

BE (Metallurgical Engineering)
WEF 2007-08 BATCH

II / IV First semester

| Code No | Subject | Periods | | | Exam Hours | Sessionals Marks | Exam Marks | Total Marks | Credits |
|--------------|---|-----------|----|----|------------|------------------|------------|-------------|-----------|
| | | L | T | P | | | | | |
| ME 211 | Maths - III | 3 | -- | -- | 3 | 30 | 70 | 100 | 4 |
| MT 212 | Fuels and Refractories | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 213 | Engineering Mechanics & Strength of Materials | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 214 | Fluid Mechanics and Heat Transfer | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 215 | Elements of Materials Science | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 216 | Metallurgical Thermodynamics – I | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 217 P | Manufacturing Technology Lab | -- | -- | 3 | 3 | 50 | 50 | 100 | 2 |
| MT 218 P | Fuels Lab | -- | -- | 3 | 3 | 50 | 50 | 100 | 2 |
| TOTAL | | 29 | | | 24 | 280 | 520 | 800 | 28 |

II / IV Second semester

| Code No | Subject | Periods | | | Exam Hours | Sessionals Marks | Exam Marks | Total Marks | Credits |
|--------------|-------------------------------------|-----------|----|----|------------|------------------|------------|-------------|-----------|
| | | L | T | P | | | | | |
| ME 221 | Maths - IV | 3 | -- | -- | 3 | 30 | 70 | 100 | 4 |
| MT 222 | Electrical Technology | 3 | 2 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 223 | Environmental Studies | 3 | -- | -- | 3 | 30 | 70 | 100 | 4 |
| MT 224 | Metallurgical Thermodynamics –II | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 225 | Mineral Beneficiation | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 226 | Principles of Extractive Metallurgy | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 227 P | Electrical Technology Lab | -- | -- | 3 | 3 | 50 | 50 | 100 | 2 |
| MT 228 P | Mineral Beneficiation Lab | -- | -- | 3 | 3 | 50 | 50 | 100 | 2 |
| TOTAL | | 29 | | | 24 | 280 | 520 | 800 | 28 |

III / IV First semester

| Code No | Subject | Periods | | | Exam Hours | Sessionals Marks | Exam Marks | Total Marks | Credits |
|--------------|-------------------------------------|-----------|----|----|------------|------------------|------------|-------------|-----------|
| | | L | T | P | | | | | |
| ME 311 | Engg. Economics | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 312 | Testing of Materials -I | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 313 | Metallography and X-Ray Diffraction | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 314 | Physical Metallurgy | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 315 | Iron Making | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 316 | Metal Casting | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 317 P | Testing of Materials Lab | -- | -- | 3 | 3 | 50 | 50 | 100 | 2 |
| MT 318 P | Metallography Lab | -- | -- | 3 | 3 | 50 | 50 | 100 | 2 |
| MT 319 P | Soft Skills Lab | -- | -- | 3 | - | 100 | - | 100 | 1 |
| TOTAL | | 33 | | | 24 | 380 | 570 | 900 | 29 |

III / IV Second semester

| Code No | Subject | Periods | | | Exam Hours | Sessionals Marks | Exam Marks | Total Marks | Credits |
|--------------|--|-----------|----|----|------------|------------------|------------|-------------|-----------|
| | | L | T | P | | | | | |
| ME 321 | Industrial Engineering & Management | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 322 | Instrumentation | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 323 | Testing of Materials - II | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 324 | Advanced Material Science | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 325 | Steel Making | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 326 | Foundry Practices | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 327 P | NDT Lab | -- | -- | 3 | 3 | 50 | 50 | 100 | 2 |
| MT 328 P | Foundry Lab | -- | -- | 3 | 3 | 50 | 50 | 100 | 2 |
| | Industrial Training (During summer vacation) | | -- | | -- | --- | -- | --- | --- |
| TOTAL | | 30 | | | 24 | 280 | 520 | 800 | 28 |

IV / IV First semester

| Code No | Subject | Periods | | | Exam Hours | Sessionals Marks | Exam Marks | Total Marks | Credits |
|--------------|---|-----------|----|----|------------|------------------|------------|-------------|-----------|
| | | L | T | P | | | | | |
| MT 411 | Advances in Steel Making & Production of Ferro Alloys | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 412 | Metal Forming | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 413 | Metal Joining Processes | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 414 | Heat Treatment | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 415 | Non Ferrous Extractive Metallurgy | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 416 | Corrosion And Protection | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 417 P | Heat Treatment Lab | -- | -- | 3 | 3 | 50 | 50 | 100 | 2 |
| MT 418 P | Electro - Metallurgy Lab | -- | -- | 3 | 3 | 50 | 50 | 100 | 2 |
| MT 419 | Industrial Training | | -- | | -- | 100 | -- | 100 | 2 |
| TOTAL | | 30 | | | 24 | 380 | 520 | 900 | 30 |

IV / IV Second semester

| Code No | Subject | Periods | | | Exam Hours | Sessionals Marks | Exam Marks | Total Marks | Credits |
|--------------|--|-----------|----|----|------------|------------------|------------|-------------|-----------|
| | | L | T | P | | | | | |
| MT 421 | Welding Metallurgy | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 422 | Strengthening mechanisms and Engg. materials | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 423 | Elective* | 3 | 1 | -- | 3 | 30 | 70 | 100 | 4 |
| MT 424 P | Project Work (Dissertation) | -- | -- | 12 | -- | | 100 | 100 | 8 |
| TOTAL | | 24 | | | 9 | 90 | 310 | 400 | 20 |

