# BE (Metallurgical Engineering)
## WEF 2007-08 BATCH

### II / IV First semester

<table>
<thead>
<tr>
<th>Code No</th>
<th>Subject</th>
<th>Periods</th>
<th>Exam Hours</th>
<th>Sessionals Marks</th>
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<th>Credits</th>
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<tbody>
<tr>
<td>ME 211</td>
<td>Maths - III</td>
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<tr>
<td>MT 212</td>
<td>Fuels and Refractories</td>
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<td>MT 213</td>
<td>Engineering Mechanics &amp; Strength of Materials</td>
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<td>MT 214</td>
<td>Fluid Mechanics and Heat Transfer</td>
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<td>MT 215</td>
<td>Elements of Materials Science</td>
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<td>Metallurgical Thermodynamics – I</td>
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<td>MT 217 P</td>
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<td><strong>24</strong></td>
<td><strong>280</strong></td>
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### II / IV Second semester

<table>
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<th>Code No</th>
<th>Subject</th>
<th>Periods</th>
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<td>MT 223</td>
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<td><strong>520</strong></td>
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### III / IV First semester

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<td>Testing of Materials -I</td>
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<td>Metallography and X-Ray Diffraction</td>
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<td>Iron Making</td>
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**III / IV Second semester**

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<td>Industrial Training (During summer vacation)</td>
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<td>24</td>
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**IV / IV First semester**

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<tr>
<th>Code No</th>
<th>Subject</th>
<th>Periods</th>
<th>Exam Hours</th>
<th>Sessionals Marks</th>
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<td>Advances in Steel Making &amp; Production of Ferro Alloys</td>
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**IV / IV Second semester**

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<th>Code No</th>
<th>Subject</th>
<th>Periods</th>
<th>Exam Hours</th>
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*(Elective - Composite Materials / Nano Materials)
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 \( \nabla \cdot F \) curl \( \nabla \times F \) 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.


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


Reference:
MT212 - FUELS AND REFRACTORIES

Periods/week: 3L - 1T Credits: 4 Sessionals: 30 Exam: 70

of PG, WG, CWG, LD gas, Coke oven gas and BF gas. Industrial gasification processes. Lurgi, Winklers and

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.
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

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


Text book:
2. Fuels, furnaces and refractories by O.P.Gupta

Reference:

MT215 - ELEMENTS OF MATERIALS SCIENCE

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.


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


Text books:
1. Material Science and Engineering by V.Raghavan

Reference books:


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


Text books:
1. Introduction to Metallurgical Thermodynamics, David R. Gaskell.

Reference:
1. Chemical Metallurgy, J.J.Moore
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.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Trade</th>
<th>Number of jobs</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Foundry</td>
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</tr>
<tr>
<td>2</td>
<td>Welding</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Machining</td>
<td>Step and taper turning-2</td>
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</table>

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.
Functions of a complex variable. Introduction f(z) its limit and continuity. Derivative of f(z) – Cauchy-Rieman equations, Analytic functions, Harmonic functions. Orthogonal system, Applications to flow problems, Integration of complex functions, Cauchy’s inequality, Lioville’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 Binominal 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 l-distribution, $x^2$-distribution, F-distribution, Fisher’s Z-distribution.


Text book:

Reference:
3. Advanced Mathematics for Engineering students, Vol.2 and Vol.3 by Narayanan,Manica- vachagaon Pillay and Ramanalah
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)


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)


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**


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


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**


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


Text books:
1. Introduction to Metallurgical Thermodynamics, David R. Gaskell.

Reference:
1. Chemical Metallurgy, J.J.Moore
3. Metallurgical Thermodynamics, ML Kapoor Part I & II
MT225 - MINERAL BENEFICIATION

Periods/week: **3L - 1T**  
Credits: **4**  
Sessionals: **30**  
Exam: **70**


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:

References:
1. *Mining 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**


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
MT227 P - ELECTRICAL TECHNOLOGY LAB

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

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.
III YEAR - I SEMESTER

ME311 - ENGINEERING ECONOMICS

Periods/week: 3L - 1T  Credits: 4  Sessionals: 30  Exam: 70


Text books:
1. Engineering Economics, Vol.1, Tara Chand

Reference:
2. Cost accounts by Shukla and Grewal.

MT312 - TESTING OF MATERIALS - I

Periods/week: 3L - 1T  Credits: 4  Sessionals: 30  Exam: 70


Text books:
1. Mechanical Metallurgy, George E.Dieter, Mc Grawhill

References:
2. Metals hand book
MT313 - METALLOGRAPHY AND X-RAY DIFFRACTION

Periods/week: **3L -1T**  
Credits: **4**  
Sessionals: **30**  
Exam: **70**


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 specto meters, qualitative and quantitative analysis, micro analysis of metals and alloys, LDX, WDX.

*Text books:*
1. *X-ray diffraction* – B.D.Cullity

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.


*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.


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

MT316 - METAL CASTING

Periods/week: 3L - 1T  
Credits: 4  
Sessionals: 30  
Exam: 70


Text books:
1. Principles of Metal Casting, Heine, Loper and Rosenthal, Tata Mc Grawhill
2. Foundry Technology, P.C.Jain, Tata Mc Grawhill
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 seleroscope 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, Conversion-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.
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

Periods/week: **3L - 1T**  
Credits: **4**  
Sessionals: **30**  
Exam: **70**


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)


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:
2. *Production and Operations Management, Everette Adam & Ronald Ebert*
MT322 - INSTRUMENTATION

Periods/week: **3L -1T**  
Credits: **4**  
Sessionals: **30**  
Exam: **70**


**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:**
2. Mechanical measurements, Sirohi, Radhakrishnam.  
3. Electron Beam Analysis of materials, Lorento

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MT 323 – TESTING OF MATERIALS - II

Periods/week: **3L -1T**  
Credits: **4**  
Sessionals: **30**  
Exam: **70**


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


**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:**
MT324 - ADVANCED MATERIAL SCIENCE


Text books:
1. Material Science and Engineering by V.Raghavan

Reference books:

MT325 - STEEL MAKING

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.


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


Text books:
1. Principles of Metal Casting, Heine, Loper and Rosenthal, Tata Mc Grawhill
2. Foundry Technology, P.C.Jain, Tata Mc Grawhill

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 contact.
3. Determination of permeability 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.
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


References:
MT413 - METAL JOINING PROCESSES


Text books:
1. Welding and Welding Technology, R.L.Little
2. Welding Technology, N.K.Srinivasan

MT414 - HEAT TREATMENT

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.


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
4. Physical Metallurgy for Engineers, Clark and Varney
MT415 - NON FERROUS EXTRACTIVE METALLURGY


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

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

Text books:

References:
1. Metallurgy of Non-Ferrous Metals, Dennis, W.H.
2. Non-Ferrous Metallurgy, Sebryukov, N.Min, Pub. Moscow

MT416 - CORROSION & PROTECTION


Text books:
1. An introduction to Electrometallurgy, Sharan and Narain, Standard Publishers
2. Corrosion Engineering, MG Fountana, Mc-Grav Hill book company
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.
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


Text Books:
1. Welding Engineering and technology, RS Parmar

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.


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**  


Text Books:  
1. Material Science and Engineering by V.Raghavan  

References:  

MT423 - NANOMATERIALS  
(Elective – II)  

Periods/week: **3L - 1T**  
Credits: **4**  
Sessionals: **30**  
Exam: **70**  


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.