

**ANDHRA UNIVERSITY: COLLEGE OF ENGINEERING**  
**DEPARTMENT OF METALLURGICAL ENGINEERING**  
**SCHEME OF INSTRUCTION & EXAMINATION**  
**(admitted batch of 2006-07)**  
**B.E. METALLURGICAL ENGINEERING**

**II Year – I Semester**

Code	Subject	Periods L/T Lab	Exam hours	Sessional Marks	Exam Marks	Total Marks	Credits
MEC 211(A)	Mathematics-III	3	3	30	70	100	4
MEC 212 (A)	Engg. Mechanics-1	3	3	30	70	100	4
MEC 213 (A)	Strength of Materials	3	3	30	70	100	4
MTE 214	Fuels, Refractories and Furnace Technology	3	3	30	70	100	4
MEC 215 (C)	Machine Drawing	4	3	30	70	100	4
MTE 216 (C)	Manufacturing Technology-1	4	3	30	70	100	4
MT 217 P	Production Technology	3	3	50	50	100	2
MT 218 P	Strength of Materials	3	3	50	50	100	2
MT 219 P	Fuels & Mechanics	3	3	50	50	100	2
<b>Total</b>		<b>33</b>		<b>330</b>	<b>570</b>	<b>900</b>	<b>30</b>

**II Year - II Semester**

Code	Subject	Periods L/T Lab	Exam hours	Sessional Marks	Exam Marks	Total Marks	Credits
MEC 221(A)	Mathematics-IV	3	3	30	70	100	4
MEC 222 (A)	Materials Science & Metallurgy	4	3	30	70	100	4
MEC 223	Environmental Studies (*)		3	30	70	100	2
MEC 224(D)	Electrical Technology	5	3	30	70	100	4
MEC 225 (D)	Industrial Electronics & Microprocessor	5	3	30	70	100	4
MTE 226	Metal Casting	5	3	30	70	100	4
MTE 227	Met. Thermodynamics & Kinetics	5	3	30	70	100	4
MT 228 P	Metal Casting	3	3	50	50	100	2
MT 229 P	Electrical Technology	3	3	50	50	100	2
<b>Total</b>				<b>310</b>	<b>590</b>	<b>900</b>	<b>30</b>

(\*) Environmental studies introduced for the 2004-05 admitted batch

**III YEAR- I Semester**

Code	Subject	Periods L/T Lab	Exam hours	Sessional Marks	Exam Marks	Total Marks	Credits
MEC 311((D))	Fluid Mechanics	5	3	30	70	100	4
MTE 312	Mineral Beneficiation	5	3	30	70	100	4
MTE 313	Mechanical Metallurgy	5	3	30	70	100	4
MTE 314	Production of Iron & Ferro Alloys	5	3	30	70	100	4
MTE 315	Metallography & X-ray Diffraction	5	3	30	70	100	4
MEC 316 (A)	Engineering Economics	4	3	30	70	100	4
MT 317 P	Mineral Beneficiation	3	3	50	50	100	2
MT 318 P	Testing of Materials	3	3	50	50	100	2
MT 319 P	Soft Skills lab	3	-	100	-	100	1
<b>Total</b>		<b>38</b>		<b>380</b>	<b>520</b>	<b>900</b>	<b>29</b>

**III YEAR- II Semester**

Code	Subject	Periods L/T Lab	Exam hours	Sessional Marks	Exam Marks	Total Marks	Credits
MTE 321	Physical Metallurgy	5	3	30	70	100	4
MEC 322(C)	Design of Machine Elements-1	5	3	30	70	100	4
MTE 323	Non-Ferrous Extractive Metallurgy	5	3	30	70	100	4
MEC324 (C)	Industrial Engg. and Management	4	3	30	70	100	4
MTE 325	Metal Forming	5	3	30	70	100	4
MTE 326	Metal joining	5	3	30	70	100	4
MTE 327 P	Physical Metallurgy	3	3	50	50	100	2
<b>Total</b>		<b>32</b>		<b>230</b>	<b>470</b>	<b>700</b>	<b>26</b>

Note: Industrial Training for a minimum of three weeks at the end of III Year II Semester during summer vacation. Assessment of the Industrial Training is made during IV Year I-Semester.