* (Elective - Composite Materials / Nano Materials)

BE (METALLURGICAL ENGINEERING)

(SYLLABII for 2007-08 ADMITTED BATCH)

II YEAR – I SEMESTER

ME211 - MATHS -III

(Common with Mechanical Engineering)

Periods/week: **3L**

Credits: **4**

Sessionals: **30**

Exam: **70**

Vector calculus. Differentiation of vectors, curves in space, Velocity and acceleration, Relative velocity and acceleration, Scalar and Vector point functions – Vector operation del. Del applied to scalar point functions – Gradient, Del applied to vector point functions – Divergence and Curl. Physical interpretation of div F curl. F del applied twice to point functions, Del applied twice to point functions, Integration of vectors, Line integral- Circulation – Work surface integral – Flux, Green's theorem in the plane, Stoke's theorem, Orthogonal curvilinear co-ordinates Del applied to functions in orthogonal curvilinear co-ordinates, Cylindrical coordinates – spherical polar co-ordinates.

Partial differential equations. Formation of partial differential equations, Solutions of a partial differential equation, Equations Solvable by direct integration. Linear equations of the first order, Homogenous linear equations with constant coefficients, Rules for finding the complementary function, Rules for finding the particular integral, working procedure to solve homogenous linear equations of any order. Non-homogeneous linear equations.

Applications of Partial Differential equations. Introduction, Methods of separation of variables, partial differential equations of Engineering, Vibration of a stretched string-wave equation, One-dimensional heat flow, Two dimensional heat flow, Solution of Laplace's equation, Laplace's equation in polar co-ordinates.

Integral Transforms. Introduction, Definition, Fourier integrals-Fourier sine and cosine integrals-complex forms of Fourier integral, Fourier transform-Fourier sine and cosine transforms – finite Fourier sine and cosine transforms, Properties of F-transforms, Convolutions theorem for properties F-Transforms, Parseval's identity for F-transforms, Relation between Fourier and Laplace transforms, Fourier transforms of the derivatives of a function, Inverse Laplace transforms by method of residuals, Application of transforms to boundary value problems.

Text books: 1. Higher Engineering Mathematics, by B.S.Grewal, Khanna Publishers, New Delhi-110006. 34th Edition, 1998.

Reference:

- 1. A text book of Engineering Mathematics - NP Bali et al, Laxmi Publications(P) Limited, New Delhi-110002*
- 2. Higher Engineering Mathematics - Dr MK Venkataraman, National Pub. Co. Madras-1*
- 3. Advanced Mathematics for Engineering Students, Vol.2, Vol.3 - Narayan, Manicavachagaon Pillay and Ramanaiah.*
- 4. Advanced Engineering Mathematics - Erwin Kreyszig, Wiley Easter Pvt. Ltd., New Delhi-49*
- 5. Engineering Mathematics – PP Gupta, Krishna Prakasham, Media(P) Ltd, Meerut Vol-2.*
- 6. Advanced Engineering Mathematics – VP Jaggi and AB Mathur, Khanna Pub. New Delhi-6*
- 7. Engineering Mathematics – SS Sastry, Prentice Hall of India, Pvt. Ltd., New Delhi-1*
- 8. Advanced Engineering Mathematics – Prof HK Dass, S.Chand and Co. Ltd. New Delhi - 51.*

MT212 - FUELS AND REFRACTORIES

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Solid fuels. Classification. Proximate analysis & ultimate analysis of coal. Carbonization of coal. Coke making and by products recovery. Testing and properties of coal and coke. Liquid fuels. Classification. Theories of formation of petroleum. Petroleum refining. Distillation. Synthetic petrol. Bergius process. Fischer-Tropsch process. Coal tar fuels. Testing and properties. Gaseous fuels. Classification. Production of PG, WG, CWG, LD gas, Coke oven gas and BF gas. Industrial gasification processes. Lurgi, Winklers and Kopper Totzek processes. Properties and testing. Liquid and gaseous fuel burners. Combustion problems.

Refractories. Definition. Properties, classification and general description. Manufacture, properties and applications of Alumino-silicate, Silica, Dolomite, Magnesite, Chromite and Carbon refractories. Importance and study of SiC, ZrO₂ and cermets. Testing of refractories.

Text books:

1. *Fuels, furnaces and refractories by O.P.Gupta*

Reference:

1. *Fuels, Technology by Hinues*

2. *Fuels by Gilchrist*

3. *Refractories by Chesty*

MT213 - ENGINEERING MECHANICS & STRENGTH OF MATERIALS

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Concurrent forces in a plane and its equilibrium. Centroids of composite plane figures. General case of 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 to displacement and free vibrations (SHM). D'Albert's principle. 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 stress and 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)*

3. *Engineering Mechanics – S.Timoshenko (relevant sections only)*

4. *Elements of Strength of Materials- S.Thimoshanko (relevant sections only)*

MT214 - FLUID MECHANICS AND HEAT TRANSFER

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Classification of flows – Steady, Unsteady, Uniform, Non-uniform, Laminar, Turbulent, Rotational, Irrotational flows, Vorticity, and circulation - 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 Couette 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 π - 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 book:

1. *Fluid Mechanics*, A.K.Mohanty, Prentice Hall of India Pvt. Ltd.
2. *Fuels, furnaces and refractories* by O.P.Gupta

Reference:

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.

