Introduction, Heat and Work, First law of thermodynamics and applications, Reversible and Irreversible process, Carnot cycle and Efficiency, Second law of thermodynamics, Carnot's Theorem, Entropy, Second law in terms of entropy, Entropy and disorder, Third law of thermodynamics (statement only).

Electromagnetism: Concept of electric flux, Gauss's law - some applications, Magnetic field - Magnetic force on current, torque on current loop, The Biot-Savart's Law, B near a long wire, B

for a circular Current loop, Ampere's law, B for a solenoid, Hall effect, Faraday's law of induction, Lenz's law, Induced magnetic fields, Displacement current, Maxwell's equations (no derivation), Magnetic materials: Classification of magnetic materials and properties.

Ultrasonic: Introduction, Production of Ultrasonic – Piezoelectric and Magnetostriction methods, acoustic grating, applications of Ultrasonic.

Optics-Interference: Principles of superposition – Young's Experiment – Coherence - Interference in thin films (reflected light), Newton's Rings, Michelson Interferometer and its applications.

Diffraction: Introduction, Differences between interference and diffraction, Fresnel and Fraunhofer diffraction, Fraunhofer diffraction at a single slit **(**Qualitative and quantitative treatment**)**.

Polarization: Polarization by reflection, refraction and double refraction in uniaxial crystals, Nicol prism, Quarter and Half wave plate, circular and elliptical polarization.

Lasers: Introduction, characteristics of a laser beam, spontaneous and stimulated emission of radiation, population inversion, Ruby laser, He-Ne laser, Semiconductor laser, applications of lasers

Fiber Optics: Introduction to optical fibers, principle of propagation of light in optical fibers, Acceptance Angle and cone of a fiber, Numerical aperture, Modes of propagations, classification of fibers, fiber optics in communications, Application of optical fibers.

Modern Physics: Introduction, De Broglie concept of matter waves, Heisenberg uncertainty principle, Schrodinger time independent wave equation, application to a particle in a box. Free electron theory of metals, Kronig - Penney model (qualitative treatment), Origin of energy band formation in solids, Classification of materials into conductors, semi conductors and insulators.

Nanophase Materials: Introduction, properties, Top-down and bottom up approaches, Synthesis - Ball milling, Chemical vapour deposition method , sol-gel methods, Applications of nano materials.

Text Books :

1. Physics by David Halliday and Robert Resnick – Part I and Part II - Wiley.
2. A textbook of Engineering Physics, Dr. M. N. Avadhanulu, Dr. P.G. Kshirsagar - S. Chand
3. Engineering Physics by R.K. Gaur and S.L. Gupta –DhanpatRai

Reference Books:

1. Modern Engineering Physics by A.S. Vadudeva
2. University Physics by Young and Freedman

MT 1103 ENGINEERING GRAPHICS

Course Objectives:

- Understand the basics of Engineering Graphics and BIS conventions.
- Develop the graphical skills for communication of concepts, ideas and design of engineering products through technical drawings

- Demonstrate and practice the various profiles/curves used in engineering practice through standard procedures.
- Demonstrate and practice the orthographic projections of points, lines, planes, solids and section of solids
- Demonstrate and practice the development of surfaces of simple solids
- Familiarize the basic concept of isometric views clearly.

Course Outcomes:

- Develop simple engineering drawings by considering BIS standards.
- Able to draw different engineering curves with standard Procedures
- Comprehend the basics of orthographic projections and deduce orthographic projections of points, lines, planes and solids at different orientations in real life environment.
- Visualize clearly the sections of solids.
- Apply the concepts of development of surfaces while designing/analyzing any product.
- Recognize the significance of isometric drawing to relate 2D environment with 3D environment.

SYLLABUS

Introduction: Lines, Lettering and Dimensioning, Geometrical Constructions, and Scales.

Curves: Conic sections, General construction of ellipse, parabola and hyperbola. Construction of involutes of circle and polygons only. Normal and tangent to curves.

Projections of Points: Principal or Reference Planes, Projections of a point situated in any one of the four quadrants.

Projections of Straight Lines: Projections of straight lines parallel to both reference planes, perpendicular to one reference plane and parallel to other reference plane, inclined to one reference plane and parallel to the other reference plane.

Projections of Straight Line Inclined to Both the Reference Planes: Projections of Planes: Projection of Perpendicular planes: Perpendicular to both reference planes, perpendicular to one reference plane and parallel to other reference plane and perpendicular to one reference plane and inclined to other reference plane. Projection of Oblique planes. Introduction to Auxiliary Planes.

Projections of Solids: Types of solids: Polyhedra and Solids of revolution. Projections of solids in simple positions: Axis perpendicular to horizontal plane, Axis perpendicular to vertical plane and Axis parallel to both the reference planes, Projection of Solids with axis inclined to one reference plane and parallel to other and axes inclined to both the reference planes.

Sections of Solids: Perpendicular and inclined section planes, Sectional views and True shape of section, Sections of solids (Prism, Pyramid, Cylinder and Cone) in simple position only.

Development of Surfaces: Methods of Development: Parallel line development and radial line development. Development of a cube, prism, cylinder, pyramid and cone.

Isometric Views: Isometric projection, Isometric scale and Isometric view. Isometric view of Prisms, Pyramids, cylinder, cone, and their combinations.

Text Book:

1. Elementary Engineering Drawing by N.D.Bhatt, Charotar Publishing House.

Reference Book:

2. Engineering Graphics by K.L. Narayana and P. Kannaiah, Tata Mc-Graw Hill

MT 1104 PRINCIPLES OF EXTRACTIVE METALLURGY

Course Objectives:

- To learn and emphasize the Principles of Pyrometallurgy, hydrometallurgy andelectrometallurgy.
- To learn scientific concepts of extraction and refining
- Obtain knowledge of equipment used in Pyrometallurgy, hydrometallurgy andelectrometallurgy

Course Outcomes:

- Classify and describe the extraction routes of pyro metallurgy, hydrometallurgy andelectrometallurgy.
- To Illustrate with the help of flow sheet of process taking place in pyro metallurgy,hydrometallurgy and electrometallurgical extractions of metal/matte.
- Choose the type of refining process according purity required.
- Understand the impact of extractive process on health environment society and will be ableto suggest suitable techniques to recycle the byproducts or to decrease energy consumptions.
- Design the suitable process for extractions.

SYLLABUS

General Methods of Extraction. Pyro-metallurgy: Roasting, Types of roasting, Roastingequipment and methods, Predominance area diagrams, Smelting, Smelting furnaces.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the significance of pyrometallurgical operations and classify the various pyrometallurgical operations.
- Describe the process of roasting, various extraction routes of pyrometallurgy and equipment, methods involved with them.

Hydro Metallurgy: Advantages and disadvantages, Principles of leaching, Leaching kineticsand factors affecting.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Gain the knowledge of advantages and limitations of hydrometallurgical operations.

- describe the process of leaching and with the help of influencing factors according to kinetics.

Electro Metallurgy- classification. Principles of refining. Use of vacuum, Zone refining, Vacuum arc re-melting, Electron beam melting, Electro slag refining. Cementation. Electro refining, Electro deposition.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the various electrometallurgical operations and classification.
- Demonstrate the process of various refining techniques with flow sheet and schematic diagrams.

Raw materials: Occurrence and distribution of iron ores in India. Evaluation of iron ore, coke and limestone. Preparation of iron ores: Methods of Beneficiation, Agglomeration of Iron ores.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the availability and distribution of iron ores in India.
- Gain the knowledge of preparation of iron ore for extraction.

Sintering and Pelletization: Raw materials, Mechanism of sintering, Sintering machine and its efficiency. Types of sinters. Recent trends in sintering practice. Pelletizing: Raw materials, Theory of Bonding, Bonding mechanism. Disc and Drum pelletiser, Firing units. Indian sinteringand pelletization plants.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the significance of sintering, it's mechanism and equipment used for sinter preparation.
- Understand the importance of pelletization, it's process and various sintering and pelletization plants.

Text books:

1. Introduction to modern iron making, R.H. Tupkary
2. Introduction to modern iron making, A.K. Biswas
3. Physical Chemistry of Iron & Steel Making, C.Bodsworth
4. Extraction of Non-Ferrous Metals, H.S.Ray, R.Sridhar and K.P.Abraham

Reference Books:

1. MSTS-United Steel Corporation, Pittsburgh
2. Blast furnace theory & practice- Vol.I& II ,Julius JH.Strysbugen
3. Metallurgy of Non-Ferrous Metals, Dennis, W.H.
4. Non-Ferrous Metallurgy, Sebryukov, N.Min, Pub. Moscow

MT 1105 FUELS, REFRACTORIES AND FURNACES

Course Objectives:

- This course is mainly intended to demonstrate the significance and characterization of conventional fuels that are employed in metallurgical processes.

- Gain an understanding of manufacture, testing, and applications of refractories.
- To gain knowledge related to working principles of furnaces used in metallurgical industries.
- To explain construction, salient features and heat transfer aspects of various furnaces.

Course Outcomes:

- Know about a fuel, classify them and compare different types of fuels and describe their testing methods. Explain the coke making process, list out the properties and its by -products recovery
- Apply principles of heat and mass transfer to basic engineering systems and understand the basic concepts and laws of the three modes of heat transfer and apply analytical techniques to the solution of conduction heat-transfer problems
- Classify and explain construction and working of different furnaces. Analyze causes of Heat losses in furnaces and suggest methods of minimization it and Waste heat recovery.
- Explain various manufacturing and testing processes of refractories. Link inherent properties of the refractory mineral and how it affects the production technology and the application.

SYLLABUS

SOLID FUELS: Classification. Proximate analysis & ultimate analysis of coal. Carbonization of coal. Coke making and by products recovery. Testing and properties of coke.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Define the terms Fuel, Calorific value – Net and gross, combustion of fuels, carbonization, flash and fire points, Ignition temperature, coking.
- Classify the fuels – based on occurrence and state.
- Distinguish between proximate and ultimate analysis of coal, Classify the coals and rank of coal.

LIQUID FUELS: Classification. Petroleum refining. Distillation.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Classify the liquid fuels and their application.
- Gain the knowledge of advantages and disadvantages of liquid fuels, Processing steps involved with petroleum refining and distillation techniques,

GASEOUS FUELS: Classification. Production of PG, WG, CWG, LD gas, Coke oven gas and BF gas.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the significance and classification of gaseous fuels.

- Describe manufacturing of PG, WG, CWG, LD gas, Coke oven gas and BF gas and their application.

REFRACTORIES: Properties, classification and general description. Manufacture, properties and applications of Alumino-silicate, Silica, Dolomite, Magnesite, Chromite and Carbon refractories. Importance and study of SiC, ZrO_2 and cermets. Testing of refractories.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Define the term Refractory, need of refractories, their classification and the properties of the refractory material.
- Explain the causes of refractory failures and remedies, the manufacturing of Alumino-silicate refractories-Fire Clay and the properties and applications of Fire Clay Refractories.
- Describe the manufacturing of SiO2 refractories, Magnesite refractories and their applications
- Name the Neutral Refractories, describe the manufacturing process of carbon bricks and state the properties and applications of carbon bricks.
- Explain the following tests on Refractories. 1. Porosity 2. P.C.E 3. R.U.L. 4. Bulk Density 5. Permeability 6. Cold Crushing Strength.

ELEMENTS OF HEAT TRANSMISSION: Steady state conduction, convection and radiation.

Learning Outcomes:

At the end of this chapter the student will be able to:

- State and explain different modes of heat transfer. Calculate the rate of heat transfer in single wall and composite walls of metallurgical systems.
- Define Radiation, black body, emissivity, absorptivity and reflectivity.
- State the Stefan- Boltzman Law of radiation.
- State Planck and Wien's law of distribution of radiant energy.

FURNACES: Classification of furnaces and their use in metallurgical industries. Heat sources, Heat utilization in furnaces, Heat losses in furnaces and furnace efficiency. Heat balance and Sankey diagrams. Principles of waste heat recovery. Recuperators and regenerators. Protective atmospheres.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Define Heat treatment furnace and the primary parts of furnace and draw different Heat treatment furnaces.
- Classify Heat treatment furnaces based on the fuels used, design, and use.
- Explain the working principle of the furnaces – Muffle furnace, Salt bath furnace, Bogie, Pit, Rotary hearth.
- Explain about the necessity of maintaining controlled atmosphere in furnaces, and the mixtures of gases which were used for controlled atmospheres.
- Describe the different reactions that takes place in furnaces and state different atmospheres that are available commercially.

Text books:

1. Fuels, furnaces and refractories by O.P.Gupta
2. Experimental methods for Engineers, J.P.Holman, McGraw Hill Publication.

Reference Books:

1. Fuels, Technology by Hinues
2. Fuels by Gilchrist
3. Refractories by Chesty

MT 1106 WORKSHOP

Course Objectives:

- The engineering work shop practice is included to introduce some common shop practices and on hands on experience to appreciate the use of skill, tools, equipment and general practices to all the engineering students.
- This laboratory course is aimed to provide the practical exposure to the students in the fields of Carpentry, Fitting, Sheet Metal and house electrical wiring works to
- Get hands on experience with the working skills in Carpentry trade.
- Know how to work with Sheet Metal tools.
- Get familiar with the working skills of Metal Fitting operations.
- Get hands on experience with house hold electrical wiring.

Course Outcomes:

- Can be able to work with Wood Materials in real time applications.
- Can be able to build various parts with Sheet Metal in day-to-day life.
- Can be able to apply Metal Fitting skills in various applications.
- Can be able to apply this knowledge to basic house electrical wiring and repairs.

SYLLABUS

Carpentry: Any three jobs from – Half lap joint, Mortise and Tenon joint, Half – lap Dovetail joint, Corner Dovetail joint, Central Bridle joint.

Sheet Metal: Any three jobs from – Square tray, Taper tray(sides), Funnel, Elbow pipe joint.

Fitting: Any three jobs from – Square, Hexagon, Rectangular fit, Circular fit and Triangular fit.

House wiring: Any three jobs from – Tube light wiring, Ceiling fan wiring, Stair-case wiring, Corridor wiring.

Text Books:

1. Elements of workshop technology, Vol.1 by S. K. and H. K. Choudary.
2. Work shop Manual / P.Kannaiah/ K.L.Narayana/ SciTech Publishers.
3. Engineering Practices Lab Manual, Jeyapoovan, SaravanaPandian, 4/e Vikas.

MT1107 PHYSICS LAB

Course Objectives:

- To enable the students to acquire skill, technique and utilization of the Instruments
- Draw the relevance between the theoretical knowledge and to imply it in a practical manner with respect to analyze various electronic circuits and its components.
- To impart the practical knowledge in basic concepts of Wave optics, Lasers and Fiber optics.
- To familiarize the handling of basic physical apparatus like Vernier callipers, screw gauge,
- spectrometers, travelling microscope, laser device, optical fibre, etc.

Course Outcomes:

- Ability to design and conduct experiments as well as to analyze and interpret
- Ability to apply experimental skills to determine the physical quantities related to Heat, Electromagnetism and Optics
- The student will learn to draw the relevance between theoretical knowledge and the means to imply it in a practical manner by performing various relative experiments.

List of Experiments:

1. Determination of Radius of Curvature of a given Convex Lens By forming Newton's Rings.
2. Determination of Wavelength of Spectral Lines in the Mercury Spectrum by Normal Incidence method.
3. Study the Intensity Variation of the Magnetic Field along axis of Current Carrying Circular Coil.
4. Determination of Cauchy's Constants of a Given Material of the Prism using Spectrometer.
5. Determination of Refractive Index of Ordinary ray μ_o and Extraordinary μ_e ray.
6. Determination of Thickness Given Paper Strip by Wedge Method.
7. Calibration of Low Range Voltmeter.
8. Calibration of Low Range Ammeter.
9. Determination of Magnetic Moment and Horizontal Component of Earth's Magnetic Field.

10. Lees Method - Coefficient of thermal Conductivity of a Bad Conductor.
11. Carey Foster's Bridge – Verification of laws of Resistance and Determination Of Specific Resistance.
12. Melde's Apparatus – Frequency of electrically maintained Tuning Fork.
13. Photoelectric cell-Characteristics.
14. Planks Constants.
15. Laser- Diffraction.

MT 1108 FUELS LAB

Course Objectives: At the end of the course the student is expected to

- To know the procedures of determining various properties of fuels
- To get familiarized with the handling of equipment calorie meters and viscometers

Course Outcomes:

- Ability to conduct experiments related to fuel properties
- Ability to gain experimental skills to determine the calorific value and viscosity of given fuel sample

List of experiments:

1. Determination of Flash and fire points of oils. (Open cup)
2. Determination of Flash and fire points of oils (Closed cup)
3. Determination of Calorific value of fuels (solids, liquids) by Bomb calorimeter
4. 4. Determination of Calorific value of fuels (gaseous) by gas calorimeter.
5. To determine the kinematic and absolute viscosity of the given sample oil using Redwood Viscometer I.
6. To determine the kinematic and absolute viscosity of the given sample oil using Redwood Viscometer II.
7. Determination of carbon residue.

SYLLABUS - I / IV SECOND SEMESTER

MT 1201 MATHEMATICS-II

Course Objectives:

- The way of obtaining rank, eigen values and eigen vectors of a matrix.
- To know the importance of Cayley-Hamilton theorem and getting canonical form from a given quadratic form.
- To solve the system of equations by using direct and indirect methods.

- To solve first order and higher order differential equations by various methods.
- To obtain the Laplace transforms and inverse Laplace transforms for a given functions and their applications.

Course Outcomes:

- Find rank, eigen values and eigen vectors of a matrix and understand the importance of Cayley-Hamilton theorem.
- Reduce quadratic form to canonical forms and solving linear systems by direct and indirect methods.
- Demonstrate solutions to first order differential equations by various methods and solve basic applications problems related to electrical circuits, orthogonal trajectories and Newton's law of cooling
- Discriminate among the structure and procedure of solving higher order differential equations with constant and variable coefficients.
- Understand Laplace transforms and its properties and finding the solution of ordinary differential equations.

SYLLABUS

Linear Algebra: Rank of a matrix- Echelon form, Normal Form - Solution of Linear System of Equations - Consistency of Linear System of Equations - Direct & Indirect Methods: Gauss elimination method, LU Factorization method, Gauss Seidal Method. Complex Matrices: Hermitian, Skew-Hermitian and Unitary Matrices and their Properties.

Eigen Values and Eigen Vectors: Eigen Values and Eigen Vectors of a Matrix - Cayley-Hamilton theorem - Inverse and Powers of a Matrix using Cayley-Hamilton's theorem and its applications. Diagonalization of a Matrix - Quadratic Forms - Reduction of Quadratic Form to Canonical Form - Nature of a Quadratic Form.

Ordinary Differential Equations of First Order and its Applications: Formation of ordinary differential equations (ODEs) - Solution of an ordinary differential equation - Equations of the first order and first degree - Linear differential equation - Bernoulli's equation - Exact differential equations - Equations reducible to exact equations - Orthogonal Trajectories - Simple Electric (LR & CR) Circuits - Newton's Law of Cooling - Law of Natural growth and decay.

Differential Equations of Higher Order: Solutions of Linear Ordinary Differential Equations with Constant Coefficients - Rules for finding the complimentary function - Rules for finding the particular integral - Method of variation of parameters - Cauchy's linear equation - Legendre's linear equation - Simultaneous linear differential equations.

Laplace Transforms: Introduction - Existence Conditions - Transforms of Elementary Functions - Properties of Laplace Transforms - Transforms of Derivatives - Transforms of Integrals - Multiplication by t^n - Division by t – Evaluation of integrals by Laplace Transforms - Inverse Laplace Transform - Applications of Laplace Transforms to Ordinary Differential Equations - Simultaneous Linear Differential Equations with Constant Coefficients - Second Shifting Theorem - Laplace Transforms of Unit Step Function, Unit Impulse Function and Laplace Transforms of Periodic Functions.

Text Book:

1. Scope and Treatment as in "Higher Engineering Mathematics", by Dr. B.S. Grewal, 43rd edition, Khanna publishers.

Reference Books:

1. Graduate Engineering Mathematics by V B Kumar Vatti., I.K. International publishing house Pvt. Ltd.
2. Advanced Engineering Mathematics by Erwin Kreyszig.
3. A text book of Engineering Mathematics, by N.P. Bali and Dr. Manish Goyal. Lakshmi Publications.
4. Advanced Engineering Mathematics by H.K. Dass. S. Chand Company.
5. Higher Engineering Mathematics by B.V. Ramana, Tata McGraw Hill Company.

MT 1202 CHEMISTRY

Course Objectives:

- To apply the basic knowledge of Chemistry to the Engineering Discipline.
- To develop knowledge about water and its treatment for industrial and potable purposes.
- To develop understanding in the areas of Polymers, Mechanism of Corrosion of Metals and Corrosion Control Methods, Fuels, Lubricants and Nanomaterials for of conducting polymers, bio-degradable polymers and fiber reinforced plastics and apply the knowledge for solving existing challenges faced in various engineering and societal areas.