**IV Year - 1st Semester**

Code	Subject	Periods L/TLab	Exam hours	Sessional Marks	Exam marks	Total Marks	Credits
MTE 411	Corrosion & Protection	5	3	30	70	100	4
MTE 412 (A)	Heat & Mass Transfer	5	3	30	70	100	4
MTE 413	Heat Treatment	5	3	30	70	100	4
MTE 414	Steel Making	5	3	30	70	100	4
MT 415 P	Heat & Mass Transfer	3	3	50	50	100	2
MT 416 P	Heat Treatment	3	3	50	50	100	2
MT 417 P	Industrial Training	-	-	100	-	100	2
<b>Total</b>		<b>26</b>		<b>320</b>	<b>380</b>	<b>700</b>	<b>22</b>

**IV Year – II Semester**

Code	Subject	Periods L/TLab	Exam hours	Sessional Marks	Exam marks	Total Marks	Credits
MEC 421 (A)	Instrumentation & Control Systems	5	3	30	70	100	4
MEC 422 (A)	Computer Aided Design	5	3	30	70	100	4
MT 424 P	Electro Metallurgy	5	3	50	50	100	2
MT 425 P	Computer Aided Design Lab	3		50	-	50	2
MT 426 P	Project work	8	-	50	50	100	8
<b>Total</b>		<b>31</b>		<b>160</b>	<b>290</b>	<b>450</b>	<b>20</b>

**A: Common for Mech, M.P.I., Metallurgy, Mech. Marine and Naval Architecture**

**C: Common for Mech, M.P.I., Metallurgy and Mech. Marine**

**D: Common for Mech, and M.P.I & Metallurgy**

## DEPARTMENT OF METALLURGICAL ENGINEERING

### II YEAR – 1<sup>ST</sup> SEMESTER SYLLABUS (2006-07 ADMITTED BATCH)

#### MEC 211: MATHEMATICS-III (Common with Mechanical Engineering)

**Periods/week: 3**

**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. 34<sup>th</sup> Edition,1998.

#### **Reference:**

1. A text book of Engineering Mathematics – NP Balieta, 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 and Vol.3 - Narayan, Manicavachagaon Pillay and Ramanaiah.
4. Advanced Engineering Mathematics, - Erwin Kreyszig, Wiley Easter Pvt. Ltd., New Delhi- 49
5. Engineering Mathematics by P.P.Gupta , Krishna Prakasham Media(P) Ltd, 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.

**MEC 212(A): ENGINEERING MECHANICS –I**  
**(Common for Mech., M.P.I., Metallurgy, Mech.Marine and Naval Architecture)**

**Periods/week: 5 L**

**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.

**Text books:**

1. Engineering Mechanics – S.Timoshenko (relevant sections only)
2. Elements of Strength of Materials- S.Thimoshanko (relevant sections only)

**MEC 213 (A) STRENGTH OF MATERIALS**  
**(Common for Mech., M.P.I., Metallurgy, Mech. Marine and Naval Architecture)**

**Periods/week: 5 L**

**Credits: 4**

**Sessionals: 30**

**Exam: 70**

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)

**MTE 214 FUELS, REFRACTORIES AND FURNACE TECHNOLOGY**

**Periods/week: 3L-2T**

**Credits: 4**

**Sessionals: 30**

**Exam: 70**

Solid fuels. Classification. Theories of formation of coal. Study types and properties of coal. Proximate analysis & ultimate analysis of coal. Carbonization of coal. Coke and by products. Testing and properties. 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. Manufacturing of refractories. Manufacture, properties and applications of Alumino-silicate, Silica, Dolomite, Magnesite, Chromite and Carbon refractories. Importance and study of SiC,ZrO<sub>2</sub> and cermets. Testing of refractories.