MT215 - ELEMENTS OF MATERIALS SCIENCE

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Introduction, classification of materials, Space lattice and unit cells, crystal systems. Indices for planes and directions. Structures of common metallic materials.

Crystal defects: point, Line and surface defects. Dislocations, types, Burgers' Vector, Dislocation movement by climb and cross slip. Dislocation sources, Dislocation point - defect interaction and pileups.

Plastic deformation of single crystals. Deformation by slip, CRSS for slip. Deformation of single crystal. Deformation by twinning. Stacking faults.

Hot working, cold working. Recovery, recrystallization and grain growth. Hall-Petch equation.

Tensile stress-strain diagrams, proof stress, yield stress, modulus of elasticity. Typical stress-strain diagrams for mild steel cast iron and aluminum alloy.

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.Van Vleck, 5th edition, Addison Wealey(1985)
2. *Structure and properties of Materials* by R.M.Rose, L.A.Shepard and J.Wulff, Vol.1,4 John 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).

MT 216 METALLURGICAL THERMODYNAMICS – I

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

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

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

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

Phase Equilibria in One Component Systems , Clausius - Claperyon Equation, Heats of Vaporization from Vapor Pressure Data, Shift in Transformation Temperature with Pressure. Fugacity, activity and equilibrium constant. Vant Hoff's isotherm. Ellingham diagrams and application.

Text books:

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

Reference:

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*

MT217 P - MANUFACTURING TECHNOLOGY LABORATORY

Periods/week: **3P**

Credits: **2**

Sessionals: **50**

Exam: **50**

Use of basic tools and operations of the following trades.

| S.No. | Trade | Number of jobs |
|-------|-----------|--------------------------|
| 1 | Foundry | 4 |
| 2 | Welding | 4 |
| 3 | Machining | Step and taper turning-2 |

MT 218 P: FUELS LABORATORY

Periods/week: **3P**

Credits: **2**

Sessionals: **50**

Exam: **50**

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. 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.

II YEAR - II SEMESTER

ME221(A) - MATHS - IV

(Common for Mech., M.P.I., Metallurgy, Mech.Marine and Naval Architecture)

Periods/week: **3L**

Credits: **4**

Sessionals: **30**

Exam: **70**

Functions of a complex variable. Introduction $f(z)$ its limit and continuity. Derivative of $f(z)$ – Cauchy-Riemann equations, Analytic functions, Harmonic functions. Orthogonal system, Applications to flow problems, Integration of complex functions, Cauchy's inequality, Liouville's theorem, Poisson's integral formulae series of complex terms- Taylor's series – Laurent's series, singular points-Residues, Residue theorem, Calculation of residues, Evaluation of real definite integrals, Geometrical representations, Special conformal transformations.

Statistical Methods. Probability. Addition law of probability, Independent events, Multiplication law of probability distribution, Continuous probability distribution, Expectation, Moment generating function, repeated trials, Binomial distribution, Poisson distribution, Normal distribution, Probable error, Normal approximation to Binomial distribution, Some other distributions, sampling, sampling distribution, standard error, Testing of hypothesis, Level of significance, Confidence limits, simple sampling of attributes, Sampling of variables- Large samples, Sampling of variables- Small samples, Student's t -distribution, χ^2 -distribution, F-distribution, Fisher's Z -distribution.

Difference equations and Z-Transforms. Z-transform- Definition, Some standard Z- transforms, Linear property, Damping rule, Some standard results, Shifting rules, Initial and final value theorems Convolution theorem, Evaluation of inverse transforms, Definition, order and solution of a difference equation, Formation of difference equations, Linear difference equations, Rule for finding C.F., Rules for finding P.I., Difference equations reducible to linear form, Simultaneous difference equations with constant coefficients, Application to deflection of a loaded string, Application of Z-transform to difference equations.

Text book:

1. *Higher Engineering Mathematics*, by Dr.B.S.Grewal, Khanna publishers, New Delhi-110 006, 34th edition, 1998.

Reference:

1. *A text book of Engineering Mathematics* by N.P.Balieta, Laxmi publications(p) limited, New Delhi-110 002.
2. *Higher Engineering Mathematics*, by Dr.M.K.Venkataraman, National Pub. Co., Madras-1
3. *Advanced Mathematics for Engineering students, Vol.2 and Vol.3* by Narayanan, Manica- vachagaon Pillay and Ramanaiah
4. *Advanced Engineering Mathematics*, by Erwin Kreyszig, Wiley Eastern Pvt.Ltd. New Delhi-49.
5. *Engineering Mathematics* by P.P.Gupta, Krishna Prakasham Media (P) Limited Meerut Vol.2
6. *Advanced Engineering Mathematics* by V.P.Jaggi and A.B.Mathur Khanna Pub. New Delhi-6.
7. *Engineering Mathematics* by S.S.Sastry, Prentice Hall of India, Pvt.Ltd., New Delhi-1
8. *Advanced Engineering Mathematics* by Prof.H.K.Dass, S.Chand and Co. Ltd, New Delhi-51
9. *Engineering Mathematics Vol.2* by Tarit Majumdar, New Central Book Agency (P) Ltd., Calcutta-9

MT222 - ELECTRICAL TECHNOLOGY
(Common for Mech, and M.P.I. & Metallurgy)

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

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 efficiency, 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. Impedance method. (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, Potentiometer 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

MT223 - ENVIRONMENTAL STUDIES

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Introduction to Environmental Studies – Importance – Types of Ecosystems – Lake-River-Marine-Forest-Desert-Bio-Diversity.