Course outcome:

- This course applies the basic concepts and principles studied in Chemistry to Engineering.
- It provides an application of chemistry to different branches of engineering
- The students will be able acquire knowledge in the areas of Water Chemistry,Polymers, Corrosion, Fuels and Lubricants and nanomaterial and suggest innovative solutions for existing challenges in these areas.

SYLLABUS

Water Chemistry: Sources of Water – Impurities and their influence of living systems – WHO Limits – Hardness and its Determination – Boiler Troubles and their removal – Water Softening Methods – Lime-Soda, Zeolite and Ion Exchange - Municipal Water Treatment-Break Point Chlorination – Desalination of Sea Water – Reverse Osmosis Method, Electro-dialysis.

Polymers and Plastics Polymers: Definition – Types of Polymerization (Addition & Condensation) – Mechanisms of Addition Polymerization – Radical and Ionic – Thermodynamics of Polymerization Process.

Plastics: Thermosetting and Thermoplastics – Effect of Polymer Structure on Properties of Cellulose Derivatives – Vinyl Resins – Nylon (6,6), Reinforced Plastics – Conducting Polymers.

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Corrosion: Origin and Theory – Types of Corrosion: Chemical and Electrochemical; Pitting, Inter granular, Waterline, Stress – Galvanic Series – Factors Effecting Corrosion.

Corrosion Controlling Methods: Protective Coatings: Metallic Coatings, Electroplating and Electroless Plating – Chemical conversion Coatings – Phosphate, Chromate, Anodized, Organic Coatings – Paints and Special Paints.

Fuels and Lubricants -Solid Fuels: Wood and Coal, Ranking of Coal – Analysis (Proximate and Ultimate) Coke Manufacture – Otto Hoffmann's Process – Applications;

Liquid Fuels: Petroleum Refining – Motor Fuels – Petrol and Diesel Oil – Knocking – Octane number – Cetane Number

Gaseous Fuels: Biogas, LPG and CNG – Characteristics – Applications

Rocket Fuels: Propellants – Classification – Characteristics

Lubricants: Classification – Mechanism – Properties of Lubricating Oils – Selection of Lubricants for Engineering Applications.

Nanomaterials: Nanomaterials, Properties and application of fullerenes, fullerols, Carbon nanotubes and nanowires. Synthesis - Top-down and Bottom-up approaches - Nanocomposites - Nanoelectronics- Applications of nanomaterials in catalysis, telecommunication and medicine.

Text Books:

1. Engineering Chemistry – PC Jain and M. Jain – DhanpathRai and Sons, New Delhi.

2. A Text book of Engineering Chemistry – S. S. Dara – S. Chand & Co. New Delhi.

Reference Books:

1. Engineering Chemistry – B. K. Sharma – Krishna Prakashan – Meerut.

2. Introduction to Nanoscience - S. M. Lindsay - OxfordUniversity Press

3. Engineering Chemistry - B. L. Tembe, Kamaluddin and M. S. Krishnan, (NPTEL).

MT 1203 ENGLISH

Course Objectives:

- To make students understand the explicit and implicit meanings of a text/topic;
- To give exposure to new words and phrases, and aid to use them in different contexts;
- To apply relevant writing formats to draft essays, letters, emails and presentations; and
- To adapt oneself to a given situation and develop a functional approach to finding solutions: adaptability and problem solving.

Course Outcomes:

- Students will be able to analyse a given text and discover the various aspects related to language and literature;
- Learn the various language structures, parts of speech and figures of speech;
- Develop one's reading and writing abilities for enhanced communication; and
- Learn to apply the topics in real-life situations for creative and critical use.

SYLLABUS

Reading: On the conduct of life: William Hazlitt
Grammar: Prepositions
Vocabulary: Word Formation I: Introduction to Word Formation
Writing: Clauses and Sentences
Life skills: Values and Ethics
If: Rudyard Kipling

Reading: The Brook: Alfred Tennyson
Grammar: Articles
Vocabulary: Word Formation II: Root Words from other Languages
Writing: Punctuation
Life skills: Self-Improvement
How I Became a Public Speaker: George Bernard Shaw

Reading: The Death Trap: Saki
Grammar: Noun-Pronoun Agreement, Subject- Verb Agreement
Vocabulary: Word Formation III: Prefixes and Suffixes
Writing: Principals of Good Writing
Life skills: Time Management
On saving Time: Seneca
Reading: Chindu Yellama
Grammar: Misplaced Modifiers
Vocabulary: Synonyms, Antonyms
Writing: Essay Writing
Life skills: Innovation Muhammad Yunus

Reading: Politics and the English Language: George Orwell
Grammar: Clichés, Redundancies
Vocabulary: Common Abbreviations
Writing: Writing a Summary
Life skills: Motivation
The Dancer with a White Parasol: Ranjana Dave

Textbooks:

1. Language and Life: A Skills Approach Board of Editors, Orient Blackswan Publishers, India. 2018.

Reference Books

2. Practical English Usage, Michael Swan. OUP. 1995.
3. Remedial English Grammar, F.T. Wood. Macmillan.2007
4. On Writing Well, William Zinsser. Harper Resource Book. 2001
5. Study Writing, Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
6. Communication Skills, Sanjay Kumar and PushpLata. Oxford University Press. 2011.
7. Exercises in Spoken English, Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

MT 1204 CPNM

Course Objectives:

- The course is designed to provide complete knowledge of C language.

- To provide students with understanding of code organization and functional hierarchical decomposition with using complex data types.
- To provide knowledge to the Students to develop logics which will help them to create programs, applications in C.
- This course aims to identify tasks in which the numerical techniques learned are applicable and apply them to write programs, and hence use computers effectively to solve the task.
- This course provides the fundamental knowledge which is useful in understanding the other programming languages.

Course Outcomes:

- Identify basic elements of C programming structures like data types, expressions, control statements, various simple functions and Apply them in problem solving.
- Apply various operations on derived data types like arrays and strings in problem solving.
- Design and Implement of modular Programming and memory management using Functions, pointers.
- Apply Structure, Unions and File handling techniques to Design and Solve different engineering programs with minimal complexity.
- Apply Numerical methods to Solve the complex Engineering problems.

SYLLABUS

Introduction to C: Basic structure of C program, Constants, Variables and data types, Operators and Expressions, Arithmetic Precedence and associativity, Type Conversions. Managing Input and Output Operations Formatted Input, Formatted Output.

Decision Making, Branching, Looping, Arrays & Strings: Decision making with if statement, Simple if statement, The if…else statement, Nesting of if…else statement, the else..if ladder, switch statement, the (?:) operator, the GOTO statement., The while statement, the do statement, The for statement, Jumps in Loops ,One, Two-dimensional Arrays, Character Arrays. Declaration and initialization of Strings, reading and writing of strings, String handling functions, Table of strings.

Functions: Definition of Functions, Return Values and their Types, Function Calls, Function Declaration, Category of Functions: No Arguments and no Return Values, Arguments but no Return Values, Arguments with Return Values, No Argument but Returns a Value, Functions that Return Multiple Values. Nesting of functions, recursion, passing arrays to functions, passing strings to functions, the scope, visibility and lifetime of variables.

Pointers: Accessing the address of a variable, declaring pointer variables, initializing of pointer variables, accessing variables using pointers, chain of pointers, pointer expressions, pointers and arrays, pointers and character strings, array of pointes, pointers as function arguments, functions returning pointers, pointers to functions, pointers to structures-Program Applications.

Structure and Unions: Defining a structure, declaring structure variables, accessing structure members, structure initialization, copying and comparing structure variables, arrays of structures, arrays within structures, structures within structures, structures and functions and unions, size of structures and bit-fields- Program applications.

File handling: Defining and opening a file, closing a file, Input/ Output operations on files, Error handling during I/O operations, random access to files and Command Line Arguments- Program Applications

Numerical Methods: Solutions of Algebraic and Transcendental Equations, Bisection Method, Newton Raphson Method. Newton's forward and backward Interpolation, Lagrange's Interpolation in unequal intervals. Numerical Integration: Trapezoidal rule, Simpson's 1/3 rules. Solutions of Ordinary First Order Differential Equations: Euler's Method, Modified Euler's Method and Runge-Kutta Method.

Text Book:

1. Programming in ANSI C, E Balagurusamy, 6th Edition. McGraw Hill Education (India)Private Limited.
2. Introduction to Numerical Methods, SS Sastry, Prentice Hall

Reference Books:

1. Let Us C ,Yashwant Kanetkar, BPB Publications, 5th Edition.
2. Computer Science, A structured programming approach using C", B.A.Forouzan andR.F.Gilberg, " 3rd Edition, Thomson, 2007.
3. The C –Programming Language' B.W. Kernighan, Dennis M. Ritchie, PHI.
4. Scientific Programming: C-Language, Algorithms and Models in Science, Luciano M. Barone (Author), EnzoMarinari (Author), Giovanni Organtini, World Scientific.

MT 1205 ELEMENTS OF MATERIALS SCIENCE

Course Objectives:

- To describe the basics of crystal structure and its types
- To gain a thorough knowledge about crystal defects
- To gain a knowledge about electrical and electronic properties of materials
- To gain knowledge of magnetic and optical properties of materials

Course Outcomes:

- To use and apply basics of material science in his own branch of engineering.
- The student will be able to justify the materials behaviour and their properties
- To get basic foundation for learning material technology
- Understand the advances in the materials development .

SYLLABUS

Introduction: classification of materials**,** Space lattice and unit cells
Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand The basics of material science.

- Define space lattice, unit cell, bravais lattice, basic terminology involved with material science like packing fraction, coordination number.

Crystal systems Indices for planes and directions. Structures of common metallic materials.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Gain the knowledge of planar directions, miller indices.
- Understand the structures of metallic materials like perovskite, structure factor, and influence of structure on properties of a material.

Crystal defects: Point, Line and surface defects. Dislocations, types, Burgers' Vector. Dislocation movement by slip, climb and cross slip. Dislocation sources.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Know about different types of surface defects.
- Understand in detail about characteristics, movement and sources of dislocations.

Slip systems for BCC, FCC and HCP metals, Critical resolved shear stress (CRSS) for slip, Twinning, Stacking faults, Jogs, Kinks.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Gain the knowledge on slip systems involved with common crystal structures, energy required for slip.
- Define slip, Twinning, Stacking faults, Jogs, Kinks.

Electrical and Electronic properties of materials, Electronic conductivity, free electron theory and band theory of solids. Intrinsic semi-conductors. Super conductivity.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Define various properties of electric materials like conductivity, resistance.
- Understand the free electron theory and band theory of solids, different types semi-conductors.

Magnetic properties, Dia, para, ferro, ferri magnetism. Soft and hard magnetic materials and applications.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Define magnetic properties of dia, para, ferro magnets.
- Gain the knowledge of different magnetic materials and their applications.

Optical properties of materials. Refractive index, absorption emission of light, optical fibers. Opto-electronic materials.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the various optical properties of materials, Opto-electronic materials and their applications.
- Define Refractive index, absorption emission of light, optical fibers and their uses.

Text books:

1. Material Science and Engineering by V.Raghavan
2. Physical Metallurgy by S. H. Avner.

Reference books:

1. Material Science and Engineering by L.H.VanVleck, 5th edition, AddisionWealey(1985)
2. Structure and properties of Materials by R.M.Rose, L.A.Shepard and J.Wulff, Vol.1,4John Willey (1966) .
3. Essentials of Material Science by A.G.Guy, McGraw Hill(1976).
4. The Science and Engineering Materials by D.R.Askeland. 2nd Edition, Chapman and Hall(1990).
5. Physical Metallurgy, Vijendra Singh

MT 1206 ENGLISH LANGUAGE LAB

Course Objectives:

- To make students recognize the sounds of English through Audio-Visual aids;
- To help students build their confidence and help them to overcome their inhibitions and self- consciousness while speaking in English;
- To familiarize the students with stress and intonation and enable them to speak English effectively
- To give learners exposure to and practice in speaking in both formal and informal contexts.

Course Outcomes:

- Students will be sensitized towards recognition of English sound patterns and the fluency in their speech will be enhanced;
- A study of the communicative items in the laboratory will help students become successful in the competitive world;
- Students will be able to participate in group activities like roleplays, group discussions and debates; and
- Students will be able to express themselves fluently and accurately in social as well professional context.

SYLLABUS

Introduction to Phonetics: The Sounds of English (Speech sound – vowels and consonants) - Stress and Intonation - Accent and Rhythm.

Listening Skills: Listening for gist and specific information - listening for Note taking, summarizing and for opinions - Listening to the speeches of eminent personalities.

Speaking Skills: Self-introduction - Conversation Skills (Introducing and taking leave) - Giving and asking for information - Role Play - Just A Minute (JAM) session - Telephone etiquette.

Reading and Writing skills: Reading Comprehension – Précis Writing - E-Mail writing - Punctuation.

Presentation skills: Verbal and non-verbal communication - Body Language - Making a Presentation.

Text Books:

1. Ashraf Rizvi. *Effective Technical Communication*. Tata McGraw Hill Education Private Limited, New Delhi.
2. *Speak Well*. Orient Blackswan Publishers, Hyderabad.
3. Allan Pease. *Body Language*. Manjul Publishing House, New Delhi.

MT 1207 CHEMISTRY LAB

Course Objectives:

- To develop the fine skills of quantitative determination of various chemical components through titrimetric analysis
- To prepare and use ionexchange/ zeolite columns for the removal of hardness of water
- To develop the skill of organic synthesis through the preparation of a polymer/ drug

Course Outcomes:

- The course provides quantitative determine the amount of various chemical species in solutions by titrations and conduct the quantitative determinations with accuracy
- The course provides to develop novel materials to be used as zeolite and prepare columns for removal of hardness of water
- The course provides to synthesize a polymer or a drug

List of Experiments

1. Determination of Sodium Hydroxide with HCl (Na_2CO_3 Primary Standard)
2. Determination of Alkalinity (Carbonate and Hydroxide) of water sample
3. Determination of Fe(II)/Mohr's Salt by Permanganometry
4. Determination of Oxalic Acid by Permanganometry
5. Determination of Chromium (VI) by Mohr's Salt Solution
6. Determination of Zinc by EDTA method

7. Determination of Hardness of Water sample by EDTA method
8. Determination of Chlorine in water by Iodometric Titration
9. Ionexchange/ Zeolite column for removal of hardness of water
10. Synthesis of Polymer/ drug

Reference Books:

1. Vogel's Quantitative Chemical Analysis – V – Edition – Longman.

2. Experiments in Applied Chemistry (For Engineering Students) – Sinita Rattan – S. K. Kataria& Sons, New Delhi

MT 1208 CPNM LAB

Course Objectives:

- To impart writing skill of C programming to the students and solving problems.
- To write and execute programs in C to solve problems such as Modularize the problems into small modules and then convert them into programs.,
- To write and execute programs in C to solve problems such as arrays, files, strings, structures and different numerical methods.
- This reference has been prepared for the beginners to help them understand the basic to advanced concepts related to Objective-C Programming languages.

Course Outcomes:

- Understand various computer components, Installation of software. C programming development environment, compiling, debugging, and linking and executing a program using the development environment.
- Analyzing the complexity of problems, Modularize the problems into small modules and then convert them into programs.
- Construct programs that demonstrate effective use of C features including arrays, strings, structures, pointers and files.
- Apply and practice logical ability to solve the real world problems.
- Apply Numerical methods to Solve the complex Engineering problems.

SYLLABUS

1. Write a program to read x, y coordinates of 3 points and then calculate the area of a triangle formed by them and print the coordinates of the three points and the area of the triangle. What will be the output from your program if the three given points are in a straight line?
2. Write a program, which generates 100 random integers in the range of 1 to 100. Store them in an array and then print the arrays. Write 3 versions of the program using different loop constructs. (e.g. for, while, and do while).

3. Write a set of string manipulation functions e.g. for getting a sub-string from a given position, Copying one string to another, Reversing a string, adding one string to another.
4. Write a program which determines the largest and the smallest number that can be stored in different data types like short, int, long, float, and double. What happens when you add 1 to the largest possible integer number that can be stored?
5. Write a program, which generates 100 random real numbers in the range of 10.0 to 20.0, and sort them in descending order.
6. Write a function for transposing a square matrix in place (in place means that you are not allowed to have full temporary matrix).
7. First use an editor to create a file with some integer numbers. Now write a program, which reads these numbers and determines their mean and standard deviation.
8. Given two points on the surface of the sphere, write a program to determine the smallest arc length between them.
9. Implement bisection method to find the square root of a given number to a given accuracy.
10. Implement Newton Raphson method to det. a root of polynomial equation.
11. Given table of x and corresponding f(x) values, Write a program which will determine f(x)value at an intermediate x value by using Lagrange's interpolation/
12. Write a function which will invert a matrix.
13. Implement Simpson's rule for numerical integration.
14. Write a program to solve a set of linear algebraic equations.

SYLLABUS - II / IV First semester

MT 2101 METALLURGICAL THERMODYNAMICS – I

Course Objectives:

- The prime aim of this course is to apply thermodynamics to various metallurgical aspectslike first law, second law, entropy, and Ellingham Diagrams.
- The course is also intended to understand basics of thermodynamics

Course Outcomes:

- Relate 1st and 2nd Law of thermodynamics
- Knowledge of enthalpy, entropy and free energy.
- Understand the principles of thermodynamics as applied equilibrium positions ofchemical reactions.
- Calculate the temperature dependence of rate constants and relate this calculation toactivity and fugacity.
- To use ellingham diagrams for extraction of metals

SYLLABUS

Introduction - Basic concepts in thermodynamics. Objectives and limitations of classical thermodynamics. Zeroth law of thermodynamics.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the basics concepts of thermodynamics, various laws of thermodynamics.
- Gain the knowledge of objectives, limitations of classical thermodynamics.

First Law of Thermodynamics - Forms of Energy, Heat and Work, Joules Experiments, Conservation of Energy, Concept of Maximum Work, Isothermal Expansion, Reversible, Adiabatic Expansion, Constant Pressure Processes, Constant Volume Processes, Enthalpy.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Define various forms of Energy, Heat and work, Conservation of Energy.
- Gain the knowledge of first law of thermodynamic in detail, concept of maximum work, isothermal expansion, reversible, adiabatic expansion

Second Law of Thermodynamics -Efficiency of cyclic process. Carnot cycle. Entropy. Thermodynamic equation of state. Statistical Entropy, Physical Meaning of Entropy, Boltzman Equation, Mixing Entropy, Stirling's Approximation,

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the second law of thermodynamics in detail and its applications.
- Define entropy, various theories related to second law of thermodynamics.

Auxiliary Functions. Fundamental Equations of State, Maxwell Relationships. Other Thermodynamic Relations, Chemical Potential, Gibbs - Helmholtz Equation, Criteria of Equilibria.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Gain knowledge on fundamental equations of states and maxwell equations.
- Define chemical Potential, Gibbs - Helmholtz Equation, criteria of equilibria.

Third law of Thermodynamics, Heat Capacity and Entropy Changes. Sensible Heats, Transformation Heats, Reaction Heats, ΔCp, $\Delta H=f(T)$, $\Delta S=f(T)$, Adiabatic Flame Temperatures, Heat Balances.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the heat capacity and entropy changes involved with third law of thermodynamics.
- Define sensible heats, transformation heats, reaction heats and solve the numerical problems with the help of heat balance equations.

Phase Equilibria in One Component Systems, Clausius - Clapeyron Equation, Heats of Vaporization from Vapor Pressure Data, Shift in Transformation Temperature with Pressure. Fugacity, activity and equilibrium constant. Van't Hoff's isotherm. Ellingham diagrams and application.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Gain knowledge on phase equilibria, Clausius - Clapeyron equation in detail.
- Define fugacity, activity, equilibrium constant, Ellingham diagrams and their applications.

Text books:

1. Introduction to Metallurgical Thermodynamics, David R. Gaskell.
2. Problems in Thermodynamics & Kinetics, G.S.Upadhyaya and R.N.Dubey.

Reference Books:

1. Chemical Metallurgy, J.J.Moore
2. Physical Chemistry of Metals, L.S.Darken and G.Gurry, Tata Mc-Graw hill.
3. Metallurgical Thermodynamics, ML Kapoor Part I & II
4. Metallurgical Thermodynamics, Tupkary

MT 2102 MINERAL BENEFICIATION

Course Objectives:

- Introduce students to the principles of ore comminution, liberation and particle size analysis and equipments used.
- Teach students about various methods of concentration/ separation and equipments used.
- Acquaint the students about quantifying concentration processes and selection of proper mineral dressing cycles for an ore/mineral.

Course Outcomes:

- Recognition of the need of the mineral dressing prior to extraction of metals.
- Describe the working and construction details of various equipments used in mineral dressing.
- Assess the efficiency of concentration processes.
- Select and describe a particular concentration process suitable to the liberated ore.