Furnaces. Classification of furnaces and their use in metallurgical industries. Elements of heat transmission. Steady state conduction, convection and radiation. 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. Fuels, furnaces and refractories by O.P.Gupta

**References:**

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

**MEC 215 (C) MACHINE DRAWING**  
**(Common with Mech., M.P.I, Metallurgy and Mech. Marine)**

**Periods/week:4P**

**Credits: 4    Sessionals:30**

**Exam: 70**

Screw threads and Screw Fastening using standard empirical formulae. Riveted joints, Keys, Cotter-joints, Pin-joints. Shaft couplings: Box and split muff couplings, Flanged, Flexible. Universal and Oldham couplings. Shaft bearings . Brackets and Hangers. Pipe joints.

Orthogonal view and sectional views of machine parts. Assembly drawing of various engine components and machine tool components.

**Text books:**

1. Machine Drawing, N.D.Bhatt, Charotal Publishing House.
2. Engineering Drawing, A.C.Parkinson, Wheeler publishing.

**MTE 216 © MANUFACTURING TECHNOLOGY-1**  
**(Common with Mech., M.P.I, Metallurgy and Mech.Marine)**

**Periods/week:4P**

**Credits: 4    Sessionals:30**

**Exam: 70**

Manufacturing concepts; Product cycle; Job, batch and mass production; Primary and secondary manufacturing processes; Principle of metal casting; Terminology; Pattern; Types; Allowances; Materials; Core boxes; Selection; Testing and preparation of moulding sands; Moulding tools and equipment; Machine moulding; Core making; Sprue; Runner, gates and risers; Types and designing; Melting and pouring the metal; Shell mold casting; Investment casting; Permanent mould casting; Casting defects.

Formability of metals; Cold and hot working; Rolling; Types; Roll size; Stretch forming, metal spinning, embossing and coining; Peening; Sheet metal forming operations; Presses; Die design.

Forging materials; Forging processes; Forging techniques; Forging presses; Forging pressure distribution and forging force; Automation of forging; Swaging; Drawing; Extrusion; High energy rate forming.

Weldability; Welding metallurgy; Principles and processes of arc welding (SMAW, GTAW, GMAW, FCAW, PAW, SAW); Welding equipment; Weld positioners and fixtures; Oxyacetylene welding; Flame cutting; Brazing and soldering; Principle of resistance welding; Types of resistance welds; Seam welding; Projection welding; Resistance butt welding; Solid state welding; Weld inspection and testing.

**Text Book:**

1. Process and Materials of Manufacture (4<sup>th</sup> Edition) by Roy A. Lindberg, Prentice-Hall of India Private Limited.

**Reference Books:**

1. Manufacturing Engineering & Technology by Kalpak Jain, Addition Wesley Edition.
2. Materials and Processes in Manufacturing by De Margo, Black and Kohsen, Prentice Hall of India.
3. Principles of Metal Casting by Hein and Rosenthol, Tata Mc-Graw Hill India.
4. Manufacturing Technology-Foundary, Forming and Welding by P.N. Rao, Tata McGraw-Hill Publishing Company.

### MT 217 P Production Technology

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	3
2	Welding	2
3	Lathe	Step and taper turning-1
4	Milling	Thread cutting -1 Offset turning - 1
5	Shaper	Spur gear-1

### MT 218 P Strength of Materials

Periods/week: 3P

Credits: 2    Sessionals: 50

Exam: 50

#### List of Experiments:

1. To study the stress strain characteristics of metals by using UTM by tension test.
2. To study the stress strain characteristics of metals by using Hounsfield tensometer.
3. Determination of compression strength of wood.
4. Determination of hardness using different hardness testing testing machines- Brinnels, Vickers and Rockwell's
5. Impact test by using Izod & charpy methods.
6. Deflections test on beams using UTM.
7. Tension shear test on MS rods.
8. To find stiffness & modulus of rigidity by conducting compression tests on springs.
9. Torsion tests on M.S.Shafts.
10. Bulking of sand.
11. Punch shear test, hardness test & compression test by using Hounsfield tensometer.
12. Hardness test using UTM
13. Sieve analysis and determination of fineness number.