Resources Natural – Water- Mineral-Food- Forest – Energy-Land-Use and Exploitation-Environmental Degradation- Remedial measures.

Environmental Pollution causes, Effects, standards and control (A) Air pollution ; (b) Water Pollution; (c) Soil pollution; (d) Marine pollution; (e) Noise pollution

Legal aspects of pollution, Air (Prevention and control of pollution) Act, Water (Prevention and control of pollution) Act, Environmental Protection 1980 Act., Forest Conservation Act.

Role of People to protect environment-Rolle of NGOS, (a) Global issues (b) Green House Effect (c) Global Warming (d) Nuclear accidents

Local issues causes and action, Air pollution due to industries, Automobiles, Public interest Litigation case studies-Success stores, Leather industries, Taaj * Mathura Refinery, Silent Valley

Text Books

- (A) Introduction to Environmental sciences – Turk & Turk and Witties
- (B) Environmental Sciences – P.D.Sarma

MT224 - METALLURGICAL THERMODYNAMICS – II

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

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.

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

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.

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

Kinetics of Metallurgical reactions. Collision theory. 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:

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.*

MT225 - MINERAL BENEFICIATION

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

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.

Laboratory sizing units. Screening. Ellutriation. 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.

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.

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.

Text books:

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

References;

1. *Mineral Processing Technology, S.K.Jain*

2. *Unit operation in Chemical Engineering.*

MT226 - PRINCIPLES OF EXTRACTIVE METALLURGY

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

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

Non-ferrous mineral wealth of India. Primary and secondary metal winning. General Methods of Extraction. Pyro-metallurgy. Roasting. Types of roasting. Roasting equipment and methods. Predominance area diagrams. Smelting. Smelting furnaces. Principles of refining. Use of vacuum. Zone refining. Vacuum arc re-melting. Electron beam melting. Electro slag refining. Hydro Metallurgy. Advantages and disadvantages. Principles of leaching. Leaching kinetics and factors affecting. Electro Metallurgy. Classification of process. Cementation. Electro refining, Electro deposition.

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*

References:

1. *MSTS-United Steel Corporation, Pittsburgh*

2. *Blast furnace theory & practice- Vol.I & II, Julius JH.Strybsugen*

3. *Metallurgy of Non-Ferrous Metals, Dennis, W.H.*

4. *Non-Ferrous Metallurgy, Sebyukov, N.Min, Pub. Moscow*

MT227 P - ELECTRICAL TECHNOLOGY LAB

Periods/week: **3P**

Credits: **2**

Sessionals: **50**

Exam: **50**

List of experiments:

1. Study on Calibration of Ammeter.
2. -do- Voltmeter
3. -do- Watt Meter
4. -do- Energy Meter
5. Measurement of low resistance (armature)
6. -do- medium resistance (field)
7. -do- insulation resistance
8. -do- filament resistance
9. Verification of KCL and KLV
10. Superposition theorem.
11. Parameters of choke oil
12. OC and SC tests on transformer
13. OC and load test D.C. shunt machine
14. OC and Load test on D.C. separately excited machine
15. Swinburnes test
16. 3 Phase induction motor(No load and rotor block tests) load test
17. Alternator regulation by syn. Impedance method

MT228 P - MINERAL BENEFICIATION LAB

Periods/week: **3P**

Credits: **2**

Sessionals: **50**

Exam: **50**

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.

III YEAR - I SEMESTER

ME311 - ENGINEERING ECONOMICS

(Common for Mech., M.P.I., Metallurgy, Mech. Marine and Naval Architecture)

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Utility, value, wealth, consumption, wants- necessities, comforts and luxuries. Laws of demand, elasticity of demand. Production, agents of production, laws of returns. Forms of business organization. Single trader, partnership and public limited company. Price determination of perfect competition, Monopoly and imperfect competition. Rent, interest, money, cheques, bills of exchange. Costing-cost concepts, Elements of cost, Methods of distribution of overhead costs. Unit costing, Job costing and process costing. Break-Even analysis, Depreciation methods, preparation of profit & loss account and balance sheet (outlines only).

Text books:

1. *Engineering Economics, Vol.1, Tara Chand*

Reference:

1. *A text book of Economic Theory, Dhingra and Gag.*

2. *Cost accounts by Shukla and Grewal.*

MT312 - TESTING OF MATERIALS - I

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Introduction. Importance of testing in quality control, Tension test. Engineering stress strain curve. True stress and true strain diagram. Instability in tension. Ductility measurements. Effect of temperature on strain rate, Typical stress strain diagrams. Yield point phenomenon, strain ageing, Bauschinger effect, Compression test. Fundamentals of testing. Applications. Behavior of materials in compression.

Hardness test. Introduction. Brinell, Meyer, Vickers and Rockwell hardness. Rockwell superficial hardness. Micro hardness. Poldi and shore sclero scope hardness. Relation between hardness and tensile strength. Hardness conversion. Hardness at elevated temperatures.

Fracture. Introduction. Types of fracture in metals. Theoretical cohesive strength of metals. Griffith theory of brittle fracture. Metallographic aspects of fracture. Fractography, Fracture at low temperature.