SYLLABUS

Objectives and scope. Classification of minerals. An elementary concept of liberation. **Comminution:** Study of primary and secondary crushing and grinding units like Jaw, Gyratory, and reduction Gyratory and roll crushers. Theory of Ball Mill operation, Rittinger's, Kick's and Bond's laws of crushing and grinding.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand what is the mineral beneficiation, and its classification.
- Study the basic comminution operations, equipment used for comminution, and mechanisms involved with it.

Laboratory sizing units. Screening. Elutriation. Sedimentation. Representation of size analysis data. Sizing equipment used in industry. Elementary concepts of movement of solids in fluids. Stokes and Newtons laws. Reynold's number. Free and hindered settling. Classification and its application in mineral dressing.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Gain knowledge on various sedimentation techniques, classification and mineral dressing.
- Define elementary concepts of movement of solids in fluids, stokes and newtons laws, reynold's number

Heavy media separation and coal washing. Tabling. Jigging. Magnetic and Electro static separation. Elementary treatment of principles of flotation. Surface tension, surface energy, and contact angle. Floatability, frothers, collectors and modifying agents. Differential flotation. Flotation circuits.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the various heavy media separation techniques like tabling. jigging. magnetic and electro static separation.
- Define surface tension, surface energy, contact angle, floatability, frothers, collectors and modifying agents.
- Gain the knowledge on principles of flotation, different flotation circuits.

Study of basic de-watering techniques like-sedimentation – filtration – drying., Simple flow sheets for Beneficiation of Fe, Mn, Cr, Cu, Pb, Zn and beach sands.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Study the fundamentals of de-watering techniques.

Describe the beneficiation of Fe, Mn, Cr, Cu, Pb, Zn with process flow sheets.

Text books:

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

References

1. Mineral Processing Technology, S.K.Jain
2. Unit operation in Chemical Engineering.

MT 2103 IRON MAKING

Course Objectives:

- Illustrate the applications of thermodynamics and kinetics in production of pig iron andrefining it.
- Outline the techniques for production and primary processing in Blast furnace.
- Differentiate between past and present production methods and examine the moderntrends in iron production.
- Identify consists and effect for blast furnace irregularities and their remedial measures.

Course Outcomes:

- Identify the required parameters and design of a blast furnace and illustrate ancillary equipment and measures to be taken for starting and trouble shooting of Blast furnace process.
- Predict the physico-chemical phenomena taking place in blast furnace. Able to perform simple mass balance and complex problems.
- Identify and explain the modernization techniques to improve quantity, quality andminimization of waste.
- Able to predict the possible alternative processes to be followed suitable to the local conditions in view of energy, environmental and efficiency considerations.

SYLLABUS

Properties and testing of raw materials: Room temperature and high temperature physical properties, Reducibility tests, factors affecting reducibility.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Gain the knowledge on properties of raw materials and various testings to check the properties of raw materials.
- Study the factors affecting reducibility of raw materials.

Blast furnace and accessories: Description of modern blast furnace. Design of blast furnace stoves, Blast furnace refractories, Blast furnace cooling system, Gas cleaning system.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the construction, design of the modern blast furnace and significance of each accessory.
- Study the various systems involved in the design of the blast furnace.

Charging system, Distribution of burden in blast furnace, Blast furnace instruments.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Gain the knowledge on charging system of burden in the blast furnace.
- Study the various blast furnace instruments which facilitates smooth blast furnace operation.

Physical chemistry: Blast furnace physical structure, blast furnace reactions, Distribution of elements in molten metal and slag. Internal and External desulphurization, Blast furnace slag properties and uses. Acid and Basic burdening practices.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the significant reactions takes place in blast furnace.
- Gain the knowledge on molten metal and slag in the blast furnace and its properties.

Blast furnace operation, irregularities and remedies. Modern developments in blast furnace practice.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Study the advantages, irregularities involved with blast furnace practice and their remedies.
- Gain the knowledge on modern developments in blast furnace operation.

Alternate routes of pig iron production: Electric arc furnace process, Low shaft furnace, Mini Blast Furnace process, Charcoal furnace process. Production of wrought iron.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the alternate routes for pig iron production and also wrought iron production.

Study the different types of furnaces used for producing iron melt.

Text books:

1. Introduction to modern iron making, R.H. Tupkary
2. Introduction to modern iron making, A.K. Biswas
3. Physical Chemistry of Iron & Steel Making, C.Bodsworth

References:

1. MSTS-United Steel Corporation, Pittsburgh
2. Blast furnace theory & practice- Vol.I&II ,JuliusJH.Strysbugen

MT 2104 PHYSICAL METALLURGY

Course Objectives:

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

Course Outcomes:

- Explain the solidification of metals and alloys, mechanisms.
- Explain the necessity of alloys, will identify the different types of alloy phases.
- Explain the construction and identification of phase diagrams and reactions.
- Explain the Fe-Fe3C diagram with invariant reactions.
- Explain the Cu-Zn and other binary diagrams and complex phase diagrams etc.

SYLLABUS

Solidification: Solidification of pure metals, alloys and eutectic. Nucleation and growth, Homogenous and Heterogeneous, constitutional super cooling, coring and segregation.
Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the solidification of various pure metals and alloys and the mechanism involved with it.
- Define the fundamental concepts of solidification like nucleation and growth, homogenous and heterogeneous, constitutional super cooling, coring and segregation.

Phase rule, principles of construction and interpretation of binary phase diagrams. Invariant reactions, Free energy composition diagrams, uses and limitations of phase diagrams.
Learning Outcomes:

At the end of this chapter the student will be able to:

- Gain the knowledge on construction and interpretation of binary phase diagrams.
- Define the phase rule, invariant reactions and limitations of phase diagrams.

Equilibrium and non-equlibrium phase diagrams-Fe-C, Cu-Zn, Cu-Sn, Al-Si, Al-Cu, Pb-Sn. Sb-Sn, Ternary diagrams and interpretation of Structures on cooling.
Learning Outcomes:

At the end of this chapter the student will be able to:

- Study the various binary phase diagrams, and their interpretation in detail.
- Understand the ternary diagrams, and reactions involved with ternary diagrams.

Diffusion of metals-Fick's law, mechanisms of diffusion, solutions to diffusion Equations, diffusion in alloys, Kirkendal effect, Factors affecting diffusion, grain Boundary diffusion, applications.
Learning Outcomes:

At the end of this chapter the student will be able to:

- Gain the knowledge on various laws of diffusion and influencing factors of diffusion.
- Define the diffusion in alloys, kirkendal effect, grain boundary diffusion and applications of diffusion.

Text books:

1. Physical Metallurgy - S.H.Avner
2. Physical Metallurgy - V.Raghavan
3. Physical Metallurgy - Vijendra Singh
4. Mechanical Metallurgy - G.E. Dieter

Reference book:

1. Physical Metallurgy - R.E.Reed Hill

MT 2105 MANAGERIAL ECONOMICS

Course Objectives:

- To bring about an awareness about the nature of Managerial Economics and its linkageswith other disciplines.
- To understand the Micro and Macro Environment of Business.
- To familiarize the prospective engineers with the concepts and tools of ManagerialEconomics with an objective to understand the real world of business.

Course Outcomes:

- Understand the various economic activities in business and industry.
- Analyse the real world business problems.
- Make optimal business decisions for the effective and efficient management ofOrganisations.

SYLLABUS

Significance of Economics and Managerial Economics:
Economics: Definitions of Economics- Wealth, Welfare and Scarcity definitions Classification ofEconomics- Micro and Micro Economics.

Managerial Economics: Definition, Nature and Scope of Managerial Economics, Differences between Economics and Managerial Economics, Main areas of Managerial Economics, Managerial Economics with other disciplines.

Demand and Utility Analysis:

Demand - Definition, Meaning, Nature and types of demand, Demand function, Law of demand - Assumptions and limitations. Exceptional demand curve.

Elasticity of demand - Definition, Measurement of elasticity, Types of Elasticity (Price, Income, Cross and Advertisement), Practical importance of Price elasticity of demand, Role of income elasticity in business decisions, Factors governing Price Elasticity of demand.

Utility Analysis: Utility- Meaning, Types of Economic Utilities, Cardinal and Ordinal Utility, Total Utility, Marginal Utility, The law of Diminishing Marginal Utility and its Limitations**.**

Theory of Production and Cost analysis:
Production - Meaning, Production function and its assumptions, use of production function in decision making;

Cost analysis - Nature of cost, Classification of costs - Fixed vs. Variable costs, Marginal cost, Controllable vs. Non - Controllable costs, Opportunity cost, Incremental vs. Sunk costs, Explicit vs. Implicit costs, Replacement costs, Historical costs, Urgent vs. Postponable costs, Escapable vs. Unavoidable costs, Economies and Diseconomies of scale.

Market Structures : Definition of Market, Classification of markets; Salient features or conditions of different markets - Perfect Competition, Monopoly, Duopoly ,

Oligopoly, Importance of kinked demand curve ;Monopolistic Competition.

Pricing Analysis : Pricing – Significance; Different Pricing methods- Cost plus pricing, Target pricing, Marginal cost pricing, Going -rate pricing, Average cost pricing, Peak load pricing , Pricing of joint Products, Pricing over the life cycle of a Product, Skimming pricing Penetration pricing, Mark- up and Mark- down pricing of retailers.

Business cycles - Definition, Characteristics, Phases, Causes and Consequences; Measures to solve problems arising from Business cycles.

Text Books:

1. Sankaran,S., Managerial Economics,Marghan Publications, 2015, Chennai.
2. Aryasri, A.R., Managerial Economics and Financial Analysis, MC Graw HillEducation, New Delhi,2015.

Reference Books:

1. Dwivedi, D.N., Managerial Economics,Vikhas Publishing House Pvt. Ltd. 6thEdition, New Delhi,2004.
2. Dewett, K.K., Modern Economic Theory, S.Chand& Company Ltd., New Delhi,2005.

MT 2106 NON METALLIC MATERIALS

Course Objectives:

- To impart knowledge about the uses and application of polymers
- Explain the uses and applications of various ceramics
- Describe about the uses and application of various textile materials
- Course Outcomes:
- At the end of the course, student will
- Appreciate the importance of polymers and their classification and apply the knowledgefor the practical applications

- Describe the properties of ceramics and choose a particular ceramic for a givenapplication.
- Correlate the structure, property and applications of ceramics and polymers.
- Able to analyse the properties of different nonmetallic materials and justify their choice.

SYLLABUS

Polymers: Classification, properties and applications, Molecular structure of polymers, Polymerization, Mechanical properties of polymers.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Study the classification, properties of polymers.
- Understand the processing techniques for polymers and their applications.

Ceramics: Classification properties and applications, Mechanical properties of Ceramics, Glass and Glass ceramics, Processing of Ceramics.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Gain the knowledge on classification and mechanical properties of ceramics.
- Describe the various processing techniques for manufacturing of ceramics and their application.

Classification, properties and applications of Textiles, Adhesives, polymer and ceramic Foams.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the classification and properties of textiles.
- Define the properties of adhesives, polymer and ceramic Foams and their applications.

Text books:

1. Textbook of Polymer Science; Fred W. Billmeyer, Wiley 2007
2. Introduction to Ceramics; Kingery, Bowen, Uhlman. Wiley India Pvt Limited, 2012
3. Composite Materials: Science and Engineering; Krishan K. Chawla, Springer, 2012

MT 2107 MINERAL BENEFICIATION LAB

Course Objectives:

- This laboratory course critically deals with the experiments related to ore dressingprinciples
- Apart from this, it also concerns about laboratory models of mineral dressing operations

Course Outcomes:

- Pick or take a representative amount of sample and conduct sieve analysis
- Determine the reduction ratio in crushing and grinding of different

materials usingvarious size reduction units

- Analyze the grindability of different coals
- Separate or concentrate the given materials using froth flotation processes

List of experiments:

1. Sampling by coning and quartering and riffle sampler.
2. Determination of average particle size by sieve analysis.
3. Determination of optimum time of sieving.
4. Studies on size reduction using laboratory Jaw Crusher.
5. Studies on size reduction using laboratory Roll Crusher.
6. Studies on size reduction using laboratory Ball Mill.
7. Heavy media separations (sink and float experiment)
8. Laboratory experimentation Froth Flotation.
9. Determination of Grindability of Coal.

MT 2108 MOULDING AND CASTING PRACTICE

Course Objectives:

- To study mould ingredients
- To understand mould making procedures for wet and dry processes
- To know the structural changes and hardness
- To know the problems during melting and casting of pure metals and alloys

Course Outcomes:

- To get moulding skill in various moulding processes
- To Gain knowledge in developing proper melting and casting procedures of various alloys
- To Know the structural and property changes on effect of moulding practices of important engineering alloys

SYLLABUS

Introduction to various mould ingredients and moulding practices of:

1. Wet moudlimg- Bentonite based process
2. Dry moudling- Sodium silicate process
    a. CO_2 process
    b. Ferrosilicon process

Melting and casting practices of:

1. Pure aluminium
2. Al-Cu binary alloys
3. Al-Cu-Mg ternary alloys

Evaluation of Castings:

1. Visual inspection
2. Microstructure studies
3. Hardness survey

MT 2109 PROFESSIONAL LAWS & ETHICS AND UNIVERSAL HUMAN VALUES

Course Objectives:

- Development of a holistic perspective based on self-exploration about themselves (humanbeing), family, society and nature/existence.
- This course will illuminate the students in the concepts of laws and its applicability to engineers
  Understanding (or developing clarity) of the harmony in the human being, family, society andnature/existence
- Strengthening of self-reflection, Development of commitment and courage to act and also enable the students to imbibe and internalize the Values and Ethical Behaviour in the personal and professional lives
- To enable the students to imbibe the Values and Ethical Behavior in the personal and Professional lives

- The students will learn the rights and responsibilities Individual, employee, team member and a global citizen

Course Outcomes:

- Grasp the meaning of the concept – Law and also Get an overview of the laws relating to Engineers and also Apprehend the importance of being a law abiding person and They would have better critical abilitySelf-explore by using different techniques to live in harmony at various levels Analyze themselves and understand their position with respect to the moral and ethical character needed for a successful and satisfactory work life
- Students are expected to become more aware of themselves and their surroundings (family, society, nature) They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
- They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society.

SYLLABUS

Need, Basic Guidelines, Content and Process for Value Education: Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation - as the process for self-exploration, Continuous Happiness and Prosperity - A look at basic Human Aspirations, Right understanding, Relationship and Physical Facility - the basic requirements for fulfillment of aspirations of every human being with their correct priority, Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfill the above human aspirations: understanding and living in harmony at various levels. Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking, Include practice sessions and case studies.

Understanding Harmony in the Human Being - Harmony in Myself!: Understanding human being as: a co-existence of the sentient 'I' and the material 'Body', the needs of Self ('I') and 'Body' - happiness and physical facility, the Body as an instrument of 'I' (I being the doer, seer and enjoyer), the characteristics and activities of 'I' and harmony in 'I', the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail, P to ensure Sanyam and Health, Include practice sessions and case studies.

Understanding Harmony in the Family and Society - Harmony in Human – Human Relationship: Understanding values in human-human relationship: meaning of Justice (nine universal values in relationships) and program for its fulfillment to ensure mutual happiness; Trust and Respect as the foundational values of relationship, the meaning of Trust; Difference between intention and competence, the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship, the harmony in the society (society being an extension of family), Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order from family to world family, Include practice sessions and case studies.

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence: Understanding the harmony in the Nature, Interconnectedness and mutual fulfillment among the four orders of nature recyclability and self-regulation in nature, Understanding Existence as Co-existence of mutually interacting units in all – pervasive space, Holistic perception of harmony at all levels of existence, Include practice sessions and case studies.

Concept of Law and Law of Torts : Understanding Essentials of a Valid Contract and the basics of contract law protecting rights and obligations, Introduction to the Law of Torts and the basics to protect oneself and the company Law affecting the Workplace Employers Responsibilities/Duties Hiring Practices, Introduction to Intellectual Property Law, Professional Code of Conduct for Engineers, Relationship between Law and Ethics, Include practice sessions and case studies.

Implications of the above Holistic Understanding of Harmony on Professional Ethics: Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems, Case studies of typical holistic technologies, management models and production systems, Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations, Include practice sessions and case studies.

Text Books:

1. R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
2. R R Gaur, R Asthana, G P Bagaria, "Teachers' Manual for A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2
3. R. Subramanian, "Professional Ethics", Oxford University Press.
4. S.B. Srivasthva, "Professional Ethics & Human Values", SciTech Publications (India) Pvt. Ltd. New Delhi.
5. D.R. Kiran, "Professional Ethics & Human Values", TATA McGraw Hill Education.
6. Saroj Kumar, "Business Law" and Avtar Singh, "Law of Contract"

Reference Books:

1. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amar kantak, 1999.
2. A. N. Tripathi, "Human Values", New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book), MohandasKaramchand Gandhi "The Story of My Experiments with Truth", E. FSchumacher. "Small is Beautiful", Slow is Beautiful –Cecile Andrews, J C Kumarappa "Economy of Permanence", PanditSunderlal "Bharat Mein Angreji Raj" and Dharampal, "Rediscovering India
4. G K Kapoor, "Business Law" and Sen&Mitra, "Business & Commercial Laws" and Calvin Frank Allen, "Business law for Engineers"

MT 2201 HEAT TREATMENT

Course Objectives:

- This course is mainly designed to impart knowledge about basic principles and processvariables of different heat treatment processes.
- To understand the techniques of thermo mechanical treatment, surface hardeningtechniques, heat treatment of steels, cast irons, non ferrous alloys in detail.
- To gain basic knowledge about different types of phase transformations, cooling curvesand effect of alloying elements on cooling curves..

Course Outcomes:

- To demonstrate a critical understanding of the importance of heat treatment in achievingfit for purpose in steels
- To apply and interpret phase and continuous cooling diagrams to assess the impact of arange of heat treatment procedures
- To choose and justify a procedure for a particular alloy in order to achieve the propertiesrequired for a particular engineering application

SYLLABUS

Phase transformation in Fe-C system, Critical temperatures. Austenite grain size designation. Inherently fine-grained and inherently coarse grained steel. Importance of grain size and its determination. Heat Treatment Furnaces and atmospheres.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the phase transformations involved in Fe-C system and their influence on properties of steel.
- Study the different heat treatment furnaces and the required controlled atmospheres.

T-T-T Curves. Effect of cooling on transformation of austinite, pearlite, bainite and martensite. Annealing, normalizing, hardening and tempering of steels. Austempering, Martempering. Patenting and spheroidizing**.**

Learning Outcomes:

At the end of this chapter the student will be able to:

- Gain the knowledge on T-T-T curves, transformation of austinite, pearlite, bainite and martensite.
- Describe the various heat treatment processes for steels.

Effect of alloying elements. Hardenability of steels. Factors affecting and its determination. Thermo-mechanical treatments. Aus-forming. Strain tempering.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the influence of alloying elements and factors affecting hardenability.

- Study the different thermo-mechanical treatments for steels.

Surface hardening. Carburizing, nitriding, cyaniding, carbonitriding. Induction and flame hardening.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Study the various surface hardening techniques like surface hardening, carburizing, nitriding, cyaniding, carbonitriding. induction and flame hardening.

Text books:

1. Heat Treatment Principles and Techniques - T.V. Rajan, C.P. Sharma and Ashok Sharma Depar
2. Heat treatment of metals, Zakharov

References:

1. Physical Metallurgy, V.Raghavan
2. Introduction to Physical Metallurgy, S.H.Avner
3. Physical Metallurgy Principles, R.E. Reed- Hill.
4. Physical Metallurgy for Engineers, Clark and Varney

MT 2202 METALLURGICAL THERMODYNAMICS – II

Course Objectives:

- The laws of diffusion.
- Interpret Ellingham diagrams
- Identify metallurgical thermodynamics principles to be applied in phase diagrams.

Course Outcomes:

- Understand and able to use Fick's I and II law.
- Interpret Ellingham Diagram for oxides
- Understand the thermal properties of solids, specifically, specific heat and some modelsfor specific heat calculation.
- Knowledge of ideal and regular solutions and free energy of mixing.
- Apply the phase rule on the metallurgical systems.
- Understanding of the nature of polarized electrochemical reactions and an introduction oftheir application in corrosion behavior of metals.

SYLLABUS

The Behavior of Gases. Compressibility Factor, Law of Corresponding States, Equations of State, Fugacity. Reactions Equilibria - The effect of temperature and pressure on equilibrium constant.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge on behavior of gases, influencing factors.
- Define the Compressibility factor, Fugacity, reaction equilibria, law of corresponding states.