### MT 219 P FUELS & MECHANICS

Periods/week: 3

Credits: 2

Sessional: 50

Exam:50

#### List of experiments:

1. To assemble the given parts of the mechanism kit for different types of mechanisms
2. To determine the moment of inertia of the given fly wheel.
3. To determine the moment of inertia of the given connecting rod.
4. To determine the modulus of rigidity of the given wire with torsional pendulum.
5. To determine the coefficient of friction with Thurston oil tester.
6. Study and valve timing diagrams of four stroke and two stroke engine.
7. Study of boilers, fuel pumps, carburetors etc.
8. To determine the volumetric efficiency of the given air compressor by  
1. Plate orifice method and 2. Tank capacity method.
9. To calibrate the given pressure gauge.
10. Determination of Flash and fire points of oils.
11. Determination of Calorific value of fuels(solids, liquid, gaseous) by bomb Calorimeter/gas calorimeter.
12. To determine the kinematic and absolute viscosity of the given sample oil using Redwood Viscometer I.
13. To determine the kinematic and absolute viscosity of the given sample oil using Redwood Viscometer II.
14. Determination of carbon residue.

## II YEAR - II SEMESTER

### MEC 221(A) Mathematics -IV

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

**Periods/week: 3L**

**Credits: 4**

**Sessional: 30**

**Exam: 70**

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, 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,  $\chi^2$ -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, 34<sup>th</sup> edition, 1998.

#### **Reference:**

1. A text book of Engineering Mathematics by N.P.Baliatal, 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,Manicavachagaon 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

**MEC 222(A) Material Science & Metallurgy**  
**(Common for Mech., M.P.I, Metallurgy, Mech. Marine and Naval Architecture)**

**Periods:4**

**Credits: 4**

**Sessional:30**

**Exam:70**

Space lattice and unit cells, crystal systems. Indices for planes and directions. Structures of common metallic materials. Crystal defects: point, Line and surface defects.

Binary phase diagrams. Gibbs rule. Lever rule. Invariant reactions. Iron-Iron carbide phase diagram. Heat treatment of steel. Isothermal transformations curves. Annealing, Normalizing, Hardening, Tempering, austempering and martempering of steels. Surface hardening of steels. Carburizing, nitriding, cyaniding, Flame and induction hardening methods.

Classification of Steels ; I.S., AISI-SAE classifications. Uses and limitations of plain-carbon steels, alloy steels. Plain carbon and low alloy steels. Tool steels. Stainless steels. Cast irons. Grey, white, Malleable and SG irons, Alloy cast irons. Non-Ferrous metals and alloys; brasses and bronzes, bearing metals.

Plastic deformation: slip, twinning critical resolved shear stress. Ductile and Brittle fracture. Mechanism of creep and fatigue. High temperature alloys. Metals at low temperature. Effect of low temperature on properties: low temperature metals.

Composite materials. Classification. Matrices and reinforcements. Fabrication methods. Examples and applications.

NDT Testing: Ultrasonic, Magnetic, Dye penetrant and visual methods and applications radiographic.

**TEXT BOOKS:**

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

**REFERENCE BOOKS:**

1. Material Science and Engineering by L.H.Van Vleck, 5<sup>th</sup> 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. 2<sup>nd</sup> Edition, Chapman and Hall (1990).



## MEC 223: ENVIRONMENTAL STUDIES

**Periods/week: 3L-2T**

**Credits: 2    Sessional: 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

- (a) Air (Prevention and control of pollution) Act
- (b) Water (Prevention and control of pollution) Act
- (c) Environmental Protection 1980 Act.
- (d) 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
- (B) Local issues causes and action
- © Air pollution due to industries
- (D)Automobiles
- C. 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

**MEC 224 (D) ELECTRICAL TECHNOLOGY**  
**(Common for Mech, and M.P.I. & Metallurgy)**

**Periods/week: 3L-2T**

**Credits: 4    Sessional: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 E.M.F. 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, Page Nos.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, Potentio meter 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

**MEC 225 (D) INDUSTRIAL ELECTRONICS & MICROPROCESSOR**  
**(Common for Mechanical, and M.P.I. & Metallurgy)**

**Periods/week: 3L-2T**

**Credits: 4**

**Sessional:30**

**Exam: 70**

Devices. Semi-conductor diode. Zenor diode. Transistor. Silicon control rectifier. Rectifiers. Amplifiers. Oscillators. Cathode ray oscilloscope. Industrial applications. Poly- phase rectifiers. Control circuits. Motor speed control. Voltage control. Time delay relay circuits. Photo electric circuits.