Brittle fracture and impact testing: The problems of brittle fracture. Notched bar impact tests. Significance of Transition temperature. Metallurgical factors affecting transition temperature. Plane strain fracture Toughness (K_{IC}), methods of determination.

Text books:

1. *Mechanical Metallurgy, George E.Dieter, Mc Grawhill*

2. *Testing of materials, A.V.K. Suryanarayana, Prentice hall of India.*

References:

1. *Testing of Engineering Materials, Donald et.al., McGraw Hill*

2. *Metals hand book*

MT313 - METALLOGRAPHY AND X-RAY DIFFRACTION

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Metallography- Macro and Micro examination of examination of metals and alloys, principles of construction of optical and electron microscopes. Resolution and magnification. Optical aberrations and correction for image quality. Specimen preparation, technique for transmission electron microscopy.

Production and properties of X-rays, Electromagnetic radiation, continuous and characteristics spectrum, absorption. Fillers. Diffraction. Bragg's law, scattering by atom, electron, unit cell, structure factor calculation.

Diffraction Methods: Laue's method, rotating crystal, Debye scherrer – Specimen preparation, film loading, powder method, Determination of crystal structure, determination of precision lattice parameter, sources of error in measurements.

Applications – Effect of plastic deformation. Determination of particle size, grain size, residual stresses, determination of phase diagrams, order-disorder transformation.

Chemical Analysis by X-ray techniques, X-ray fluorescence. X-ray spectro meters, qualitative and quantitative analysis, micro analysis of metals and alloys, LDX, WDX.

Text books:

1. *X-ray diffraction – B.D.Cullity*

2. *Transmission Electro Microscopy-G.Thomas.*

MT314 - PHYSICAL METALLURGY

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Solidification. Solidification of pure metals, alloys and eutectic. 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.

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

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

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*

MT315 - IRON MAKING

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Properties and testing of raw materials: Room temperature and high temperature physical properties, Reducibility tests, factors affecting reducibility. Blast furnace and accessories: Description of modern blast furnace. Design of blast furnace stoves, Blast furnace refractories, Blast furnace cooling system, Gas cleaning system. Charging system, Distribution of burden in blast furnace, Blast furnace instruments.

Physical chemistry: Blast furnace physical structure, blast furnace reactions, Distribution of elements in molten metal and slag. Internal and External desulphurization, Constitution of blast furnace slag's, properties and uses. Acid burdening and Basic burdening, Blast furnace operation, irregularities and corrections. Modern developments in blast furnace practice and methods of increasing production.

Alternate routes of pig iron production: COREX process, Electric arc furnace process, Low shaft furnace, Mini Blast Furnace process, Char coal furnace process. Production of sponge iron: Principles and classification of sponge iron processes, HYL process, Midrex process, Kiln process SL/RN process. Uses of sponge iron. Production of wrought iron.

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 ,Julius JH.Strybsugen*

MT316 - METAL CASTING

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Introduction. Status of foundry industry and comparison with other manufacturing processes. Types of foundries. Basic operations. Patterns. Pattern making. Materials for pattern making. Types of patterns . Pattern allowance. Core boxes. Moulding materials. Properties. Preparation and testing.

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

Solidification – Crystallization and development of cast structure. Directional solidification and single crystal growth. Foundry characteristics. Principles of gating and risering. Casting design considerations.

Text books:

1. *Principles of Metal Casting, Heine, Loper and Rosenthal, Tata Mc Grawhill*
2. *Foundry Technology, P.C.Jain, Tata Mc Grawhill*
3. *Foundry Technology, P.R.Beeely, London-Buterworths.*

MT317 P - TESTING OF MATERIALS LABORATORY

Periods/week: **3P** Credits: **2** Sessionals: **50** Exam: **50**

List of Experiments:

1. Ericsen Cupping Test
2. Tensile & Bend Testing
3. Coating thickness
4. Shore scleroscope hardness test
5. Testing of a welded joint
6. Poldi Testing
7. Cold working & annealing
8. Fatigue testing
9. Impact testing

MT318 P: METALLOGRAPHY LABORATORY

Periods/week: **3P** Credits: **2** Sessionals: **50** Exam: **50**

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

MT319 – SOFT SKILLS LAB

Periods/week: **3P** Credits: **1** Sessionals: **100**

1. Basic skills, Listening, Speaking, Reading, Writing
2. Non-Verbal, Grooming (Personnel Appearance), Using Space, Body Language, Paralanguage
3. Basic Etiquette, Introducing, Conversation-Small talks, Table Manners, Telephone / Cell phone manners
4. Goal Setting, Immediate, short term, long term, Smart Goals, Strategies to achieve goals
5. Time-Management, Types of time, Identifying time wasters, Time Management Skills
6. Using Telephone, Making and receiving calls, Handling wrong numbers and unnecessary calls, Intonation, Enunciation
7. Leadership and Team Management, Qualities of good leader, Leadership styles, Decision Making, Problem solving, Negotiation skills
8. Assertiveness, Assertiveness and aggressiveness, Disagreement, Openness and Expressiveness, Self Concept, Positive thinking
9. Group Discussion, Purpose (intellectual ability, Creativity, Approach to a problem, solving, Tolerance, Qualities of a leader), Group behaviour, Analysing Performance
10. Job Interview, Identifying Job Openings, Preparing a Resume (Basic, Functional, specific), Covering letter (solicited / unsolicited), Interview (Opening, Body-Answer Q, Close-Ask Q), Types of questions, Handling difficult questions