Equilibria in Gaseous Systems, The Equilibrium Constant and ΔG°, Reaction Extent Problems, Equilibria in Systems Containing Condensed Phases, Ellingham Diagram, Activities.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand in detail about equilibria in gaseous systems, Ellingham diagrams and activities.
- Solve the problems related to Reaction Extent, the Equilibrium Constant and ΔG°

Solution Thermodynamics - Thermodynamic solutions. Raoult's law. Henry's law. Sievert's law. Absolute and Partial and Integral Molar Quantities, Relative and Partial Integral Molar Quantities, Ideal Solutions, Excess Quantities, Gibb's Duhem Equation, Tangent Intercept Method, a=f(T), Change in Reference State, 1 wt % Reference State Interaction Parameters. Actual solutions. Regular solutions.

Learning Outcomes:

At the end of the chapter the student will be able to:

- State the Raoult's law, Henry's law, Sievert's law, Absolute and Partial and Integral Molar Quantities, Ideal Solutions.
- Gain the knowledge on Gibb's Duhem Equation, Tangent Intercept Method.
- Differentiate Actual solutions, Regular solutions and Ideal Solutions.

Application of the laws of thermodynamics to metallurgical processes, electrochemistry, interfacial phenomena, extraction and refining of materials.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge on application of the laws of thermodynamics to metallurgical processes
- Understand in detail about electrochemistry, interfacial phenomena, extraction and refining of materials.

Kinetics of Metallurgical reactions. Collision theory. Theory of absolute reaction rates.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Get to know about kinetics of metallurgical reactions in detail.
- Understand the collision theory and theory of absolute reaction rates.

Text books:

1. Introduction to Metallurgical Thermodynamics, David R. Gaskell.
2. Problems in Thermodynamics & Kinetics, G.S.Upadhyaya and R.N.Dubey.

Reference Books:

1. Chemical Metallurgy, J.J.Moore
2. Physical Chemistry of Metals, L.S.Darken and G.Gurry, Tata Mc-Graw hill.
3. Metallurgical Thermodynamics, ML Kapoor Part I & II
4. Metallurgical Thermodynamics, Tupkary.

MT 2203 NONDESTRUCTIVE TESTING

Course Objectives:

- To gain and understanding of the response of various metals under the application ofstress and/or temperature.
- Obtain a working knowledge of various hardness testing machines BHN, VHN, RHN
- Obtain a working knowledge of creep and fatigue testing methods and analysis of data.
- To get an exposure to NDT techniques for detection of various types of flaws.

Course Outcomes:

- Understand and interpret the results of various hardness tests and impact tests.
- Evaluate various tensile properties of ferrous and Non Ferrous Metals and solveproblems related to the tensile tests.
- Analyse the modes of failure occurring due to fatigue and suggest remedial measures.
- Analyse the methods of failure of materials at high temperature by creep and stressrupture and the mechanisms responsible for fracture
-
- Determine appropriate tests to be employed to determine the given mechanical propertiesusing both destructive and non-destructive techniques
- Knowledge of various testing methods for based on Destructive Techniques &Nondestructive Techniques and their importance in enhancing service / component life.

SYLLABUS

Visual Examination: Leakage Testing, Penetrant methods, Principles, equipment, applications and limitations.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the significance of visual inspection methods and their principles.
- Gain the knowledge of precise operations involved to determine the surface cracks by liquid penetrant test by using cleaner, penetrator and developer.
- Know about various equipment used for visual inspection methods, and their limitations.

Magnetic methods: Principles of magnetism and magnetization. Principles of magnetic particle inspection. The magna flux machine-process. The magnetic bath. Methods for the application of magnetic bath. Demagnetization. Application of the method. Salient features of the process.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Learn about the significance of magnetic methods of NDT and their principles.
- Gain the knowledge of precise operations involved and their principles.
- Know about various equipment used for magnetic methods, and their applications.

Ultrasonic testing: Types of ultrasonic waves. Flow detection and ultrasonic energy. Interpretation of results and limitations.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the importance of Ultrasonic testing and their principle.
- Gain the knowledge of precise operations involved and their principles.
- Know about various equipment used for magnetic methods, and their applications.

X-ray radiography: Production of X-rays. X-ray tube. The Radiograph. Optical factors which effect the radiograph. X-ray films. Filters and screens. Sensitivity of a radiograph. Gamma ray radiography: Production of gamma-rays, interpretation of the radiograph. Safety precautions.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge on X-ray radiography, influencing factors and data interpretation.
- Understand in detail about production of gamma rays, its analysis and safety measures.

Electrical methods: Thermoelectric methods. Eddy Current methods. Detection of the eddy currents. Eddy current instruments. Continuous inspection and testing.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the electrical methods involved in non-destructive testing and the instruments used, in detail.

Text Book:

1. Testing of Materials - AVK Suryanarayana

Reference Books:

1. Metals Hand Book Vol.11 (Non-Destructive Testing)
2. Non-Destructive Testing-W.J.Mc GONNANGLE

MT 2204 NON FERROUS EXTRACTIVE METALLURGY –I

Course Objectives:

- To explain the various methods of extraction of non ferrous metals.
- To describe the procedure and equipment used for production of non ferrous metals from their ores.

Course Outcomes:

- Get detailed information about the properties of non ferrous metals, ores of non ferrous metals, pre treatment processes, thermodynamics and kinetics involved in extractionprocess
- Describe and explain ore treatment techniques and learn the fundamental concepts of metallurgical pre-treatment methods, production of metals from ore, concentrate and secondary sources
- Emphasize the strategic importance of raw and supplementary materials in the production, and explain the concepts of technological and economical feasibility
- Identify the beneficiation of byproducts materialize during the metal production, within the framework of technology-environment-ecology
- Explain processes based on an advanced thermodynamic perspective and explain material and energy flows related to extraction of metals and alloys
- Understand about Extractive metallurgy processes and explain their relative merits and demerits and also Conduct a detailed and individual research about production of a specific metal, as part of their responsibility.

SYLLABUS

Extraction of Metals: Aluminum-Uses, Ores. Bayer's process of Alumina production. Hall-heroult process. Cryolite and carbon electrode manufacture. Hoopes process of refining. Indian plant practice. New processes. Alcoa process.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the significance of Aluminum and its uses.
- Gain knowledge on various extraction processes of Aluminum, their advantages and disadvantages.

Magnesium: Uses. Ores. Pidgeon's process. Extraction by Dows process.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Describe the importance of Magnesium and its uses, availability of magnesium ores.
- Gain knowledge on various extraction processes of magnesium, their advantages and disadvantages.

Tin: Uses. Ores. Concentration, smelting and refining.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the significance of Tin and its uses.
- Gain knowledge on extraction processes of Tin, their advantages and disadvantages.

Copper: Uses. Pyro-metallurgical processes. New processes. Flash smelting. WORCA and Noranda processes. Hydro-metallurgy of copper. Copper production in India.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the significance of Copper and its uses, copper production in India.
- Describe the pyrometallurgical, hydrometallurgical extraction processes of Copper and advanced processing techniques with schematic diagram.

Nickel: Brief description of Ni extraction from sulphide ores.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand and explain about the Ni and its extraction processes.

Lead: Uses. Ores. Treatment of ore and production of metal.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Describe the significance of Lead and its uses.
- Gain knowledge on various extraction processes of lead, their advantages and disadvantages.

Zinc: Uses. Pyro-metallurgical and hydro-metallurgical extraction methods. Imperial smelting process.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the significance of zinc and its applications.
- Gain knowledge on various extraction processes of zinc, their advantages and disadvantages.

Text books:

1. Extraction of Non-Ferrous Metals, HS Ray, R Sridhar and KP Abraham

Reference Books:

1. Metallurgy of Non-Ferrous Metals, Dennis, WH
2. Non-Ferrous Metallurgy, Sebryukov, N Min, Pub. Moscow

MT 2205 MECHANICAL PROPERTIES OF MATERIALS

Course Objectives:

- To gain and understanding of the response of various metals under the application of stress and/or temperature.
- To build necessary theoretical back ground of the role of lattice defects in governing both elastic and plastic properties of metals will be discussed.
- Obtain a working knowledge of various hardness testing machines BHN, VHN, RHN
- Obtain a working knowledge of creep and fatigue and analysis of data.

Course Outcomes:

- Describe and correlate the structure and mechanical properties of different kind of metals.
- Identify, formulate and solve engineering problems related to mechanical behaviour.
- To know the behaviour of material under different loading conditions.
- Demonstrate fracture, and fatigue control on structure.
- Selection of proper testing method to analyze physical structure and hardness of material.
- Knowledge of how to incorporate material strength limitation into engineering design.

SYLLABUS

Introduction to Mechanical testing: Introduction, Impact of testing.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge on significance of material testing
- Understand the material testing terminology and the equipment involved with testing.

Tension test: Engineering stress strain curve. True stress and true strain diagram. Ductility measurements. Typical stress strain diagrams. Yield point phenomenon, strain ageing.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Define various engineering properties – Elastic limit, Yield strength, Ultimate Tensile strength, % elongation, % reduction in area, Resilience, Toughness.
- Analyze the tensile properties from the stress strain curve.
- Understand the strength increasing criteria like yield point phenomenon, strain ageing.

Compression Test: Fundamentals of testing, applications.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the significance of compression test, Compression Test Setup and specimens.
- Describe the behavior of ductile and brittle materials in Compression, barreling.

Hardness test: Introduction, Brinell, Vickers and Rockwell hardness, Micro hardness.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the importance of hardness test, define hardness and classification of hardness tests.
- Gain the knowledge on various test procedures and conversion formulae for hardness value.

Fracture: Introduction, types of fracture in metals. Brittle fracture and impact testing: The problems of brittle fracture. Notched bar impact tests, significance of transition temperature, metallurgical factors affecting transition temperature.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand what is the fracture and types of fracture, differentiate the ductile and brittle fracture. Derive the equation for theoretical cohesive strength.
- Explain the Griffith theory of brittle fracture. Analyze different metallographic aspects of fracture.
- Explain the principle of operation of Izod and Charpy impact tests. Define notch sensitivity, notch toughness and transition temperature.
- Gain the knowledge on the factors effecting transition temperature.

Creep and stress rupture: The creep curve. Stress rupture test. Structural changes during creep, mechanisms of creep deformation, High temperature alloys, presentation of engineering creep data, prediction of long time properties.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Define creep and importance of creep test. Gain knowledge on the essential features of creep test.
- Explain the creep curve, its regions and the mechanism involved with it, the analysis of creep data.
- Describe the stress rupture test. Distinguish between stress – rupture test and creep test.

Fatigue: Introduction, Stress cycles, S-N diagram, mechanisms of fatigue, Factors influencing fatigue properties, corrosion fatigue, thermal fatigue.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the importance of the fatigue test, the specifications of test samples for fatigue test, the theories of fatigue – Orowon's and Wood's concept.
- Explain the different cycles of stress – Alternating, Repeating & fluctuating and loading systems – reverse bend, torsion and tension- compression.
- Plot the S-N curve from the test data and identify the endurance limit, analysis of a typical fatigue failure.
- Discuss the effect of stress concentration on fatigue and the effect on surface roughness on fatigue,
- Discuss effect of surface residual stress, the effect of corrosion and the effect of metallurgical variables on fatigue properties.
- Explain the effect of temperature on fatigue properties.

Text books:

1. Mechanical Metallurgy, George E Dieter, McGraw Hill.
2. Testing of Materials, A.V.K.Suryanarayana, Prentice Hall of India.

Reference Books:

1. Testing of Engineering Materials, Donald et.al., McGraw Hills.
2. Metals hand book

MT 2206 METALLOGRAPHY LAB

Course Outcomes

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

SYLLABUS

About 12 experiments on the Metallography of common ferrous and Non-Ferrous metals and alloys, experiments on thermal analysis.

MT 2207 MECHANICAL METALLURGY LAB

Course Outcomes:

- Explain the methods of destructive testing (Hardness testing, Tensile testing, Impact and cupping tests) and non destructive testing (LPT, MPT and UT).
- Analyze, interpret and present the observation from the tests conducted.
- Identify the reasons for failure through Non-Destructive Examination.
- Can prepare formal laboratory reports describing the experimental and the results obtained.
- Solve material problems associated with testing.

List of Experiments:

1. Hardness testing (Brinell, Vickers, Rockwell)
2. Ericsen Cupping Test
3. Tensile & Bend Testing
4. Shore seleroscope hardness test
5. Poldi Testing
6. Cold working & annealing
7. Impact testing

MT 2208 WELDING PRACTICE

Course Objectives:

- Study of welding procedures for metals and alloys
- Study of structural changes and hardness
- Study of problems during welding of ferrous and non-ferrous alloys

Course Outcomes:

- Get welding skill in joining various engineering alloys
- Gain knowledge in use of proper procedure in welding of various alloys
- Know the structural and property changes during welding of important engineering alloys

SYLLABUS

Welding procedure: Cleaning, Edge preparation and Selection of welding parameters

Shielded Metal arc welding and Gas Tungsten Arc Welding

Welding of mild steel, Welding of Stainless steels, Welding of Aluminium alloy, Welding of Titanium alloy

Identification of various zones Microstructural changes, Hardness survey

Text Books:

1. Welding Technology - RS Parmar

Reference Books:

1. Metal casting and Joining - KC John

MT 2209 ENVIRONMENTAL SCIENCE

Course Objectives:

- Familiarize the fundamental aspects of environment and the environmental management'
- Provide information of some of the important international conventions which will be useful during the future endeavors after graduation.
- Make realize the importance of natural resources management for the sustenance of the life and the society.
- Apprise the impact of pollution getting generated through the anthropogenic activities on the environment
- Provide the concept of Sustainable Development, energy and environmental management
- Impart knowledge on the new generation waste like e-waste and plastic waste.

Course Outcomes:

- Knowledge on the fundamental aspects of environment and the environmental management
- The knowledge on the salient features of the important international conventions
- Understanding of the importance of natural resources management for the sustenance of the life and the society.
- Familiarity on various forms of pollution and its impact on the environment.

- Understand the elements of Sustainable Development, energy and environmental management
- Knowledge on the new generation waste like e-waste and plastic waste.

SYLLABUS

Introduction: Structure and functions of Ecosystems-Ecosystems and its Dynamics-Value of Biodiversity-impact of loss of biodiversity, Conservation of bio-diversity. Environmental indicators - Global environmental issues and their impact on the ecosystems.
Salient features of International conventions on Environment: Montreal Protocol, Kyoto protocol, Ramsar Convention on Wetlands, Stockholm Convention on Persistent Organic Pollutants, United Nations Framework Convention on Climate Change (UNFCCC),

Natural Resources Management: Importance of natural resources management-Land as resource, Land degradation, Soil erosion and desertification, Effects of usage of fertilizer, herbicides and pesticide- watershed management.

Forest resources: Use and over-exploitation, Mining and dams – their effects on forest ecosystems and the living beings.

Water resources: Exploitation of surface and groundwater, Floods, droughts, Dams:benefits and costs.

Mineral Resources: Impact of mining on the environment and possible environmental management options in mining and processing of the minerals.
Sustainable resource management (land, water, and energy), and resilient design under the changing environment.

Environmental Pollution: Local and Global Issues. Causes, effects and control measures. Engineering aspects of environmental pollution control systems.

Air pollution: impacts of ambient and indoor air pollution on human health. Water pollution: impacts water pollution on human health and loss of fresh water resources. Soil pollution and its impact on environment. Marine pollution and its impact on blue economy. Noise pollution.

Solid waste management: Important elements in solid waste management- Waste to energy concepts. Air (prevention and control of pollution) Act, Water (prevention and control of pollution) Act and their amendments. Salient features of Environmental protection Act, 1986.

Sustainable Development: Fundamentals of Sustainable Development– Sustainability Strategies and Barriers – Industrialization and sustainable development. Circular economy concepts in waste (solid and fluid) management.

Energy and Environment: Environmental Benefits and challenges, Availability and need of conventional energy resources, major environmental problems related to the conventional energy resources, future possibilities of energy need and availability. Solar Energy: process of photovoltaic energy conversion, solar energy conversion technologies and devices, their principles, working and applications, disposal of solar panel after their usage. Biomass energy: Concept of biomass energy utilization, types of biomass energy, conversion processes, Wind Energy, energy conversion technologies, their principles, equipment and suitability in context of India.

Management of plastic waste and E-waste: Sources, generation and characteristics of various e- and plastic wastes generated from various industrial and commercial activities; Waste management practices including onsite handling, storage, collection and transfer. E-waste and plastic waste

processing alternatives. E-Waste management rules and Plastic waste management rules, 2016 and their subsequent amendments.

Text Books:

1. Bharucha, Erach (2004). Textbook for Environmental Studies for Undergraduate Courses of all Branches of Higher Education, University Grants Commission, New Delhi.
2. Basu, M., Xavier, S. (2016). Fundamentals of Environmental Studies, Cambridge University Press, India
3. Masters, G. M., &Ela, W. P. (1991). Introduction to environmental engineering and science. Englewood Cliffs, NJ: Prentice Hall.
4. Enger, E. and Smith, B., Environmental Science: A Study of Interrelationships, Publisher: McGraw-Hill Higher Education; 12th edition, 2010.

Reference Books:

1. Sharma, P. D., & Sharma, P. D. (2005). Ecology and environment. Rastogi Publications
2. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
3. Clark R.S. (2001). Marine Pollution, Clanderson Press Oxford (TB)
4. Jadhav, H & Bhosale, V.M. (1995). Environmental Protection and Laws. Himalaya Pub. House, Delhi 284 p.
5. MoEF&CC, Govt. of India, CPCB: E-waste management rules, 2016 and its amendments 2018.
6. MoEF&CC, Govt. of India, CPCB: Plastic waste management rules, 2016.

SYLLABUS - III / IV First semester

MT 3101 FOUNDRY TECHNOLOGY

Course Objectives:

- To study the science and engineering of casting.
- To study the various moulding materials and techniques
- To study various types of patterns and materials

Course Outcomes:

After completing this course the student have:

- Knowledge of technical procedures of making patterns and moulds
- The ability to design gating system for the castings

SYLLABUS

Introduction: Status of foundry industry and comparison with other manufacturing processes. Types of foundries. Basic operations.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the basic foundry operations and types of foundries.
- Explain the significance of foundry industry over other manufacturing processes.

Patterns. Patternmaking. Materials for pattern making. Types of patterns. Pattern allowance. Core boxes.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study about the different types of patterns and materials for pattern making.
- Gain the knowledge on pattern allowances and core boxes.

Moulding materials. Properties. Preparation and testing. Moulding processes. Sand mounding.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the properties of moulding materials, preparation of moulds and their testing.
- Describe the sand moulding in detail.

Moulding techniques. Hand and machine compaction. Machine moulding. Cores and core making. Sodium silicate processes. Shell, Investment and Die-casting. Centrifugal casting.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge on various moulding techniques, the process of making moulds and properties of moulds.
- Explain about different casting techniques and their applications.

Solidification – Crystallization and development of cast structure. Directional solidification. Principles of gating and risering. Modernization and mechanization of foundries.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the development of cast structure under solidification and the mechanism of solidification.
- Study the principles for gating and risering, advancements in solidification.

Text Books:

1. Principles of Metal Casting, Heine, Loper and Rosenthal, Tata McGraw Hill
2. Principles of Foundry Technology, P.L. Jain, Tata McGraw Hill

Reference Books:

1. Foundry Technology, PR Beeely, London-Buterworths

MT 3102 ADVANCES IN IRON MAKING

Course Objectives:

- This course introduces the principles of sponge iron making
- To know the various smelting reduction processes

Course Outcomes:

- Describe the physical and chemical processes that take place during sponge iron making
- To familirize with recent developments in iron making
- Describe various methods of smelting and reduction

SYLLABUS

Sponge Iron making: Principles and classification of sponge iron processes, Coal based processes: Rotary kiln process; Rotary hearth furnace process (Fastmet process, ITmk3 process); Gas based processes –Finmet process, Midrex process, HYL processes (HYL -III & HYL –IVM processes).

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the principles and classification of sponge iron processes.

- Describe the various sponge iron production processes with process flow sheets.

Smelting Reduction (SR): Fundamental of SR, Classification and important SR processes: Mini Blast Furnace process, COREX process, Finex process, Fastmelt process, Hismelt process, Romelt process.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge of different smelting operations and fundamentals of SR practices.
- Explain about various SR processes in detail with process, equipment and schematic diagrams.

Text books:

1. Iron making & Steel Making- Theory and Practice- Ahindra Ghosh, Amit Chattterjee
2. Sponge Iron Production by Direct reduction of Iron Oxide – Amit Chatterjee

Referance Books:

1. Hot metal production by Smelting Reduction of Iron Oxide –Amit Chatterjee

MT 3103 NONFERROUS EXTRACTIVE METALLURGY -II

Course Objectives:

- To know the extraction procedures of gold, silver and various nuclear metals
- To know the basics of nuclear reactor technology

Course Outcomes:

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

- Able to understand the extraction procedures used for Gold and Silver
- Able to know the procedures and principles of extracting various nuclear metals
- Able to know the working of Nuclear reactors and its technology
- To know the production practice of nuclear metals in India

SYLLABUS

Production flow sheets of extraction of Gold and Silver.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the extraction of gold and silver.
- Explain about extraction process of gold and silver in detail with process, equipment and schematic diagrams.