Resistance welding, Induction heating-Dielectric heating. Servomechanism: Open loop and closed loop system (Elementary treatment only).

Introduction to Digital Electronics. Fundamentals of digital electronics. Number system and codes. Logic gates. Boolean algebra. Arithmetic logic units. Flip-flops. Registers and counters.

Memories. ROM,PROM, EPROM and RAM.

Introduction to Microprocessors. The Intel-8085 microprocessor. Architecture. Instruction set. Execution of instructions. Addressing structurism. Timing and machine cycles of 8085 and programming I/O operations. Interrupts. Serial input and serial output. Programming the I/O ports. Programming the timer.

Text books:

1. Industrial Electronics by Mithal (Khanna Publications)
2. Digital Computer Electronics – An introduction to Micro Computer, Albert Paul Malvino.  
Tata Mc Graw Hill Publishing Co. Ltd., New Delhi-2.

Reference:

1. Engineering Electronics by Ryder-McGraw Hill.
2. Micro Processor by Leventhal.

**MTE 226 METAL CASTING**

**Periods/week: 3L-2T**

**Credits: 4**

**Sessional: 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.

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.

## MTE 227: METALLURGICAL THERMODYNAMICS & KINETICS

**Periods/week: 3L-2T**

**Credits: 4**

**Sessional: 30**

**Exam:70**

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

First law of thermodynamics. Internal energy and work. Calculation of work for various thermodynamic processes. Heat capacities. Thermo chemistry. Hess's law. Kirchoff's law.

Second law of Thermodynamics. Efficiency of cyclic process. Carnot cycle. Entropy. Thermodynamic equation of state. Statistical interpretation of entropy. Free energy functions. Gibbs- Helmholtz equation. Maxwell's relations. Third law of Thermodynamics.

Fugacity, activity and equilibrium constant. Vant Hoff's isotherm. Variation of equilibrium constant with temperature. Clausius-Clapeyron's equation. Ellingham diagrams and application.

Thermodynamic solutions . Raoult's law. Henry's law. Sievert's law. Properties of ideal solutions, chemical potentials. Partial Molar properties and their inter relations. Gibbs Duhem equation and its integration. Actual solutions. Regular solutions. Excess thermodynamic properties. Application to phase diagrams. Derivation of phase rule. Thermodynamics of Electrochemical cells. Nernst equation. Emf method of measurement of Thermodynamic properties.

Kinetics of Metallurgical reactions. Collision theory. Theory of absolute reaction rates. Order and molecularity of reactions. Determination of order. Catalysis and chemical reactions.

### **Text books:**

1. Physical Chemistry of Metals, L.S.Darken and G.Gurry, Tata Mc-Graw hill.

### **Reference:**

1. Chemical Metallurgy, J.J.Moore
2. Problems in Thermodynamics & Kinetics, G.S.Upadhyaya and R.N.Dubey
3. Metallurgical Thermodynamics, ML Kapoor Part I & II
4. Metallurgical Thermodynamics, Tupkary

## MT 228P: METAL CASTING

**Periods/week: 3P**

**Credits: 2**

**Sessional: 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.

## MT 229 P: ELECTRICAL TECHNOLOGY

**Periods/week: 3P**

**Credits: 2**

**Sessional: 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 KVL
10. Superposition theorem.
11. Parameters of choke coil
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

### III YEAR-1<sup>ST</sup> SEMESTER – SYLLABUS

#### MEC 311(D) FLUID MECHANICS (Common for Mech, and M.P.I. & Metallurgy)

**Periods/week: 3L-2T**

**Credits: 4**

**Sessional: 30**

**Exam: 70**

Properties of fluids-Viscosity – Pressure measurement and Manometers – Hydrostatic forces on surfaces.

Fluid Kinematics & Fluid Dynamics. Stream line- Stream tube – Stream function – Potential function – 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- Vortex motion – Free and forced vortices- Basic solutions of ideal fluid flows-Flow net analysis.