Reference Books

1. '*Technical Communication' Principles & practice* by Meenaskshi Raman and Sangeetha Sharma, Oxford University Press.
2. '*Development Communication Skills*' by Krishna Mohan & Meera Banerji, Macmillian Publishers.
3. '*Technical Writing' Process and Product* by Sharon J.Gerson & Steven M.Gerson, Pearson Education Publishers
4. '*Technical Communication skills*' by Rizvi, Tata McGraw Hill Publications
5. '*The Oxford Guide to Writing and Speaking*' by John Seely, Oxford University Press

III YEAR II SEMESTER

ME 321 - INDUSTRIAL ENGINEERING & MANAGEMENT

(Common for Mech., M.P.I., Metallurgy & Mech. Marine)

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Concepts of Industrial Management. Principles of management – Growth of management thought functions of management, principles of organization, types of organization and committees.

Introduction to personnel management. Functions. Motivation. Theories of motivation. Hawthorne studies, Discipline in industry, Promotions, Transfer lay off and discharge, Labour turnover.

Industrial relations. Trade unions. Industrial disputes, Strikes, Lockout, Picketing, Gherao, Settlement of industrial disputes, Collective bargaining, Industrial Dispute Act 1947 and Factories Act 1948.

Production planning and control. Types of productions, Production cycle, product design and development, Process planning, forecasting, loading, scheduling, dispatching, routing, progress, control, simple problems.

Plant layout. Economics of plant location, Rural Vs Suburban sites, types of layouts, types of building, travel chart technique. Assembly line balancing simple problems.

Materials handling principles, concept of unit load, containerization, pelletisation, selection of material handling equipment, Applications of belt conveyors, cranes, Forklift trucks in industry. Plant Maintenance. Objective and types. Work-study of productivity (simple problems)

Method study. Basic steps in method study. Process chart symbols. Charts, Diagrams and models used, Principles of motion economy, Therbligs, Simo chart. Work measurement- Stop watch procedure of time study, Performance rating and allowances, work sampling, Simple problems.

Materials Management. Introduction, Purchasing, Objectives of purchasing department, Buying techniques, Purchase procedure, Stores and material control, Receipt and issue of materials, Store records.

Quality control-Single and double sampling plans. Control charts of variables and attributes (use of formulae only).

Text book:

1. *Industrial Engineering Management, Dr.O.P.Khanna*

References:

1. *Principles of Management, Koontz & Donnel.*
2. *Production and Operations Management, Everette Adam & Ronald Ebert*
3. *Operations Management, John McClain & Joseph Thames.*

MT322 - INSTRUMENTATION

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

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, photo conductive 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*

MT 323 – TESTING OF MATERIALS - II

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Fatigue. Introduction. Stress cycles. The S-N diagram. Effect of mean stress. Structural features of fatigue . Fatigue crack propagation. Effect of stress concentration. Size effect. Surface effect. Corrosion fatigue. PARIS equation.

Creep and stress rupture. High temperature materials problem. Time dependent mechanical behavior. The creep curve. Stress rupture test. Structural changes during creep. Mechanism of creep deformation. Fracture at elevated temperatures. High temperature alloys. Presentation of engineering creep data, prediction of long time properties.

Introduction, role of NDT in product cycle, sources of defects during process of casting, forming, welding. Advantages, Limitations and Types of NDT methods.

Liquid penetrant Testing: Principles, Testing methods, Testing systems, Penetrant process flow chart, Advantages and limitations.

Magnetic particle testing: Magnetic theory, magnetic materials, principles of magnetic particle testing, surface preparation, post cleaning, types of magnetization, magnetizing currents, methods of demagnetization, different techniques and methods, interpretation and evaluation, advantages and limitations.

Radiography: Principle, Equipment, Process details, Filters and Screens, Radiographic sensitivity measurement, Exposure calculation, Processing of exposed films, Interpretation of radiographs, safety aspects of industrial radiography.

Ultrasonic Testing: Ultrasonic energy and modes of vibration, attenuation, acoustic impedance, generation of ultrasonic waves, search units and their construction, characteristics, test methods and procedures, ultrasonic equipment and systems, types of blocks and applications.

Eddy current Testing: Basic principle, characteristics of eddy currents, Methods of eddy current testing, applications, advantages and limitations.

Text books:

1. *Metals Handbook, Vol. XI, 8th Edition ASM, 1980.*
2. *J. Krautkramer and H. Krautkramer, Ultrasonic Testing of Material, Springer Verlag, 1983.*
3. *R.C. McMaster, Ed., Non-Destructive Testing Handbook, Vol.I and Vol.II Ronald Press, N.Y., 1959.*
4. *J.F. Hinsley, Non-Destructive Testing, MacDonald and Evans, London.*

MT324 - ADVANCED MATERIAL SCIENCE

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Electrical and Electronic properties of materials, Electronic conductivity, free electron theory and band theory of solids. Intrinsic semi-conductors. Super conductivity. Magnetic properties, Dia, para, ferro, ferri magnetism. Soft and hard magnetic materials and applications. Optical properties of materials. Refractive index, absorption emission of light, optical fibers. Opto-electronic materials.

Polymerization, cross linking, glass transition, classification of polymers. Mechanical properties, dielectric behaviour of materials. Uses of polymers. Ceramics and glasses, crystalline and non-crystalline ceramics. Structure of ceramics and glasses. Major mechanical and optical properties.