Uranium. Extraction of Uranium. Production flow sheet of Jaduguda ore.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the extraction of uranium and its significance.
- Explain about extraction process of uranium in detail with process, equipment and schematic diagram and applications.

Production flow sheets of extraction of Thorium.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge of extraction process of Thorium with process, equipment and schematic diagrams.

Brief outlines of extraction of Plutonium.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Describe the extraction process of Plutonium with process flow sheet and schematic diagrams.

Titanium. Production of Titanium chloride from Ilmenite. Production of Ti sponge.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Explain the extraction process of Titanium with process flow sheet and schematic diagrams.
- Give a detailed description on production of Ti sponge.

Zirconium production in India.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the zirconium production with process flow sheet and schematic diagrams.
- Explain significance and applications of zirconium and its production in India.

Nuclear Reactor Technology. Fuel for nuclear reactors. Basic components of a reactor characteristics and requirements. Types of reactors.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the significance of nuclear technology and fundamentals of a nuclear reactor.
- Gain knowledge on types of reactors, their characteristics and requirements.

Text books:

1. Extraction of Non-Ferrous Metals, HS Ray, R Sridhar and KP Abraham

References:

1. Metallurgy of Non-Ferrous Metals, Dennis, WH
2. Non-Ferrous Metallurgy, Sebryukov, N Min, Pub. Moscow

MT 3106 HEAT TREATMENT LAB

Course Objectives:

- Conduct heat treatment in furnaces under suitable/ required time, temperature and atmospheric conditions.
- Modify the microstructures of metals and alloys through heat treatment practice for obtaining desired properties in present and future.

Course Outcomes:

- To modify the bulk and surface properties of steels.
- To determine hardenability by performing Jominy end quench test
- Analyze, correlate and interpret the results obtained in the tests conducted.
- Report the observations in a proper format.

SYLLABUS

List of Experiments:

1. Annealing, Normalizing, hardening and tempering of steels.
2. Recovery and recrystallization of cold worked metal.
3. Effect of quenching media on hardening
4. Study of welded structures.
5. Jomney End Quench Test.
6. Pack carburizing of low carbon steels.
7. Age hardening of aluminum alloys
8. Effect of time and temperature on tempering

Text Books:

1. Heat Treatment of Metals - Zakharov
2. Heat Treatment Principle and Techniques - Rajan & Sharma

Reference Books:

1. Physical Metallurgy – Lakhtin
2. Physical Metallurgy - Clark and Varney
3. Physical Metallurgy Principles - Reed Hill
4. Physical Metallurgy – Raghavan

MT 3107 METAL CASTING LAB

Course Objectives:

- Introduce and explain various properties of moulding sand
- To know the procedure of testing moulding sand

Course Outcomes:

- Have fundamental knowledge of properties of moulding sand
- Understand test procedures of mould sand properties
- Have basic knowledge of ranges of moulding sand properties
- Evaluate suitability of various sands for moulding purpose
- Learn more by practical knowledge and develop their scientific and technical competences in the field of foundry.

List of Experiments

Various sand tests will be carryout to evaluate the mould properties. The tests are included like:

1. Clay content
2. AFS grain size measurement
3. Permeability test
4. Green Compression

5. Green Shear
6. Dry Compression
7. Dry shear
8. Toughness
9. Hardness
10. Shatter Index

Text Books:

1. Heine, Loper and Rosenthal, "Principles of Metal Casting", Tata Mc Graw Hill Publishing Co, Ltd; New Delhi, 1995.
2. Foundry Technology - Devendra Kumar and S.K . Jain
3. Metals Hand book Vol.5 published by ASM, Ohio.
4. Foundry Technology- Jain.
5. Foundry Technology Principle- Ramana Rao.

MT 3108 FOUNDRY PRACTICE

Course Objectives:

- Broad knowledge about different types of melting and casting practices
- To know the foundry practice of various cast irons
- Understand issues related to melting practices of non-ferrous metals and alloys.

Course Outcomes:

- To know the melting procedures of non-ferrous metals and alloys
- Understanding foundry practice of various types of cast irons
- Able to know the reasons for the defects in castings
- Able to know the procedure of quality control of castings

SYLLABUS

General principles of melting Cupola and its operation. Modern developments in cupola. Melting practice of Al, Cu and Mg alloys.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the fundamentals and principles of cupola furnace and its operations.
- Study the developments in cupola furnace in detail.

Defects in castings.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Describe the casting defects, causes and remedies in detail.

Fettling.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Explain the fettling and mechanism involved with it.

Inspection and quality control.
Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge on inspection methods and various quality control techniques.

Metallurgy of cast irons. Foundry practices of white, gray, SG and malleable irons. Alloy cast irons.
Learning Outcomes:

At the end of the chapter the student will be able to:

- Study about the different foundry operations used for white, gray, SG and malleable irons, alloy cast irons.

Steel foundry practice.
Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the fundamentals and forundry practices for Steel and their advantages, disadvantages.

Modernization and mechanization of foundries.
Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the influence of mechanization and significance modernization on foundry operations.

Text books:

1. Principles of Metal Casting, Heine, Loper and Rosenthal, Tata McGrawhill
2. Foundry Technology, PC Jain, Tata McGrawhill
3. Foundry Technology, PR Beeely, London-Buterworths.

Reference Books:

1. Heine, Loper and Rosenthal, “Principles of Metal Casting”, Tata Mc Graw Hill Publishing Co, Ltd; New Delhi, 1995.

2. Foundry Technology - Devendra Kumar and S.K . Jain
3. Metals Hand book Vol.5 published by ASM, Ohio.
4. Foundry Technology-Jain.
5. Foundry Technology Principle- Raman Rao.

SYLLABUS - III / IV Second semester

MT 3201 METAL FORMING

Course Objectives:

- To Know the mechanical and metallurgical fundamentals for metal forming processes.
- To Know the processes parameters, forming loads, process design and tool design in different processes.
- To Analyze the behavior of metals during plastic deformation.

Course Outcomes:

- Compare and classify different forming processes.
- Analyze the behaviour of materials during forming processes.
- Determine forming processes controlling parameters.
- Estimate required forming loads, powers of different forming equipment and processes.
- Determine the cause of the defects that may take place during forming processes.
- Integrate knowledge gained in this course to select and design a complete metal forming system.

SYLLABUS

Fundamentals of metal working. Classification of forming processes, Temperature in metal working, Strain-rate effects, Metallurgical Structure, Friction and Lubrication.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the fundamentals and classification of metal forming operations.
- Gain knowledge on temperature, strain rate effects, friction and lubrication

Forging: Classification, forging equipment, Open die and closed die forging, Calculation of forging loads in closed die forging and Forging defects.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the fundamentals and classification of metal forging operations.
- Explain about different types of forging processes and defects.

Rolling classification. Rolling mills and accessories. Hot and cold rolling. Forces and geometric relationships in rolling. Rolling variables. Problems and defects in rolled products.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Describe the classification of rolling, rolling mills and accessories involved.
- Gain knowledge on rolling variables, defects and problems involved with rolled products.

Extrusion: Classification, Extrusion equipment, Hot extrusion, lubrication and defects in extrusion. Extrusion of tubing.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the fundamentals and classification of extrusion operations.
- Describe the equipment required for extrusion and defects involved with extrusion.

Drawing of rods wires and tubes. Sheet metal forming.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain knowledge on drawing operation of rods, wires, tubes and equipment involved with it.
- Explain fundamentals of sheet metal forming and equipment required.

Text Books:

1. Mechanical Metallurgy by G.E. Dieter McGraw Hill Book Co.,
2. Introduction to Physical Metallurgy by S.H. Anver, McGraw Hill

Reference Books:

1. Mechanical working of metals - Avitzone.
2. Engineering Metallurgy – Part-II – Higgins

MT 3202 ENVIRONMENTAL DEGRADATION OF MATERIALS

Course Objectives:

- To Know the electrochemical and thermodynamic aspects of corrosion.
- To Know the various forms of corrosion.
- To know the preventive methods of corrosion

Course Outcomes:

- Explain the importance of studying corrosion
- Describe the thermodynamic aspects of corrosion
- Describe the kinetic aspects of corrosion
- Indicate the various forms of corrosion
- Explain the measurement and control of corrosion.

SYLLABUS

Corrosion – Electrochemical aspects of Corrosion. Corrosion cells/Electro chemical cells, Determination of Electrode potential. Thermodynamic aspects - Nerrnest equation. Galvanic series. Polarization, Linear polarization technique for evaluation of Icorr. Pourbaix diagrams

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the electrochemical, thermodynamic aspects of corrosion and fundamentals involved with it.
- Define polarization, different polarization techniques, significance of Pourbiax diagrams in detail.

Types and Forms of Corrosion. Uniform Corrosion, Pitting Corrosion, Galvanic Corrosion, and Integranular Corrosion. Stress Corrosion cracking, Cavitation Erosion, Erosion Corrosion. Corrosion Fatigue.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the fundamentals and mechanisms involved with various forms of corrosion,
- Describe possible reasons for corrosion occurrence in detail.

Prevention Methods: Coatings, Metallic and Non Metallic, Design rules, Control of Environment, Anodic and Cathodic Protection Techniques.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Explain the various preventive measures for corrosion.
- Describe the protection techniques against corrosion in detail.

Text books:

1. An introduction to Electrometallurgy, Sharan and Narain, Standard Publishers
2. Corrosion Engineering, MG Fountana, Mc-Graw Hill Book Company

MT 3203 ADVANCES IN STEEL MAKING & PRODUCTION OF FERRO ALLOYS

Course Objectives:

- To gain a thorough knowledge about thermodynamics and phase relations in the production of iron and ferroalloys.
- To understand the production methodology for a particular type of iron/ferroalloy from given ore, other raw materials and set of conditions.

Course Outcomes:

At the end of the course the student will be able:

- To understand the fundamentals including thermodynamics and phase relations in the production of iron and ferroalloys.
- To perform basic calculations like mass and energy balance relating to production of iron and ferroalloys, taking into consideration the thermodynamic limitations and kinetics.
- To know details about several aspects involved in ferrous metallurgy like procuring raw materials and its preparation, furnaces and its accessories, blast furnace irregularities and process control, alternate routes of iron making.
- To identify and choose a production methodology for a particular type of iron/ferroalloy from given ore, other raw materials and set of conditions.

SYLLABUS

Hybrid Steel making processes, SIP and EOF process.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the fundamentals and classification of hybrid steel making processes.
- Describe the equipment required for different hybrid steel making processes along with process flow sheets.

Continuous steel making processes: WOCRA, IRSID, Spray steel making, Recent trends in steel making processes.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the fundamentals and different types of continuous steel making processes.
- Explain about the equipment required for different continuous steel making processes and advancement in steel making processes.

Secondary steel making processes: Stirring Treatments, Synthetic slag refining, Injection metallurgy, Plunging Techniques, Post solidification treatments, vacuum treatments, decarburization techniques, secondary refining furnaces (LF furnace).

Learning Outcomes:

At the end of the chapter the student will be able to:

- Describe the fundamentals of secondary steel making processes and the process requirements.
- Gain the knowledge about secondary refining operations involved with iron making and

their process in detail.

Gases in steel, vacuum treatment of liquid steel

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the influence of gases on steel and its properties.
- Study the vacuum treatment of liquid steel and its significance with detailed flow sheet.

Production of Ferro alloys: Fe-Si, Fe-Mn, Fe-Cr, Fe-V, Silico-Manganese.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Explain the significance and production of various ferro-alloys in detail.
- Describe the influence of ferro-alloys in iron and steel making.

Text books:

1. Steel Making, R.H. Tupkary
2. Steel Making, Kudrin
3. Steel Making, A.K Biswas

Reference Books:

1. The making, shaping and treating of steel-USS.

MT 3206 ELECTROMETALLURGY LAB

Course objectives:

- Electrometallurgy principles in metal deposition and winning are to be verified practically.
- To know the procedures of plating and anodizing.

Course Outcomes:

- Able to know the practical relevance of faradays laws
- Able to know the requirements and procedures of electro plating of metals
- Able to know the procedure of anodizing

LIST OF EXPERIMENTS:

1. Experimental verification of Faraday's laws.
2. Determination of throwing power of electrolytes.

3. Electro plating of copper.
4. Electro plating of Nickel.
5. Anodizing of Aluminium.

MT 3207 MATERIALS PROCESSING LAB

Course Objectives:

- Know the procedure of alloy making
- Know the fabrication methods of composites
- Know the basics of hot and cold working

Course Outcomes:

- Able to make an alloy of required composition
- Able to manufacture various types of composites
- Able to know the application of cold and hot working processes

List Of Experiments

1. Alloy preparation
2. Composites preparation
    a. Metal matrix composites
    b. Polymer matrix composites
    c. Characterization of prepared MMCs and PMCs
3. Cold working studies
4. Hot working studies

MT 3208 NDT LAB

Course Objectives:

- To know the difference between Destructive and Non-Destructive Tastings
- To Understand the basic working principles of Non-Destructive testing
- To identify various types of Defects that Occur in the materials

Course Outcomes:

- Provide knowledge and experience to observe various material defects through NDT.

Non-destructive evaluation will be carried out by following Experiments

1. Visual Inspection
2. Die penetration testing
3. Magnetic particle testing
4. Ultrasonic testing
5. Radiography testing

MT 3209 SOFT SKILLS

Course Objectives:

- To develop skills to communicate clearly.
- To aid students in building interpersonal skills.
- To enhance team building and time management skills.
- To inculcate active listening and responding skills.

Course Outcomes:

- Make use of techniques for self-awareness and self-development.
- Apply the conceptual understanding of communication into everyday practice.
- Understand the importance of teamwork and group discussions skills.
- Develop time management and stress management.

SYLLABUS

Introduction to Soft Skills: Communication – Verbal and Non Verbal Communication - Personal grooming (Etiquette, Attitude, Body Language), Posture, Gestures, Facial Expressions, Eye Contact, Space Distancing, Presentation Skills, Public Speaking, Just a Minute (JAM) sessions, Adaptability.

Goal Setting and Time Management: Immediate, Short term, Long term, Smart Goals, Strategies to Achieve goals, Types of Time, Identifying Time Wasters, Time Management Skills, Stress Busters.

Leadership and Team Management: Qualities of a Good Leader, Team Dynamics, Leadership Styles, Decision Making, Problem Solving, Negotiation Skills.

Group Discussions: Purpose (Intellectual ability, Creativity, Approach to a problem, Tolerance), Group Behaviour, Analysing Performance.

Job Interviews: Identifying job openings, Covering Letter and CVs / Resumes, Interview (Opening, Body-Answer Q, Close-Ask Q), Telephone Interviews, Types of Questions.

Text Books:

1. Hasson, Gill. *Brilliant Communication Skills.* Great Britain: Pearson Education, 2012

Reference Books:

1. Krannich, Caryl, and Krannich, Ronald L. *Nail the Resume! Great Tips for Creating Dynamite Resumes*. United States, Impact Publications, 2005.
2. Prasad, H. M. *How to Prepare for Group Discussion and Interview*. New Delhi: Tata McGraw-Hill Education, 2001.
3. Pease, Allan. *Body Language*. Delhi: Sudha Publications, 1998.
4. Rizvi, Ashraf M. *Effective Technical Communication*: India, McGraw-Hill Education. 2010
5. Thorpe, Edgar &Showick Thorpe. *Winning at Interviews*. 2nd Edition. Delhi: Dorling Kindersley, 2006.

SYLLABUS - IV / IV First semester

MT4107 ADVANCED MATERIALS PROCESSING

Course Objectives:

- To understand the basic concepts of nano structures
- To provide and train the students about nano material synthesis and thin film deposition techniques.
- To understand various Nanostructure characterization techniques.

Course Outcomes:

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

- Identify and understand various top-down and bottom-up approaches for nano material synthesis.
- To know the procedure of high energy ball milling for making nano powders
- To give evidence for the nano materials by characterization techniques

SYLLABUS

Introduction to nanotechnology

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the significance and applications of nanotechnology.
- Describe the characteristics and influence of nanomaterials.

Discussion on various techniques of synthesis of nano materials

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the various techniques for synthesizing nano materials and their process.
- Explain the properties and characteristics of nano materials synthesized by various techniques,

Synthesis of nano materials by High energy ball milling method

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the process of Synthesis of nano materials by high energy ball milling method.
- Describe the characteristics of nano material synthesized by high energy ball milling method.

Characterization of nano powders

i. Crystallite size
ii. Strain calculations
iii. XRD studies
iv. SEM studies

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge on various characterization techniques of nano powders.
- study the interpretation and analysis of data from different characterization techniques of nano powders.

Nano Composites preparation by Mechanical alloying method.

Learning Outcomes:
At the end of the chapter the student will be able to:

- Explain about the nano composites preparation by mechanical alloying method.
- Describe the properties and applications of nano composites in detail.

Characterization of prepared nano composites

Learning Outcomes:
At the end of the chapter the student will be able to:

- Study about the various characterization techniques used for nano composites.
- Explain about characteristics of nano composites prepared by various manufacturing techniques.

Description on applications of nano materials
Learning Outcomes:
At the end of the chapter the student will be able to:

- Describe the significance, influence of nano materials and their wide range of applications.

Text Books:

1. Nano structures and Nanomaterials: Synthesis, properties and applications. Guozhong Cao – Imperial College Press.

Reference books:

1. Mauro Sardela, Practical Materials Characterization, Springer, 2014.
2. Richard Leach, Fundamental Principles of Engineering Nanometrology, Elsevier, 2014

SYLLABUS OF PROFESSIONAL ELECTIVES

1. STEEL MAKING

Course Objectives:

- This course introduces the principles of steel making
- To know the various types of steel making
- To know the recent advances in steel making

Course Outcomes:

- Describe the physical and chemical processes that take place during steel making
- Analyze the effect to change in process parameters in steel making processes
- Describe the methods for casting of steel

SYLLABUS

History of Steel Making: Cementation and crucible processes.
Learning Outcomes:
At the end of the chapter the student will be able to:

- Understand the history of steel making process and its evolution.
- Explain the conventional processes used for steel making, formerly.

Principles Steel Making: Chemistry of Steel Making processes, Theories of slag. Oxidation of Si, Mn and C. Desulphurization, Dephosphorization and deoxidation. Mixers, Raw materials for steel making.
Learning Outcomes:
At the end of the chapter the student will be able to:

- Study the fundamentals and principles of steel making in detail.
- Gain the knowledge of various refining techniques and materials used in the making of steel.

Pneumatic Steel Making Process: Acid and basic Bessemer process, Side blown converter.
Learning Outcomes:
At the end of the chapter the student will be able to:

- Describe the fundamentals of pneumatic steel making process and processes involved with it.
- Study the construction of various furnaces and their significance in the process.

Open Hearth Process: Operation and chemistry of the process. Developments in OHP: AJAX, TANDEM, Tilting and twin hearth process.
Learning Outcomes:
At the end of the chapter the student will be able to:

- Describe the operation and chemistry of open hearth process in detail.
- Explain the advancements in the OHP with process and equipment.

BOF Process: LD, LD-AC, LAM process, OG process, Kaldo, Rotor and OBM.
Learning Outcomes:
At the end of the chapter the student will be able to:

- Study the different processes used for steel making and their significance.
- Explain the advantages of various steel making processes along with construction and process variations.

Electric Furnace Process: Various electric processes, their advantages and limitations. EAF construction, lining and operation. Discussion on manufacture of stainless steel.

Learning Outcomes:
At the end of the chapter the student will be able to:

- Explain the various electric furnaces with their advantages and process limitations.
- Describe a detailed note on manufacturing of stainless steel.

Casting: Pit side process and teeming methods. Ingot moulds. Solidification of steel. Ingot defects and remedies. Continuous casting of steel.

Learning Outcomes:
At the end of the chapter the student will be able to:

- Understand the different types of casting process with schematic diagrams.
- Gain the knowledge on ingot defects and their remedies, fundamentals of continuous casting of steel.

Text books:

1. Steel Making, R.H.Tupkary
2. Steel Making, Kudrin
3. Steel Making, Biswas

References:

1. The making, shaping and treating of steel-USS.

2. COMPOSITE MATERIALS

Course Objectives:

- To obtain knowledge on classification, processing, characterization and applications of composite materials.
- To obtain knowledge on mechanical properties and failure mechanisms of composites under loadingconditions for engineering applications.

Course Outcomes:

- Knowledge on classification, processing, characterization and applications of various composite materials
- Ability to select proper method of fabrication for the given type of composite material

SYLLABUS

Introduction: Definition, classification, properties, applications, advantages and limitations of composites, Types of matrix and reinforcements, and their properties. Mechanics of Composites, Iso-strain and Iso stress conditions, Role of fibers, Critical fiber length.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the fundamentals, classification of composites and their properties.
- Gain the knowledge of various types of matrix and reinforcements, mechanics involved with it.

Fabrication of Polymer Matrix Composites (PMCs): Properties, Applications and Limitations of PMCs; Various fabrications methods- Hand Layup technique, Spray Up Technique, Filament welding, Pultrusion, Autoclave based methods, Injection moulding, Extrusion.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the different fabrication techniques of PMCs and their properties.
- Explain the applications and limitations of PMCs.

Fabrication of Metal Matrix Composites (MMCs): Properties, Applications of MMCs; Fabrications methods: Liquid methods- Duralcan process, Spray forming, Squeeze casting, Stir casting; Solid state process- Diffusion bonding.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Describe the different fabrication techniques of MMCs and their properties.
- Explain the applications and process limitations of MMCs.

Fabrication of Ceramic Matrix Composites (CMCs): Properties, Applications and limitations of CMCs; Various fabrications methods: Cold pressing and sintering, Hot pressing, Liquid infiltration, Lanxide process.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the different fabrication techniques of CMCs and their properties.
- Gain the knowledge of applications and process limitations of CMCs.

Fabrication of Carbon-Carbon Composites (CCCs): Properties, Applications and limitations of CCCs; Processing of CCC- Solid, Liquid and Gas phase pyrolysis processes.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the different fabrication techniques of CCCs and their properties.
- Explain the applications and process limitations of CCCs.

Text books:

1. Materials Science and Engineering: An Introduction - William D CallisterJr

2. Composite Materials-Krishma K Chawla.

Reference books:

1. ASM Handbook Volume 21: Composites.

3. STRENGTHENING MECHANISMS

Course Objectives:

- To explain and describe various strengthening mechanisms involved in the development of existing alloys and new alloys.

Course Outcomes:

- Explain the process of strengthening by grain / grain boundary in materials.
- Explain and illustrate how alloying can improve strength in metals
- Choose cold working and annealing cycles for improving strength and ductility in materials for suitable applications.

- Compare and contrast the different means of strengthening by small second phase particles.
- Distinguish composite strengthening by various methods of orientation of fibers in materials.
- Choose a particular strengthening mechanisms for design of high strength metals and alloys.

SYLLABUS

Strengthening from grain boundaries, Hall-Petch relation, ASTM grain size measurement, yield-point phenomenon, strain aging.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Describe the grain boundary strengthening and solve the problems related to grain size.
- Define Hall-Petch relation, yield- point phenomenon and strain aging.

Solid solution strengthening: Elastic interaction, modulus interaction, stacking fault interaction, electrical interaction, short range order interaction, long range order interaction.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the solid solution strengthening and its influence.
- Explain different types of interactions involved with solid solution strengthening.

Cold working: Strain hardening of single crystals, annealing of cold worked metal, recovery, recrystallization and grain growth.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the cold working and mechanism of strain hardening.
- Describe the various stages in formation of strain free grains and the process of annealing.

Strengthening from fine particles: Principle, mechanisms and examples of Precipitation hardening (age hardening), Dispersion hardening. Fiber strengthening, strength and moduli of composites (Iso-strain and Iso-stress condition), influence of fiber length, orientation and concentration.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge on precipitation hardening and dispersion hardening mechanisms.
- Study the fiber strengthening and its influencing factors.

Strengthening by phase transformations: Annealing, Normalizing and Hardening. Martensite strengthening.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Explain the strengthening resulted from various heat treatment processes.
- Describe the transformations and mechanisms involved with the heat treatment processes.

Text Books:

1. Mechanical Metallurgy - George E Dieter
2. Materials Science and Engineering an Introduction - William D CallisterJr
3. Materials Science and Engineering – V Raghavan

Reference Books :

1. Mechanical Behaviour of Materials - Thomas H Courtany

4. ENGINEERING MATERIALS

Course Objectives:

- To understand the importance of various materials used in engineering and obtain a qualitative analysis of their behavior and applications

Course Outcomes:

- Understands various types of steels their properties in various conditions.
- Understands various types of cast irons and their properties in various applications.
- Understands various types of light alloys like Al, Mg, Ti, Be and Cu alloys as well as their properties and applications.

SYLLABUS

Carbon Steels: Low, medium and high carbon steels, HSLA, Dual Phase steels.
Learning Outcomes:
At the end of the chapter the student will be able to:

- Study the characteristics of different types of Carbon steels and their properties.
- Describe the manufacturing process of various carbon steels and their applications.

Alloy Steels: High strength structural steels, Tool steels, Stainless steels, High Temperature alloys.
Learning Outcomes:
At the end of the chapter the student will be able to:

- Explain the characteristics of different types of alloy steels and their making process.
- Gain the knowledge on properties of alloy steels and their applications.

Cast irons: White cast iron, Malleable Cast iron, Grey Cast iron, Ductile Cast iron.
Learning Outcomes:
At the end of the chapter the student will be able to:

- Understand the significance of cast irons and their manufacturing.
- Study the properties of cast irons and their wide range of applications.

Light alloys: Al, Mg, Ti, Be and its alloys.
Learning Outcomes:
At the end of the chapter the student will be able to:

- Explain the classification of various light alloys and their properties, significance.
- Describe the manufacturing processes of various light alloys and their applications.

Copper and its alloys

Learning Outcomes:
At the end of the chapter the student will be able to:

- Study the characteristics of classification of copper alloys and their properties.
- understand the manufacturing process of copper alloys and their applications.

Text Books:

1. Introduction to Physical Metallurgy - SH Avner.
2. Physical Metallurgy Principles and Practice –Raghavan.V

Reference Books :

1. Materials Science and Engineering an Introduction - William D Callister Jr

5. NANO MATERIALS

Course Objectives:

- To recognize the differences between nanomaterials and conventional materials and to become familiar with a wide range of nanomaterials, their synthesis, characterization, properties and applications.

Course Outcomes:

- Indicate the differences between nanomaterials and conventional materials.
- Indicate how specific synthesis techniques can result in nanomaterials.
- Give examples of specific nanomaterial and explain the scientific reasons for the Properties displayed by them.

SYLLABUS

Introduction to Nano Technology: Importance of Nano–Technology, Emergence of Nano–Technology, Bottom-Up and Top–down approaches, challenges in Nano–Technology.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the significance of nano technology and its evolution.
- Describe the synthesizing processes used for nano technology and the challenges in the process.

Zero-dimensional Nano particles through homogeneous nucleation: Growth of nuclei, synthesis of metallic nano particles, Nano particles through heterogeneous nucleation.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the synthesis of zero- dimensional nano particles through various techniques.
- Gain the knowledge of characteristics of zero- dimensional nano particles and their applications.

One-dimensional Nano wires and rods, Spontaneous growth: Evaporation and Condensation growth, vapor- liquid - solid growth.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Explain the synthesis of one- dimensional nano particles through different techniques.
- Understand the characteristics one- dimensional nano particles and their applications.

Two Dimensional Nano-structures: Physical Vapour Deposition (PVD, Chemical Vapour Deposition (CVD), Atomic Layer Deposition (ALD). Applications of Nano materials.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the synthesis of two- dimensional nano particles through various techniques.
- Describe the characteristics of two- dimensional nano particles and their applications.

Text Books:

1. Nanostructures and Nanomaterials: Synthesis, properties and applications

Reference Books:

1. Guozhong Cao – Imperial College Pres

6. FUNCTIONAL MATERIALS

Course Objectives:

- To introduce the student to functional materials and the science behind the performance of the functional material. To enable the student to understand the applications of functional materials.

CourseOutcomes:

- Indicate the various type of functional materials
- Explain the principle of operation of the functional material
- Indicate the applications of the functional materials

SYLLABUS

Characteristics and types of functional materials. Crystal structure and Properties. Effect of size on properties, effect of interfaces on properties.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the fundamentals of functional materials and their properties.
- Describe the characteristics of functional materials and their applications.

Band structure, Semiconductor devices: Theory, examples and applications of Optically active materials.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Explain the basics of semiconductor materials and their properties.
- Understand the characteristics of functional materials, mechanism involved with them and their applications.

Dielectrics: piezo- and ferro electric materials

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the fundamentals of piezo- and ferro electric materials and their properties.
- Describe the manufacturing of piezo- and ferro electric materials and their applications.

Magnetic materials: storage applications, Smart materials

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the significance of magnetic materials and their properties.
- Gain the knowledge on manufacturing of magnetic materials and their applications.

Applications in electronic, communication, aerospace, automotive, energy industries

Learning Outcomes:

At the end of the chapter the student will be able to:

- Describe the various applications of functional materials in electronic, communication, aerospace, automotive, energy industries.

Text Books:

1. Functional Materials: Electrical, Dielectric, Electromagnetic, Optical and Magnetic applications; Deborah D L Chung, World Scientific Publishing, 2010

Reference Books:

1. Materials Science–Raghavan.V
2. Materials Science and Engineering an Introduction - William D Callister Jr

7. ENERGY MATERIALS

Course Objectives:

- To learn the operating principle of several environmentally friendly energy technologies. To identify the material issues relevant to these technologies and to evaluate various operational aspects associated with these technologies.

Course Outcomes:

- Evaluate an energy technology for environmental friendliness.
- Explain the operating principle of several energy technologies.
- Indicate the material requirements for these energy technologies.
- Demonstrate the ability to understand the characterization, performance, and failure data related to these technologies.

SYLLABUS

Energy requirements in a global scale and in the Indian context.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the significance of energy materials and their properties.
- Gain the knowledge on manufacturing of energy materials and their applications in India, world-wide.

Evolution of energy sources from the perspective of clean energy. Carbon equivalent.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Describe the evolution of energy materials with respect to clean energy.
- Define carbon equivalent and its influence on environment.

Introduction to different types of energy storage and conversion devices and technologies. Synthesis and characterization of materials used for these technologies, Properties desired in the materials, Techniques to evaluate the properties and performance, failure modes and analysis, environmental impact of the following technologies:

I. Fuel cells
II. Batteries
III. Super capacitors
IV. Solar energy conversion devices
V. Wind Energy
VI. Mechanical Energy storage

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the different types of energy materials and their properties.
- Gain the knowledge on synthesis of energy materials and their applications.
- Explain about various revolutionary technologies of energy materials and their impact on the environment.

Text Books:

1. Renewable Energy: Power for a Sustainable Future, Godfrey Boyle, Oxford University Press, 2004.

Referance Books:

1. Bio Material Science Buddy D.Ratneer
2. Materials Science and Engineering an Introduction - William D Callister Jr

8. BIOMATERIALS

Course Objectives:

- To introduce the student to the range of biomaterials and the science and engineering of biomaterials. To understand constraints associated with the use of biomaterials.

Course Outcomes:

- Explain the types of Biomaterials and their relative advantages and disadvantages.
- Indicate the constraints placed on the use of materials in biological environments.
- Explain the characterization of materials from the perspective of application as a biomaterial.

SYLLABUS

Types of biomaterials, biological environment

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the significance of bio materials and their properties under biological environment.
- Gain the knowledge on manufacturing of bio materials and their applications.

Mechanical and physio-chemical properties of biomaterials, Resorbability, biodegradation, biological responses, compatibility, cytotoxicity, cell bio-material interactions, associated characterization.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the mechanical and physio-chemical properties of biomaterials and influence on applications.
- Define resorbability, biodegradation, biological responses, compatibility, cytotoxicity, cell bio-material interactions.

Metals, Polymers, Ceramics, Natural biomaterials Blends, composites, biopolymers, Hydrogels, drug delivery systems.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Explain about various bio materials in material classification and their properties.
- Understand the fabrication of bio materials according to the application.

Reference books:

1. Introduction to Biomaterials: Basic Theory with Engineering Applications; C.L Agrawal, J.L. Ong, Mark R Appleford, Gopinath Mani, Canbridge University Press, 2013

9. ELECTRONIC MATERIALS

Course Objectives:

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

Course Outcomes:

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

SYLLABUS

Intrinsic semiconductors. Electron and hole (carrier) concentrations.

Learning Outcomes:
At the end of the chapter the student will be able to:
- Understand the significance of electronic materials and their properties.
- Gain the knowledge on manufacturing of intrinsic semiconductors and their applications.

Fermi energy level, effect of temperature on Fermi energy.

Learning Outcomes:
At the end of the chapter the student will be able to:
- Define fermi energy level and effect of temperature on fermi energy.
- Gain the knowledge on influence of fermi energy level on thermal, electrical, optical, magnetic properties.

Carrier mobility. Direct vs. indirect band gap materials.
Learning Outcomes:
At the end of the chapter the student will be able to:
- Study the carrier mobility and its significance.
- Explain about the direct, indirect band gap materials and their properties.

Elemental vs. compound semiconductors. Extrinsic semiconductors. Doping – p and n type semiconductors.
Learning Outcomes:
At the end of the chapter the student will be able to:
- Understand the elemental and compound semiconductors and their properties.
- Describe about the extrinsic, p and n-type of semiconductors and their applications.

carrier concentration and Fermi level as a function of temperature. Drift mobility. Light and heavy doping.
Learning Outcomes:
At the end of the chapter the student will be able to:

- Gain the knowledge on carrier concentration and fermi level as a function of temperature.
- Define drift mobility, light and heavy doping, and their applications.

Semiconductor diodes p-n junctions at equilibrium. Forward and reverse bias. I- V characteristics. Band diagram. Diode breakdown mechanisms.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study about semiconductor diodes, forward and reverse bias and their significance in detail.
- Describe various diode breakdown mechanisms.

LEDs and solar cell materials. Transistors – MOSFETs. Band diagram and channel formation. Threshold voltage. I-V characteristics.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand about LEDs and solar cell materials, transistors- MOSFETs and their applications.
- Define Band diagram, channel formation and threshold voltage and their significance.

Introduction to semiconductor manufacturing – history, process flow, manufacturing goals. Bulk Si crystal growth.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge on manufacturing of semiconductors for their various applications
- Explain about process steps with flow sheet and limitations.

Overview of manufacturing technology – oxidation, photolithography, etching, doping, deposition, planarization. Clean room classifications.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Describe about various manufacturing techniques, oxidation, photolithography, etching, doping, deposition, planarization and their process in detail.

CMOS manufacturing steps. Process monitoring – blank and patterned thin film measurement. Defect inspection. Electrical testing. Yield monitoring & statistical process control. Definitions of yield, process control, defect density. Process integration. Assembly and packaging.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the steps in manufacturing of CMOS and defect inspection.
- Define yield, process control, defect density.

Text books:

1.Semiconductor Materials, Devices and Fabrication, Parasuraman Swaminathan, Wiley 2017

Reference books:

1.Principles of Electronic Materials and Devices, S. O. Kasap, McGraw Hill Education, 2017

10. FATIGUE AND FRACTURE MECHANICS

Course Objectives:

- To study the different types of fatigue failures and their mechanisms in the engineering applications.
- To study the basic theory of fracture mechanics and its relationship with fatigue and creep

failure mechanisms.
- To understand the damage tolerance approach in the life estimation of structures.

Course Outcomes:

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

SYLLABUS

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

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge about significance of Fatigue in failure, and types of fatigue with mechanisms.
- Explain about fatigue testing methods and equipment used for it.

Types of Cracks: Crack initiation and propagation, Mechanisms, Macrostructural and microstructural aspects, Use of fracture mechanics in fatigue Local strain approach, effect of different factors on fatigue – Stress concentration, Size, Surface, Temperature, Frequency, Environment, Microstructure, Residual stresses, Fretting, Creep-fatigue interaction, Multiaxial stresses, Thermomechanical loading.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the influence of various factors on fatigue in detail.
- Describe the types of cracks, crack propagation and mechanism involved.

Fatigue behaviour of different materials: Metallic materials and weldments, Ceramics, Polymers, Composites, Metallic glasses, Shape memory alloys, Ultrafine grained materials, Nanocrystalline materials, Biomaterials, Metallic foams Case studies on fatigue failures, Design considerations, Methods for fatigue life improvement.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study about effect of fatigue behavior on different materials with case studies.
- Explain about design considerations according to fatigue behavior and methods to improve fatigue life.

Text Books:

1. Fatigue of Materials, Suresh, Cambridge India, 2015.

Reference books:

1. Fracture Mechanics, Fundamentals and Applications, T.L. Anderson, CRC Press 2017.

11. COMPUTATIONAL MATERIALS ENGINEERING

Course Objectives:

- This course introduces computational methods in the domain of metallurgical and materials engineering.

Course Outcomes:

- Analyze a metallurgical problem to create a well posed numerical problem.
- Identify initial and boundary conditions of a problem relevant to materials domain.
- Propose a solution procedure for a numerical problem in the domain of materials engineering.
- Demonstrate ability to quantify a materials engineering problem through numerical analysis.

SYLLABUS

Software and languages for numerical computation

1. Linear algebra ic systems
2. Eigen value problems
3. Curve fitting
4. Root finding
5. Optimization
6. Numerical differentiation, numerical integration
7. Digital processing using fast Fourier transforms, principal component analysis etc.
8. Libraries for accurate and fast numerical computation

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge about numerical computation software and languages for data interpretation and analysis.
- Describe the significance of numerical computation software and languages and their application.

Application of computational methods to study structure of materials at different length scales, transport phenomena, phase transformations and kinetics of reactions. Examples can be drawn from processes and topics covered in core curriculum of materials engineering.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the applications of computational methods in various domains according to the requirements.
- Solve the problems and analyze challenges occur during materials processing.

Text books:

1. Introduction to Computational Materials Science – Richard LeSar, Cambridge University Press (2013).
2. Applied numerical methods for engineering using matlab and C – R.J. Schilling and S.L. Harris, Cengage Learning (2007)

Reference books:

1. Mathematical Methods for Physics and Engineering, 3rd Edition – R.F. Riley, M.P.

Hobson, S.J. Bence, Cambridge University Press (2012).
2. Modeling in materials processing – J.A. Dantzig and C.L. Tucker III, Cambridge University Press (2001)

12. SURFACE ENGINEERING

Course Objectives:

- To understand the need for Surface Engineering and to become familiar with the techniques associated with Surface Engineering.

Course Outcomes:

- Indicate the need for surface engineering.
- Indicate the different methods of surface engineering.
- Differentiatebetweenthemethodsusedandindicatetheirrelativemerits.
- Understandaspectsassociatedwithindustrialapplicationsofsurfaceengineering.

SYLLABUS

Need for engineered surface, Conventional surface hardening methods, definition and principles,

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge about significance of engineered surface and applications
- Describe the various conventional surface hardening techniques and principles.

Methods involving no change in the chemical composition of the surface, Methods involving change in chemical composition of the surface.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the different surface hardening techniques based on with and without modification in the chemical composition.
- Explain about process and applications of above surface hardening techniques.

Application of advanced techniques such as ion and electron beam towards creating new engineered surface.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the fabricating surface hardened material using ion and electron beam.
- Describe the advantages, limitations of above process and their applications.

Controlled high quality surface modification by techniques such as CVD, PVD, Plasma, laser, ion bombardment.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge of high quality surface modification by techniques such as CVD, PVD, Plasma, laser, ion bombardment.
- Study about their process, equipment required and their applications.

Effect of process variables and structure- property correlations, thermo- chemical, thermo- mechanical and thermal processes Treatments for industrial components, Case studies.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the influence of process variables on material properties.
- Describe the different types processes and their significance.
- Explain about various treatments used for industrial components along with case studies.

Text Books:

1. Introduction to Surface Engineering, P. A. Dearnley, Cambridge University Press, 2017.

Reference Books:

1. Basics Of Surface Engineering , M Kamaraju

13. PHASE TRANSFORMATIONS

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.

Course Outcomes:

- 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

SYLLABUS

Definition and types of Phase transformations.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge of fundamentals and different types of phase transformations.
- Study about significance of phase transformations and their applications.

Diffusion: Fick's laws of diffusion, solution of Fick's second law and its applications, atomic model of diffusion and role of crystal defects, temperature dependence of diffusion coefficient.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the laws of diffusion and its applications.
- Study about role of crystal defects in diffusion and influencing factors.

Kirkendall effect. Diffusional transformation in solids and diffusionless transformation in solids.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Describe the kirkendall effect, its mechanism and application.
- Explain diffusional transformation and diffusion-less transformation in solids.

Nucleation and growth - energy considerations; homogeneous nucleation, heterogeneous nucleation, growth kinetics, overall transformation rates.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the different types of nucleation, their mechanism and influencing factors of nucleation.
- Understand the growth kinetics and overall transformation rates in nucleation and growth.

Crystal interfaces and microstructure. Microstructure evolution including recrystallization and grain growth.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge of various crystal interfaces and their possible microstructure.
- Study about their process, equipment required and their applications.

Precipitation from solid solution: Homogeneous and heterogeneous nucleation of precipitates, the aging curve, mechanisms of age hardening, examples from Al-Cu and other alloy systems.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Describe the homogeneous and heterogeneous nucleation of precipitates and their mechanism.
- Explain the age hardening and its mechanism with the help of Al-Cu and other alloy systems.