Composite materials. Classification. Matrices and reinforcements. Fabrication methods. Examples and applications. Nano Materials: Importance, Emergence of Nano-Technology, Bottom-Up and Top-down approaches, challenges in Nano-Technology. Applications.

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.Van Vleck, 5th edition, Addison Wealey(1985)
2. *Structure and properties of Materials* by R.M.Rose, L.A.Shepard and J.Wulff, Vol.1,4 John 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).

MT325 - STEEL MAKING

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

History Of Steel Making: Cementation and crucible processes.

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

Pneumatic Steel Making Process: Construction, lining of various parts of the converter, Acid and basic Bessemer process, Side blown converter.

Open Hearth Process: Construction, lining of various parts of OHF, fuel and Raw materials, operation and chemistry of the process. Developments in OHP: AJAX, TANDEM, Tilting and twin hearth process.

BOF PROCESS: Developments in converter steel making process: LD, LD-AC, LAM process, OG process, Kaldo, Rotor and OBM.

Electric Furnace Process: Various electric processes, their advantages and limitations. Brief EAF process, construction, lining and operation. Brief outline of manufacture of alloy steels.

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

MT326 - FOUNDRY PRACTICES

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

General principles of melting Cupola and its operation. Modern developments in cupola. Melting practice of Al, Cu and Mg alloys. Defects in castings. Fettling. Inspection and quality control. Metallurgy of cast irons. Foundry practices of white cast iron gray cast iron, S.G. and malleable iron. Alloy cast iron. Steel foundry practice. Modernization and mechanization of foundries

Text books:

1. *Principles of Metal Casting, Heine, Loper and Rosenthal, Tata Mc Grawhill*
2. *Foundry Technology, P.C.Jain, Tata Mc Grawhill*
3. *Foundry Technology, P.R.Beeely, London-Buterworths.*

MT327 P - NDT LAB

Periods/week: **3P**

Credits: **2**

Sessionals: **50**

Exam: **50**

List of Experiments

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

MT 328 P: FOUNDRY LAB

Periods/week: **3P**

Credits: **2**

Sessionals: **50**

Exam: **50**

List of Experiments

1. Determination of AFS grain fineness number.
2. Determination of AFS clay content.
3. Determination of permeability of moulding sands.
4. Determination of GCS, GSS & DCS & DSS of moulding sands.
5. Determination of flowability and compatibility of moulding sands.
6. Determination of moisture content.
7. Determination of shatter index.
8. Study on the combined effect of Bentonite and moisture on green properties of moulding sands.
9. Study on melting practice and casting of simple shapes in Al.
10. Study on casting defects of aluminum casting.
11. Study on the effect of additives on properties of moulding sand.

IV YEAR - I SEMESTER

MT411 - ADVANCES IN STEEL MAKING & PRODUCTION OF FERRO ALLOYS

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Hybrid Steel making processes, SIP and EOF process.

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

Gases in steel, vacuum treatment of liquid steel.

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

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.*

MT412 - METAL FORMING

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

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

Forging classification. Forging equipment. Open die and closed die forging. Calculation of forging loads in closed die forging. Forging defects. Rolling classification. Rolling mills and accessories. Hot and cold rolling. Elements of roll pass design. Rolling of bars and shapes. Forces and geometric relationships in rolling. Rolling variables . Problems and defects in rolled products. Torque and Horse power.

Extrusion .Classification. Extrusion equipment . Hot extrusion. Deformation, lubrication and defects in extrusion. Hydrostatic extrusion. Extrusion of tubing. Miscellaneous working operations . Drawing of rods wires and tubes.. Sheet metal forming.

Powder Metallurgy. Methods of production of metal powders. Particle size analysis. Characterization of metal powders. Compacting, sintering and their mechanisms. Industrial applications.

References:

1. *Mechanical Metallurgy by G.E. Dieter McGraw Hill Book Co.,*
2. *Introduction to Physical Metallurgy by S.H.Anver, McGraw Hill*
3. *Powder Metallurgy-A.K.Sinha*

MT413 - METAL JOINING PROCESSES

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Introduction. Importance and classification. Basic concepts in arc welding and gas welding. General theory of arc welding. Principle, operation and application of shielded metal arc welding. Tungsten inert gas, plasma arc, studs, submerged arc, metal inert gas and CO₂ welding processes. Electro-slag welding.

Resistance welding processes. Spot, seam, flash butt, upset butt, Thermit welding. Electron beam and laser beam welding. Solid state welding processes. Diffusion bonding, ultrasonic. Explosive inertia/friction welding. Soldering and brazing.

Text books:

1. *Welding and Welding Technology, R.L.Little*
2. *Welding Technology, N.K.Srinivasan*

MT414 - HEAT TREATMENT

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

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.

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

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

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

Text books:

1. *Heat treatment, Rajan*
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*

MT415 - NON FERROUS EXTRACTIVE METALLURGY

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

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. Magnesium. Uses. Ores. Pidgeon's process. Extraction by Dows process. Tin: Uses. Ores. Concentration, smelting and refining.

Copper. Uses. Pyro-metallurgical processes. New processes. Flash smelting. WORCA and Noranda processes. Hydro-metallurgy of copper. Copper production in India. Nickel: Brief description of Ni extraction from sulphide ores. Lead. Uses. Ores. Treatment of ore and production of metal. Zinc. Uses. Pyro-metallurgical and hydro-metallurgical extraction methods. Imperial smelting process.