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.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study about characteristics of martensitic transformation, and bain distortion model.
- Understand the kinetics of martensitic transformations with examples of ferrous and non-ferrous alloy systems.

Order-disorder Transformation Examples of ordered structures, long and short range order, detection of super lattices, influence of ordering on properties.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge of order-disorder transformation with examples of ordered structures, long and short range ordered structures.
- Explain the detectionof super lattices and influence of ordering on properties.

Spinodal decomposition.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study about spinodal decomposition, mechanism involved with spinodal decomposition.
- Describe the role of spinodal decomposition in phase transformations and influencing factors.

Text books:

1. Solid State Phase Transformations, V. Raghavan, Prentice Hall India Learning Private Limited, 1987.
2. Phase Transformations in Metals and Alloys, David A. Porter and Kenneth E. Easterling, Third Edition, CRC Press, 2017

Reference books:

1. Physical Metallurgy Principles, Reza Abbaschian, Lara Abbaschian, and Robert E. Reed-Hill, Cengage, 2013.
2. Mechanisms of Diffusional Phase Transformations in Metals and Alloys, Hubert I. Aaronson, Masato Enomoto, and Jong K. Lee, CRC Press, 2016.

14. INTRODUCTION TO TRANSPORT PHENOMENA

Course Objectives:

- This course will introduce the concepts of fluid flow, heat transfer and mass transfer with behavior and processing of engineering materials as the focus.

Course Outcomes:

- Identify suitable geometry and boundary conditions for the problem.
- Solve simple partial differential equations relevant to transport phenomena.
- Plot different parameters and interpret the solutions.

SYLLABUS

Balance of quantities using elemental volume approach, continuity equation.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge of balancing the equations used in elemental volume approach.
- Define the continuity equation and solve the problems related to it.

Newton's law of viscosity, Navier-Stokes equation, laminar flow problems, exact solutions in rectangular, cylindrical and spherical coordinate systems.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the Newton's law of viscosity and its significance, application.
- Describe Navier-Stokes equation, laminar flow problems and exact solutions in rectangular, cylindrical and spherical coordinate systems.

Friction factors, correlations for turbulent regime, Darcy's law, flow through porous media.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the friction factors and its significance, correlations for turbulent regime
- Study about Darcy's law and flow through porous media in detail.

Fundamentals of heat conduction, convection, radiation and their combined effect; steady and unsteady heat transfer, exact analytical solutions, correlations for conjugate heat transfer.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain the knowledge of fundamentals of heat conduction, convection, radiation and their combined effect.
- Describe the steady and unsteady heat transfer, exact analytical solutions and correlations for conjugate heat transfer.

Diffusion and its application in solid state, convective mass transfer, unsteady diffusion in finite and infinite bodies, diffusion and chemical reactions.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Explain about diffusion and its application in solid state, convective mass transfer.
- Study about unsteady state diffusion in finite and infinite bodies, diffusion and chemical reactions, in detail.

Coupled phenomena in transport, non-dimensional numbers and their correlations of different regimes and analogies.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the coupled phenomena in transport and its significance.
- Describe the non-dimensional numbers and their correlations with different remedies and analogies.

Text books:

1. Transport phenomena, 2nd Edition: R. Byron Bird, Warren E. Stewart and Edwin N Lightfoot; John Wiley & Sons.
2. Fundamentals of Momentum, Heat and Mass Transfer, 4th Edition: James R. Welty, Charles E. Wicks, Robert E. Wilson and Gregory Rorrer; John Wiley & Sons.

Reference books:

1. Transport phenomena in materials processing : D.R. Poirier and G.H. Geiger, TMS
2. Introduction to Fluid Mechanics, 5th Edition: Robert W. Fox & Alan T. McDonald: John Wiley & Sons.

15. PHYSICS OF MATERIALS

Course Objectives:

- To understand the science behind the properties exhibited by materials. To recognize the size scale from which the property originates and hence the impact of various material constituents on the properties of the materials.

Course Outcomes:

- Explain the origin of the various properties of materials.
- Indicate the phenomena that impact specific properties.
- Use quantum mechanical approach to explain material properties.
- Utilize reciprocal space.
- Explain the similarities and differences between classical particles, Fermions, and Bosons

SYLLABUS

Overview of properties of materials

Thermal expansion Electrical Conductivity, Measuring electrical conductivity Free electron gas, ideal gas.

Free electron theory of metals, Wiedemann-Franz law, Drude model, Successes and Limitations of Drude model, Source of limitations of Drude model.

Large systems and Statistical Mechanics, Maxwell Boltzmann statistics

Classical Particles, Quantum particles, History of quantum mechanics, Drude- Sommerfeld model

Fermi-Dirac Statistics, Features of Fermi-Dirac Distributions, comparison with Maxwell-Boltzmann statistics

Anisotropy and Periodic potential, Confinement and Quantization, Density of states

Fermi Energy, Fermi Surface, Fermi Temperature, Electronic contribution to Specific Heat at Constant Volume Reciprocal space

Calculating allowed and forbidden energy levels, Free electron approximation, tight binding approximation

Electron compounds, Semiconductors, Optoelectronic properties, magnetic properties, phonons

Superconductivity, Bose-Einstein statistics, Meissner effect, BCS theory, Physics of nanoscale materials.

Text Books:

1. Physics of Materials, Essential concepts of Solid State Physics. PrathapHaridoss, Wiley 2015.

Referencebooks:

1. Solid State Physics, Ashcroft and Mermin, Cengage 2003.

SYLLABUS OF OPEN ELECTIVES

1. MATERIALS CHARACTERIZATION

Course objectives:

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

Course Outcomes:

- Determine crystal structure of materials
- Analyze microstructure of materials at different length scales
- To use XRD to study grain size, phase diagram and residual stresses
- To use XRD to determine chemical composition and order-disorder transformation

SYLLABUS

Metallography- Macro and Micro examination of examination of metals and alloys, Resolution and magnification. Construction of optical microscope.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the macro and micro examination of examination of metals and alloys in detail.
- Gain the knowledge on construction of optical microscope, resolution and magnification.

Principles of construction of electron microscopes. Specimen preparation techniques for transmission electron microscopy.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Study the principles of construction of different types of electron microscopes.
- Explain about specimen preparation techniques for optical, scanning electron microscopy and transmission electron microscopy.

Production and properties of X-rays, Electromagnetic radiation, continuous and characteristics spectrum, absorption. Filters. Diffraction. Bragg's law, scattering by atom, Structure factor calculations.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Study the principles in the production of X-rays and their characteristics.
- Define electromagnetic radiation, continuous and characteristics spectrum, absorption, filters, Bragg's law, scattering by atom and also calculate the structure factor.

Diffraction Methods: Laue's method, rotating crystal method, powder method, Determination of crystal structure, determination of precision lattice parameter, sources of error in measurements.

Learning Outcomes:
At the end of this chapter the student will be able to:

- Gain the knowledge on different diffraction methods, their data interpretation and limitations.
- Understand the determination of crystal structure, precision lattice parameter, sources of error in measurements.

Applications of XRD – Effect of plastic deformation. Determination of particle size, grain size, residual stresses, determination of phase diagrams, order-disorder transformation.

Learning Outcomes:
At the end of this chapter the student will be able to:

- Study about the determination of effect of plastic deformation and its data interpretation, analysis.
- Describe the determination of particle size, grain size, residual stresses, phase diagrams, order-disorder transformation through XRD.

Text books:

1. Elements of X-ray diffraction: B.D. Cullity, Pearson Education 2014
2. Electron and analysis: P. J. Goodhew, J. Humphreys, R. Beanland, 3rd edition, CRCPress 2000.

2. METAL JOINING PROCESSES

Course objectives:

- To develop understanding fundamentals of welding
- To know the requirements of Joining a material
- To know the various types of joining processes

Course outcomes:

- Able to select welding process for the given application
- Identify different energy sources like electron beam, laser beam, plasma arc, explosion welding, ultrasonic welding etc and analyze the concept, mechanism, parameters associated with the processes
- Demonstrate weld design procedures and can also Describe soldering and brazing techniques convincingly

SYLLABUS

Introduction: Importance and classification. Basic concepts in arc welding and gas welding.
Learning Outcomes:
At the end of this chapter the student will be able to:

- Study about the significance of material joining techniques and their classification.
- Describe the fundamentals of arc welding and gas welding and their applications.

General theory of arc welding. Principle, operation and application of shielded metal arc welding. Tungsten inert gas, plasma arc, submerged arc, metal inert gas and CO_2 welding processes. Electro-slag welding.
Learning Outcomes:
At the end of this chapter the student will be able to:

- Explain about the principle of arc welding and its significance.
- Understand the process of different types of arc welding techniques, their advantages and disadvantages.

Resistance welding processes. Spot, seam, projection
Learning Outcomes:
At the end of this chapter the student will be able to:

- Gain the knowledge about the principle of resistance welding and different types of resistance welding techniques.
- Describe the process spot, seam, projection welding techniques, their advantages and disadvantages.

Special welding processes Thermit welding, Electron beam and laser beam welding.
Learning Outcomes:
At the end of this chapter the student will be able to:

- Understand about the principles of thermit welding, electron beam and laser beam welding and their significance.
- Explain the equipment required for thermit welding, electron beam and laser beam welding techniques, their advantages and disadvantages.

Solid state welding processes. Diffusion bonding, ultrasonic. Explosive inertia/friction welding.

Soldering and brazing.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Describe the principles of solid state welding, soldering and brazing and their significance.
- Study the equipment required for solid state welding, soldering, brazing techniques, their advantages and disadvantages.

Text books:

1. Welding and Welding Technology, R.L.Little

Reference Books:

1. Welding Technology, N.K.Srinivasan

3. POWDER METALLURGY

Course objectives:

- This course introduces the particulate technology to create components from powder route.
- To build the necessary back ground of emergence and importance of powder metallurgy scope and limitations.
- Obtain a necessary knowledge about various powder production techniques and characteristics.
- Obtain a working knowledge of compaction and sintering techniques.

- Gain an effective knowledge of applications of powder metallurgy products.

Course Outcomes:

- Appreciate the importance of powder metallurgy technology for production of materialsand components in comparison with other fabrication techniques.
- List out the advantages, limitations and applications of powder metallurgy technique.
- Able to choose the production method to get the required size and shape of the powders.
- Knowledge of various characterization methods to control the properties of the powders.
- Describes the consolidation and sintering processes in powder metallurgy route.
- Can develop and design powder metallurgical components for specific applications andneeds of various industries.

SYLLABUS

Introduction: Advantages and limitations of powder metallurgy.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Study the significance of powder metallurgy and applications of powder metallurgy.
- Gain the knowledge on advantages and limitations of powder metallurgy.

Powder production methods:

Mechanical, Chemical, Electrolytic and atomization Methods. Commercial production of metallic powders.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the various powder metallurgy techniques and their process in detail.
- Describe the commercial production of metallic powders and process limitations in detail.

Powder characteristics:

Composition and structure, particle size, shape, specific surface, surface topography, flow rate, apparent and tap density, pressing properties.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Study the powder characteristics produced by various powder metallurgy techniques and their properties.
- Explain the influencing factors of powder characteristics in their production.

Compaction of metal powders:

Pressure and Pressure less compaction techniques: Die compaction, Cold Isostatic pressing, Powder rolling, Powder forging, Explosive forming; High Temperature Compaction methods: Hot Pressing, Hot Extrusion, Spark Plasma Sintering, H I P.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Describe the various pressure and pressure less compaction techniques and their process in detail.
- Understand the advantages and disadvantages of compaction methods and applications.

Principles and practice of sintering:

Sintering mechanisms, stages of sintering, Driving forces for sintering, sintering atmospheres, Liquid phase sintering, Post sintering operations.

Learning Outcomes:
At the end of this chapter the student will be able to:

- Describe the fundamentals, principles of sintering and its mechanism.
- Study the influencing factors of sintering and different type of sintering techniques.

Applications of powder metallurgy: Cermets, bearing materials, dispersion strengthened materials and other miscellaneous applications.

Learning Outcomes:
At the end of this chapter the student will be able to:

- Understand the wide range applications of powder metallurgy and their significance.

Text books:

1. Powder metallurgy: science, technology and materials AnishUpadhyaya, G.S.Upadhyaya, Universities Press
2. Power metallurgy: science, technology and materials–P.C. Angelo, R.Subramanian, PrenticeHall India Learning Pvt.Ltd.

Reference books:

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

4. FAILURE ANALYSIS

Course Objectives:

- To highlight factors governing the failure of materials and types of failure
- To evaluate the mechanisms and environmental effects associated with failure
- To identify various failures in heat treatments, and deformation processing, andmethods to prevent them

Course Outcomes:

After completing this course the student will have:

- The ability to identify the types of failures in engineering components under service
- Knowledge of the tools and techniques to perform failure analysis
- The skill set to perform fractographic analysis after various failures
- The ability to identify different failure mechanisms resulting from manufacturing processes
- Sources of Failures, Steps in Failure Analysis,

SYLLABUS

Sources of Failures, Steps in Failure Analysis, characteristics of ductile and brittle fracture, ductile to brittle transition. High temperature failures

Learning Outcomes:
At the end of this chapter the student will be able to:

- Describe the Sources of failure and steps in failure analysis.
- Understand the characteristics of ductile and brittle fracture, ductile to brittle transition and influencing factors.
- Gain the knowledge on high temperature failures and the causes with the help of case studies.

Fatigue failures

Learning Outcomes:
At the end of this chapter the student will be able to:

- Study the fatigue failures, stages involved with it and the reasons for the failure in detail.
- Gain the knowledge on different types of fatigue failures and methods to improve fatigue life with the help of case studies.

Corrosion failures and their identification
Learning Outcomes:
At the end of this chapter the student will be able to:

- Explain about various corrosion failures and type of corrosion associated with failure by studying the different case studies.
- Describe the reasons for corrosion failures and preventive measures to resist corrosion failure.

Failures of industrial components like casting and welding. Some case studies in failure analysis.
Learning Outcomes:
At the end of this chapter the student will be able to:

- Study about various failures of industrial components like casted and welded components.
- Gain the knowledge on failure of components with the help of case studies and causes for the failure.

Text Books:

1. Analysis of Metallurgical failures-VJ Collangelo and PA Heiser

Reference Books:

1. Mechanical Metallurgy Dieter

5. INTRODUCTION TO MATERIALS ENGINEERING

Course Objectives:

- To give the students a broad overview to various aspects of Materials Science andEngineering. Instill interest and curiosity in the discipline.

Course Outcomes:

- Have a broad knowledge of the discipline.
- Have an exposure to methods and techniques used in the discipline.
- Understand the flow of courses through the rest of their undergraduate education.
- Develop a preliminary understanding of which courses address which topics in thediscipline.

SYLLABUS

Design, synthesis & processing, characterization, applications of materials Failure analysis & forensics of different types of materials starting from common metals and alloys to exotic materials. Examples and case studies will be taken up and shown to the students.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the design of materials, processing of different types of materials, characterization and applications of materials in failure analysis.
- Gain the knowledge on forensics of various materials with the help of case studies.

Demonstrations using sophisticated and state-of-the-art instruments pertaining to aspects of synthesis, processing, characterization and failure analysis will be carried out in the laboratories.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Study the equipment's used for processing of materials used for failure analysis.
- Explain about characterization techniques used for failure analysis and their data interpretataion.

Comprehensive visits/conducted tours to the research laboratories will be carried out videos and simulations describing materials and their properties will be shown along with specific and interesting case studies.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Study the wide range of materials synthesis and structure, property correlation, failure analysis through visits to research laboratories and videos along with case studies.

Text books:

1. Materials Science and Engineering: An Introduction: William D Callister; Wiley, 2014
2. Materials and Design: The Art and Science of Material Selection in Product Design, Mike
3. Ashby and Kara Johnson, 3rd Edition, Butterworth-Heinemann, 2014.
4. Engineering Materials 1 (2011) and 2 (2012), D.R.H. Jones and M.F. Ashby, 4th Edition,Butterworth-Heinemann.

Reference books:

1. The New Science of Strong Materials or Why You Do Not Fall Through The Floor, J.E.Gordon. Penguin, 1991.
2. 2. Stuff Matters, Mark Miodownik. Penguin, 2014.

6. MATERIALS THERMODYNAMICS

Course Objectives:

- To highlight the fundamental role of Thermodynamics in describing metallurgical and materials processes. To learn and use thermodynamic functions, rules and relations and interpret thermodynamic plots and diagrams.

Course Outcomes:

- Use the various thermodynamic functions appropriately under different experimental situations involving gases, liquids and solids
- Derive and explain the Gibbs Phase rule
- Utilize Ellingham diagrams
- Utilize Pourbaix diagrams

SYLLABUS

History of thermodynamics, Ideal Gas, Energy and Work, Extensive and Intensive Properties.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the basics concepts of thermodynamics, various laws of thermodynamics.
- Gain the knowledge of objectives, limitations of classical thermodynamics.

First Law of Thermodynamics, Internal Energy, Enthalpy, Heat Capacity, Reversible Processes

Learning Outcomes:

At the end of this chapter the student will be able to:

- Define various forms of Energy, Heat and work, Conservation of Energy
- Gain the knowledge of first law of thermodynamic in detail, concept of maximum work, isothermal expansion, reversible, adiabatic expansion

Second Law of Thermodynamics, Entropy and equilibrium, Reversibility, Heat Engine, Statistical Interpretation of Entropy, Boltzmann Equation.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the second law of thermodynamics in detail and its applications.
- Define entropy, various theories related to second law of thermodynamics.

Auxiliary Functions Enthalpy, Free Energy, Chemical Potential, Maxwell's Equations, Gibbs-Helmholtz Equation, Enthalpy as a Function of Temperature and Composition.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Gain knowledge on fundamental equations of states and maxwell equations.
- Define chemical Potential, Gibbs - Helmholtz Equation, criteria of equilibria.

Third Law of Thermodynamics Phase Equilibrium in a One-Component System, Equilibrium between Vapor and Condensed Phase, and between condensed phases.

Learning Outcomes:

At the end of this chapter the student will be able to:

- Understand the heat capacity and entropy changes involved with third law of thermodynamics.
- Define sensible heats, transformation heats, reaction heats and solve the numerical problems with the help of heat balance equations.

Gases: Ideal, Real, van der Waals, Raoult's Law and Henry's Law, Activity, Gibbs-Duhem Equation.

Learning Outcomes:
At the end of this chapter the student will be able to:

- Gain knowledge on various types of gases.
- Define Raoult's Law, Henry's Law, Activity, Gibbs-Duhem equation and their applications.

Properties of Ideal and Non-ideal Solutions, Regular Solutions Activity, Phase Diagrams of some Binary Systems.

Learning Outcomes:
At the end of this chapter the student will be able to:

- Explain about different properties of ideal, non- ideal, regular solutions.
- Study about the phase diagrams of binary systems.

Effect of Temperature and Pressure on the Equilibrium Constant for a gas mixture, Ellingham Diagrams, The Gibbs Phase Rule.

Learning Outcomes:
At the end of this chapter the student will be able to:

- Understand about influence of temperature and pressure on the equilibrium constant for a gas mixture.
- Gain the knowledge on Ellingham diagrams and their application, The Gibbs Phase Rule in detail.

Electrochemistry, Concentration and EMF, Standard Reduction Potentials, Pourbaix Diagrams.

Learning Outcomes:
At the end of this chapter the student will be able to:

- Study about fundamentals, electrochemical aspects of Electro chemistry.
- Gain the knowledge on Pourbiax diagrams and their application in detail.

Text books:

1. Introduction to Thermodynamics of Materials, 5th Edition, David R Gaskell, Taylor andFrancis, 2016.
2. Materials Thermodynamics with Emphasis on Chemical Approach, Hae-Geon Lee, World Scientific Publishing, 2012.

Reference books:

1. Thermodynamics in Materials Science, Robert DeHoff, CRC Press, 2006.

7. IRON MAKING AND STEEL MAKING TECHNOLOGY

Course objectives:

- This course introduces the principles of iron making and steelmaking

Course Outcomes:

- Describe the physical and chemical processes that take place during iron making and steelmaking
- Analyse the effect of change in process parameters in iron making and steelmaking processes
- Describe the methods for control of quality in iron and steel production
- Solve numerical problems involving reaction kinetics and composition control

SYLLABUS

Principles of Iron making and steelmaking. Feasibility of reactions and chemical kinetics.

Learning Outcomes:
At the end of the chapter the student will be able to:

- Understand the fundamentals and principles in iron and steel making.
- Explain about process flow sheet and reaction as well as chemical kinetics in detail.

Iron making through blast furnace route, steady state heat and material balance in blast furnace, effect of different process parameters on the productivity and quality of pig iron.

Learning Outcomes:
At the end of the chapter the student will be able to:

- Gain the knowledge on material balance and heat balance equations, various reactions involved in the iron making process through blast furnace.
- Study about influence of process parameters on the productivity and quality of pig iron in the blast furnace.

Alternate methods for reduction of iron, Steel making primary process: pneumatic and hearth, secondary steel making, quality steelmaking,deoxidation, inclusion.

Learning Outcomes:
At the end of the chapter the student will be able to:

- Describe the different methods required for iron making process other than blast furnace.
- Explain in detail about primary, secondary steel making, reaction and chemical kinetics involved with it.

Control of composition and quality of steel using slags: ferrous slags, physical chemistry ofslag metal reactions.

Learning Outcomes:
At the end of the chapter the student will be able to:

- Gain the knowledge on control of composition and quality of steel using various slags.
- Study about different chemical kinetics and slag- metal reactions in detail.

Text books:

1. A first course in iron and steel making, Dipak Mazumdar, Orient BlackswanPvt.Ltd.,(2015)

2. Iron making and steelmaking: Theory and Practice, GhoshAhindra, ChatterjeeAmit, Phi Learning Private Limited,(2001)

Reference books:

1. Extractive Metallurgy1: Basic Thermo dynamics and Kinetics, Alain ignes(ISTELtd.,)
2. Extractive Metallurgy2: Metallurgical Reaction Processes, Alain Vignes (ISTELtd.,)
3. Extractive Metallurgy3: Processing Operations and Routes, Alain Vignes (ISTELtd.,)
4. An introduction to modern steelmaking, R.H.Tupkary , Khanna Publishers(2000)
5. An introduction to modern iron making ,R.H.Tupkary ,Khanna Publishers(2004)

8. MATERIALS PROCESSING

Course Objectives:

- To understand the fundamentals of deformation processing related to various manufacturing processes
- To obtain knowledge of various metal joining processes of various engineering alloys

- To understand concepts associated with solidification and its physical metallurgy
- To obtain the basic knowledge of processing of ceramic and glassy materials and their comparison with other materials

Course Outcomes:

- Relate the theory of plasticity to various deformation processing methods
- Identify the various materials joining processes and their applications
- Indicate the joining processes of ceramics and glassy materials

SYLLABUS

Principles of plasticity related to metal forming: cold, warm, and hot working, dynamic recovery and recrystallization. Basic metal forming processes such as Rolling, Forging, Extrusion, Wire Drawing, Sheet metal working.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Understand the different material working operations with detailed process.
- Explain about equipment required for various operations and applications.

Welding versus other joining processes: Welding processes, welding metallurgy, TTT and CCT diagrams, carbon equivalent, welding of ferrous and non-ferrous alloys, joining of dissimilar metals.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study about welding metallurgy of different material joining processes, transformations occur during welding.
- Describe the influence of welding on the fabricated material property and its significance.

Casting: Thermodynamics of solidification, Nucleation and growth, undercooling, dendritic growth, structure of castings and ingots, heat transfer during solidification, types of casting processes.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Gain knowledge of various mechanisms involved in solidification of a casting.
- Explain about types of casting techniques, their advantages and disadvantages.

Structure of ceramics and glassy materials: ceramic powder preparations, forming and consolidation processes. Comparison of processing and applications of different materials.

Learning Outcomes:

At the end of the chapter the student will be able to:

- Study the different manufacturing processes of ceramics and glass materials.
- Describe the process advantages, limitations and their applications.

Text books:

1. Principles of metal casting by R.W.Haine, C.Loper and p.C.Rosenthal. mc graw hill education,2001

Reference Books:

1. Introduction to ceramics by kingery, Bowen ,Uhlman. Wiley indiapvtl imited,2012

9 INTRODUCTION TO INSTRUMENTATION

Course objectives:

- To learn the principle of Pressure, Temperature, flow, level, density and viscosity measurements.
- To know about the selection, calibration and installation of different instruments
- To explore the application of measuring instruments in various industries

Course outcomes:

- Apply the knowledge of various Measuring Instruments to design a simple Instrumentationsystem.
- Calibrate the industrial instruments and use them in various fields.
- Select suitable instrument for a given application
- Analyzing the instrument in Industry
- Perform Calibration of Instruments
- Design Instrumentation Circuits for measurement systems.

SYLLABUS

Basic concepts. Introduction. Definition of terms. Calibration standards. Generalized measurement system. Basic concepts in dynamic measurements. Causes and types of experimental errors. Analysis.

Transducer and electric sensing devices. Differential transformer. Capacitive, piezo electric, photoconductive and ionization transducers.

Pressure measurement: Mechanical pressure measurement devices. Low pressure measurement. McLeod gauge- Pirani Thermal conductive gauge- Ionization gauge.
Flow measurement methods.

Temperature measurement: by mechanical and electrical effects-Measurement by radiation. Transient response of thermal systems.High speed temperature measurement.

Strain measurement: Strain gauges. Temperature compensation.Strain gauge rosettes.

Text books:

1. Experimental methods for Engineers, J.P.Holman, McGraw Hill Publication.
2. Mechanical measurements, Sirohi, Radhakrishnam.
3. Electron Beam Analysis of materials, Lorento

10. FLUID MECHANICS AND HEAT TRANSFER

Course objectives:

- Identify and obtain values of fluid properties and relationship between them.
- Understand the principles of continuity, momentum, and energy as applied to fluid motions.
- Recognize these principles written in form of mathematical equations.
- Apply these equations to analyze problems by making good assumptions and learn systematic engineering method to solve practical fluid mechanics problems.
- Apply fundamental principles of fluid mechanics for the solution of practical civil

engineering problems of water conveyance in pipes, pipe networks, and open channels.

Course outcomes:

- The Student will be acquainted with the principles relating to the measuring equipment offluid flow.
- Further the student is capable of understanding the basic laws of fluid dynamics and theirapplications to the engineering problems occurring during their practice.

SYLLABUS

Classification of flows: Steady, Unsteady, Uniform, Non-uniform, Laminar, Turbulent, Rotational, Irrotational flows, Vorticity, and ciruculation - Conservation of mass- Equation of continuity, Conservation of momentum- Euler's equation, Conservation of energy– Bernoulli's equation and its applications.

One-dimensional Viscous flow. Couette flow - Plane couetee flow. Two Dimensional Viscous Flow:Navier stokes equations and solutions.

Laminar Boundary Layer. Momentum integral equation: Flow over a flat plate- Displacement thickness, Momentum thickness and energy thickness. Turbulent Boundary Layer. Laminar – Turbulent transition - Momentum equations and Reynold's stresses.

Dimensional Analysis and Modeling Similitude. Fundamental and derived dimensions – Dimensionless groups – Buckingham theorem – Raleigh method.

Elements of heat transmission. Steady state conduction: convection and radiation. Furnaces. Classification of furnaces and their use in metallurgical industries. Heat utilization in furnaces, available heat, factors affecting it. Heat losses in furnaces and furnace efficiency. Heat balance and Sankey diagrams. Principles of waste heat recovery.

Recuperators and regenerators. Types and applicability. AMTD and LMTD in recuperators. Protective atmosphere and their applications. Salt bath furnaces.

Text books:

1. Fluid Mechanics, A.K.Mohanty, Prentice Hall of India Pvt. Ltd.
2. Fuels, furnaces and refractories by O.P.Gupta

Reference books:

1. Fluid Mechanics and Hydraulic Machines, R.K.Bansal, Laxmi Publications.
2. Foundations of Fluid Mechanics, Yuan, Prentice Hall of India.
3. Fluid Mechanics and its applications, S.K.Gupta and A.K.Gupta, Tata McGraw Hill, New Delhi.

11. ENGINEERING MECHANICS & STRENGTH OF MATERIALS

Course objectives:

- The student will be given maximum flexibility in an areas of Dynamics and Vibrations -itsinterfaces to materials and structures for understanding on applications.
- Towards characteristics of structures and study on material and structure and Applied Mathematics and Numerical Methods, Experimental Mechanics and Materials, Strength of materials & structural analysis

Course outcomes:

- After completing the course student will have the basic knowledge on material and structuresat analysis level.
- This will also integrate the science, engineering and mathematical concept for student understanding

SYLLABUS

Concurrent forces in a plane and its equilibrium Centroids of composite plane figures.General caseof forces in a plane.

Moment of inertia of plane figures. Parallel axis theorem. Polar MI. Concept of mass MI. Rectilinear translation.

Kinematics. Principle of dynamics. Motion of a particle under constant force. Force proportional todisplacement and free vibrations (SHM) .

D'Albert'sprinciple. Momentum. Impulse work and energy. Rotation of a rigid body about a fixed axis kinematics. Equation of motion of a rigid body about a fixed axis. Rotation under constant moment. Torsional vibration.

Simple stresses and strains: Stresses on inclined plane.2-Dimensional stress systems. Principal stressand principal planes. Mohr's circle. Shearing force and bending moment. Types of loads. Types of supports. SF and BM diagrams for formula. Bending stresses in the above types of beams with rectangular and circular sections. Torsion of circular shafts. Determination of shear stress.

Text books:

1. Engineering Mechanics – S.Timoshenko (relevant sections only)
2. Elements of Strength of Materials- S.Thimoshanko (relevant sections only)

Reference Books:

1. Engineering Mechanics – S.Timoshenko (relevant sections only)
2. Elements of Strength of Materials- S.Thimoshanko (relevant sections only)

12. ELECTRICAL TECHNOLOGY

Course objectives:

- Understand the basic principles of operation of rotating electric machines (Generatorsand Motors), their classification and basic efficiency and performance characteristics.
- Understand the operation and basic configurations of separately excited, permanent magnet,shunt and series DC machines and speed control methods.
- To know the basic principle of single phase transformers and its performance.
- To understand the basic principle of three-phase induction motor and alternators
- To understand the basic principle of special motors and electrical instruments.

Course outcomes:

- Student will be able to analyze the performance of DC Generators and DC Motors.
- Student will be able to analyze the performance of transformers.
- Student will be able to learn in-depth knowledge on three phase induction motor.
- Student will be able to analyze the performance of special motors and electrical instruments.

SYLLABUS

Magnetic circuits: Definitions of magnetic circuit, Reluctance, Magnetomotive force (m.m.f), magnetic flux, simple problems on magnetic circuits, Hysteresis loss (Chapter 8, Page Nos.155-175)

Electromagnetic induction: Faraday's law of electromagnetic induction, induced E.M.F., Dynamically induced EMF. Statically induced EMF, Self-inductance, and mutual inductance. (Chapter 9, Page Nos.176-190)

D.C. generators. D.C. Generator principle, construction of D.C. generator, E.M.F. equation of D.C. generator, types of D.C. generators, Armature reaction, Losses in D.C. generator, Efficiency, characteristics of D.C. generators, Applications of D.C. generator. (Chapter 10, 11, Page Nos.208- 238)

D.C. Motors: D.C. Motor principle, working of D.C. Motors, significance of back E.M.F., Torque equation of D.C. motors, types of D.C. motors, characteristics of D.C. motors, speed control methods of D.C. motors, Applications of D.C. motors, Testing of D.C. machine: losses and efficienc6y, Direct load test and Swinburne's test (Chapter 12,13, Page Nos.239-267).

A.C. Circuit: Introduction to steady state analysis of A.C. circuits. Single and balanced 3 phase circuits. (chapter 16, Page Nos.323-348)

Transformers: Transformer principle, EMF equation of transformer, Transformer on load, Equivalent circuit of Transformer, Voltage regulation of transformer, losses in a transformer, Calculation of efficiency and regulation by open circuit and short circuit tests. (Chapter 20, Page Nos.423-455)

Three phase inductance motor: Induction motor working principle.Construction of 3 phase induction motor, principle of operation. Types of 3 phase induction motor, Torque equation of induction motor, Slip-Torque characteristics, Starting Torque, Torque under running condition, Maximum Torque equation, power stages of induction motor, efficiency calculation of induction motor by direct loading (Chapter 21, Pg 463-489).

Alternator: Working principle, EMF equation of Alternator, Voltage regulation by Sync.Impedancemethod. (Chapter 23, Page Nos.505-515)

Synchronous Motor: Synchronous motor principle of operation., Construction, Methods of

starting of synchronous motor. (Chapter 24, Page Nos.516-526)

Electrical measurements: Principles of measurement of current, Voltage power and energy, Ammeters, Voltmeters, Wattmeter's ,Energy Meters, Electrical conductivity Meter, Potientiometer and Megger.

Text book:

1. Elements of Electrical Engineering and Electronics by V.K.Mehta, S.Chand& Co.

Reference book:

1. A first course in Electrical Engineering, by Kothari

SYLLABUS OF HSS ELECTIVES

1. ORGANIZATIONAL BEHAVIOUR

Course Objectives:

- To understand the basic concepts of organisational behaviour, its foundations and importance.
- To enable students to have a basic perspective of Motivation and Motivation theories.
- To acquaint the students about group behaviour in organizations, including communication, leadership conflicts and organizational change and how these are linked to and impactorganizational performance.

Course Outcomes:

- Indentifying fundamental aspects of organizational dynamics.
- Evaluate main theories of motivation and formulating suitable motivational strategies.
- Analyze the behaviour of individuals and groups in organizations.
- Understanding of Leadership theories and Leadership behaviour.
- Apply relevant theories, concepts to address important Organizational Behaviour questions.
- Understand the nature and role of Organizational Behaviour and its relevance to the workplace.
- Analyze and compare different theories of Motivation and design strategies to improvemotivation at the workplace.
- Gain insights of group dynamics and demonstrate skills required for team building. Examinefactors which influence group cohesiveness and performance.
- Indentify the various Leadership Styles and adopt suitable style.
- Communicate effectively in oral and written forms.
- Develop appropriate methods and styles of communication for the organization.
- Adopt strategies for managing conflicts in organizations.
- Implement Organizational change in a planned way and overcome resistance to change ifany.

SYLLABUS

Organisational Behaviour : Concept of Organisation - Concept of Organisational Behaviour -

Nature of Organisational Behaviour - Role of Organisational behaviour - Disciplines contributing to Organisational Behaviour.

Motivation: Definition - Nature of Motivation - Role of Motivation - Theories of Motivation : Maslow's Need Hierarchy Theory, Herzberg's Motivation Hygiene Theory and McGregor's TheoryX and Theory Y.

Group Dynamics: Meaning - Concept of Group - Types of groups -Formal and Informal groups - Group development - Group cohesiveness and factors affecting group cohesiveness.

Leadership: Concept of Leadership - Difference between Leadership and Management - Importance of Leadership - Leadership styles: Autocratic leadership, Participative leadership and Free Rein leadership.

Communication: Meaning - Communication Process - Forms of communication: Oral, Written and Non- Verbal communication - Direction of communication : Downward, Upward and Horizontal communication.

Organisational conflicts: Concept of conflict - Reasons for conflict - Types of Conflict: Intrapersonal conflict, Interpersonal conflict, Intragroup conflict, Intergroup conflict, Interorganisational conflict - Conflict management.

Organisational Change: Nature - Factors in Organisational change -Planned change: Process of planned change - Resistance to change: Factors in resistance to change - Overcoming resistance to change.

Text Books:

1. L.M.Prasad: Organisational Beaviour, Sultan Chand & Sons, New Delhi -110002
2. K. Aswathappa: Organisational Behaviour, Himalaya Publishing House, New Delhi

Reference Books:

1. Stephen Robbins: Organisational Behaviour, Pearsons Education, New Delhi.

2. INDUSTRIAL MANAGEMENT AND ENTREPRENEURSHIP

Course Objectives:

- To relate the concepts of Management with industrial organizations.
- To explain the factors affecting productivity and how productivity can be increased in anIndustrial undertaking.
- To set forth a basic framework for understanding Entrepreneurship.

Course Outcomes:

- Understand the roles, skills and functions of management.
- Distinguish the different types of business organizations.
- Identify the factors involved in Production Operations Management.

- Diagnose organizational problems and take suitable decisions.
- Establish good Human Resource Management practices.
- Acquire necessary knowledge and skills required for organizing and carrying out
- Understand the nature and functions of Management.
- Ability to plan, organize, direct, control and coordinate organizational activities.
- Categorize business organizations on the basis of ownership and functioning and determinethe choice of an appropriate form of business organization.
- Understand and evaluate the key entrepreneurial skills needed to initiate and develop asuccessful business.
- Analyse various factors for selecting the location for a Business Enterprise.
- Apply Break-even analysis to take managerial decisions.
- Design and formulate various Human Resource Management processes.
- Raise necessary capital from different sources.
- Design effective marketing strategies.
- Understand the institutions that aid Entrepreneurship development.
- Acquire the ability to promote a business enterprise.

SYLLABUS

Management :- Definition, Nature and Importance ; Functions of the Management; Levels of Management; F.W Taylor's Scientific Management; Henry Fayol's Principles of Management;

Forms of Business Organizations: Introduction, Types of Business organizations, Private Sector- Individual Ownership, Partnership, Joint stock companies and Co-Operative organizations Public sector- Departmental Organizations, Public Corporations and Government Companies. The Joint sector Management.

Production and operations Management: Plant location- Factors to be considered in the selection of Plant location; Break - even analysis- Significance and managerial applications; Importance of Production Planning and Control and its Functions; Human Resource Management and Functions of Human Resource Manager (in brief); Functions of Marketing; Methods of Raising Finance.

Entrepreneurship : Definition, Characteristics and Skills , Types of Entrepreneurs, Entrepreneur vs. Professional Managers, , Growth of Entrepreneurs, Nature and Importance of Entrepreneurs, Women Entrepreneurs, Problems of Entrepreneurship.

Entrepreneurial Development and Project Management: Institutions in aid of Entrepreneurship Development, Idea generation: Sources and Techniques;, Stages in Project formulation ; Steps for starting a small enterprise - Incentives for Small Scale Industries by Government.

Text Books:

1. Sharma,S.C, and Banga, T.R., Industrial Organization & Engineering Economics, KhannaPublishers, Delhi, 2000.
2. VasantDesai ,The Dynamics of Entrepreneurial Development and Management (Planningfor future Sustainable growth),HImalayan Publishing House, 2018.

Reference Books:

1. Aryasri , A.R., Management Science, McGraw HIll Education (India Private Limited ,New Delhi 2014.
2. Sheela, P. , and JagadeswaraRao, K., Entrepreneurship, Shree Publishing House, Guntur,Andhra Pradesh, 2017.

3. OPERATIONS RESEARCH

Course Objectives:

- Formulate a real world problem as a mathematical programming model.
- Provide knowledge of optimization techniques and approaches.
- Understand and study inventory problems.
- Know the network models.
- Put on knowledge in solving replacement problems and different queueing models

Course Outcomes:

- Learned to translate a real-world problem into a mathematical formulation.
- Formulate and Solve Transportation, Assignment and sequencing problems.
- Resolve inventory problems.
- Able to solve maximum flow and shortest path problems.
- Capable to solve replacement problems and analyze queueing models.

SYLLABUS

Introduction: Definitions of Operations Research; Phases of Operations Research; Types of Operations Research models; applications, merits and demerits of Operations Research.

Allocation: Linear Programming problem formulation; Basic assumptions; Graphical solution; Simplex method; Artificial variable technique; Two phase method; Big M method; Duality principle; Primal and Dual relation.

Transportation: Formulation; Solution methods; Unbalanced transportation problems - North west corner rule;Least cost entry method; Vogel's approximation method; Optimal solution; degeneracy.

Assignment: Formulation; Variations in Assignment problem; Travelling salesman problem

Sequencing: Sequencing of - *n* jobs through two machines; *n* jobs through three machines; *n*jobs through *m* machines; 2 jobs through *m* machines.

Inventory Control: Introduction; Types of Inventory; Inventory costs; Deterministic models -

Economic order quantity (EOQ) and Economic Production Quantity (EPQ) with and without shortages; Quantity discounts; P system; Q system; Inventory control Techniques.

Network Analysis: Network definitions; Time estimates in network analysis; Labeling using Fulkerson's rule; Forward pass computations; Backward pass computations; Project management using Critical Path Method(CPM) and Programme Evaluation and Review Technique(PERT).

Network Analysis: Network definitions; Time estimates in network analysis; Labeling using Fulkerson's rule; Forward pass computations; Backward pass computations; Project management using Critical Path Method(CPM) and Programme Evaluation and Review Technique(PERT).

Replacement: Introduction, Replacement of items that deteriorate with time - Value of money unchanging and changing, Replacement of items that fail completely.

Queueing models: Introduction; Single channel poisson arrivals; Exponential service times; Unrestricte queue with in finite population and finite population models; Multichannel poisson arrivals Exponential service times with infinite population and restricted queue.

TextBooks:

1. Hamdy A Taha, "Operations Research- An Introduction" by TAHA, Prentice Hall, 2009.
2. F.S.Hiller, G.J. Liberman,B. Nag and P.Basu "Introduction To Operations Research,McGraw Hill Education(India), 2012.
3. S.D.Sharma,"Operations Research", KedarnadhRamnadh& Co.,2017

Reference Books:

1. R. Pannerselvam, "Operations Research", PHI..
2. Richard Bronson, Schaum's Series," Operations Research", McGraw Hill
3. N.V.S.Raju,"Operations Research- Theory and Practice" BS publications.