Uranium. Extraction of Uranium. Production flow sheet of Jaduguda ore. Brief outlines of extraction of Pu and Th. Titanium. zirconium.

Zirconium production in India. Production of Titanium chloride from Ilmenite. Production of Ti sponge.

Brief production flow sheets of extraction of Gold and Silver.

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

Text books:

1. *Extraction of Non-Ferrous Metals, H.S.Ray, R.Sridhar and K.P.Abraham*

References:

1. *Metallurgy of Non-Ferrous Metals, Dennis, W.H.*

2. *Non-Ferrous Metallurgy, Sebyukov, N.Min, Pub. Moscow*

MT416 - CORROSION & PROTECTION

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Corrosion – Electrochemical aspects of Corrosion. Corrosion cells/Electro chemical cells, Concentration cells, Temperature cells. Determination of Electrode potential. Thermodynamic aspects - Nernst equation, Helmholtz equation. Galvanic series. Polarization resistance, Linear polarization technique for evaluation of I_{corr} .

Corrosion – Practical aspects. Importance. Direct and indirect losses. Types and Forms of Corrosion. Uniform Corrosion, Pitting Corrosion, Galvanic Corrosion, and Intergranular Corrosion, Stress Corrosion cracking. Cavitation Erosion, Erosion Corrosion. Corrosion Fatigue. Differential aeration corrosion. Corrosion rate expressions. Testing methods. Effect of velocity, flow-rate, concentration, temperature and inhibitors on corrosion rates. Corrosion rate calculations.

Electroplating, Principles – Throwing power and its evaluation. Commercial plating of Cu, Ni, Cr, Zn. Commercial anodizing process. Cathodic and Anodic protection.

Text books:

1. *An introduction to Electrometallurgy, Sharan and Narain, Standard Publishers*

2. *Corrosion Engineering, MG Fountana, Mc-Graw Hill book company*

3. *Electro Beam Analysis of Materials, Loretto.*

MT417 P - HEAT TREATMENT LAB

Periods/week: **3P**

Credits: **2**

Sessionals: **50**

Exam: **50**

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

MT418 P - ELECTRO METALLURGY LAB

Periods/week: **3P**

Credits: **2**

Sessionals: **50**

Exam: **50**

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.

MT419 - INDUSTRIAL TRAINING

Credits: **2**

Exam: **100**

The students of Metallurgical Engineering are required to undergo 4 weeks of training during the summer vacation and submit a report. Evaluation is based on the report and an oral test.

IV YEAR II SEMESTER

MT421 - WELDING METALLURGY

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Heat flow and temperature distribution in and around weld metal. Calculation of heat input and heat affected zone width. Metallurgical considerations in welding. Structure property changes.

Problems during welding of carbon steels, cast irons, Heat treatment of weldments. Welding of Stainless steels. Schaffler diagram.

Welding of Aluminum alloys and Cu-base alloys. Welding of Titanium alloys and Nickel base alloys. Welding of Dissimilar metals.

Corrosion of welds. Weld defects. Testing, inspection and quality control welds. Weldability and its testing.

Text Books:

1. *Welding Engineering and technology, RS Parmar*
2. *Modern welding Technology, Howard.B.cary.*

MT422 - STRENGTHENING MECHANISMS AND ENGINEERING MATERIALS

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Introduction to strengthening of crystalline materials, Grain boundaries and deformation, Grain boundary strengthening, Yield point phenomenon, Strain aging, Solid solution strengthening. Strain hardening.

Strengthening from fine particles, Precipitation hardening. Basic requirements. Effects of time and temperature on ageing. Mechanisms of precipitation hardening. Dispersion hardening. Fiber strengthening..

Heat treatment of plain carbon , alloy and tool steels. HSLA, dual phase, alloy, high speed , stainless, hadfield manganese, maraging steels and super alloys, dies, springs, cast irons. Non-ferrous metals and alloys. Brasses , bronzes. Duraluminium , Al-Li alloys, Al bronzes, Be bronzes, Monels, Bearing materials, Titanium alloys and super alloys. Types, properties, microstructure and applications.

Text Books:

1. *Mechanical Metallurgy, G.E.Dieter*
2. *Physical Metallurgy , Vijendra Singh*

MT423 - COMPOSITE MATERIALS

(Elective – I)

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

Introduction. Particle reinforced composites. Large particle composites. Dispersion strengthened composites. Fibre reinforced composites. Influence of fibre length. Influence of fibre orientation and concentration. Fibre phase. Matrix phase. Interface. Polymer matrix composites. Ceramic matrix composites. Metal matrix composites. Carbon-carbon composites. Hybrid composites. Structural composites. Laminar composites. Sandwich panels.

Text Books:

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

References:

1. *Material Science and Engineering* by L.H.Van Vleck, 5th edition, Addison Wealey(1985)
2. *Structure and properties of Materials* by R.M.Rose, L.A.Shepard and J.Wulff, Vol.1,4 John 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).

MT423 - NANOMATERIALS

(Elective – II)

Periods/week: **3L -1T**

Credits: **4**

Sessionals: **30**

Exam: **70**

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

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

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

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

Applications of Nano materials.

Text Books:

Nanostructures and Nanomaterials: Synthesis, properties and applications
Guozhong Cao – Imperial College Press.

MT 424P: PROJECT WORK

Periods/week: **12**

Credits: **8**

Exam: **100**

The student has to submit a comprehensive Design/Experimental project report on a selected topic.