One-dimensional Viscous flow. Couette flow- Plane Couette flow, Favourable pressure gradient and adverse pressure gradient- Flow through pipes-Hagen Poiseuille flow- Fanning's friction factor – Darcy's Weisbach friction factor – Loss of head due to friction in pipes – Laminar and turbulent regimes – Flow potential and flow resistance – Flow through branched pipes, Momentum equation-Forces due to pipe bends, Curved tubes, Sudden enlargement, Sudden contraction flow through porous media- Darcy's equation . Two Dimensional Viscous Flow: Navier Stokes equations and solutions – Order of magnitude analysis- Boundary layer equations.

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- Fully developed turbulent flow through a pipe – Turbulent boundary layer on a flat plate – Laminar sub-layer – Boundary layer separation and control.

Dimensional Analysis and Modeling Similitude. Fundamental and derived dimensions – Dimensionless groups – Buckingham  $\pi$ - theorem – Rayleigh method- Model testing – Types of similarity – Geometric , Kinematic and Dynamic similarities- Hydraulic diameter.

Compressible fluid flow. Thermodynamic relations – Continuity, Momentum and Energy equations- Velocity of sound in a compressible fluid- Mach number and its significance – Limits of incompressibility – Pressure field due to a moving source of disturbance – Propagation of pressure waves in a compressible fluids- Stagnation properties – Stagnation pressure, Temperature and density – Area velocity relationship for compressible flow – Flow of compressible fluid through nozzles- Condition for maximum discharge through nozzles – Variation of mass flow with pressure ratio – Compressible flow through a venturimeter – Pitot static tube in a compressible flow.

**Text book:**

1. Fluid Mechanics, A.K.Mohanty, Prentice Hall of India Pvt. Ltd.

**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.

## MTE 312: MINERAL BENEFICIATION

**Periods/week: 3L-2T**

**Credits: 4    Sessional: 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. 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.

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.

## MTE 313: MECHANICAL METALLURGY

**Periods/week: 3L-2T**

**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 and strain rate. Typical stress strain diagrams. Yield point phenomena. 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 skelero 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.

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.

An elasticity and internal friction. Theories of failure. Von Mises and Treasca Yield criteria. Miscellaneous tests. Shear test. Testing of sheets and tubes.

Non-destructive testing. Principles and applications of visual, liquid penetrant and dye penetrant tests. Fluorescent test. Radiography. X-ray, Gamma ray and Neutron methods. Sonic and ultrasonic methods of inspection. Magnetic methods. Magna flux and magna glow methods. De magnetization. Eddy current tests. Pressure testing.

### **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



## MTE 314: PRODUCTION OF IRON & FERRO ALLOYS

**Periods/week: 3L-2T**

**Credits: 4    Sessionals: 30**

**Exams: 70**

Raw materials. Occurrence and distribution of iron ores in India. Evaluation of iron ore., coke and limestone. Preparation of iron ores. Concentration. Sintering principles. Sintering machine and its efficiency. Types of sinter. Raw material requirements. Pelletising. Bonding mechanism. Equipment . Firing units.

Blast furnace and accessories. Description of modern blast furnace. Design of blast furnace. Stoves. Gas cleaning system. Charging system. Blast furnace instruments and refractories . Distribution of burden in blast furnace.

Physical chemistry. Distribution of elements in molten metal and slag. Constitution of blast furnace slag's, properties and uses. Blast furnace operation, irregularities and corrections. Modern developments in blast furnace practice and methods of increasing production. Alternate routes of production of pig iron. Electric process. Low shaft furnace. Production of sponge iron by HYL process, SL/RN process. Midrex process. Kiln 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.Strybgen

## MTE 315 METALLOGRAPHY & X-RAY DIFFRACTION

**Periods/week: 3L-2T**

**Credits: 4    Sessionals: 30**

**Exams: 70**

1. Metallographs- 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.

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

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

4. Applications – Determination of orientation simple crystal, back reflection and transmission Laue method, effect of plastic deformation. Determination of particle size, grain size, residual stresses, determination of phase diagrams, order-disorder transformation.

5. 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.

**MEC 316 (A) ENGINEERING ECONOMICS**  
**(Common for Mech., M.P.I., Metallurgy, Mech.Marine and Naval Architecture)**

**Periods/week: 4L**

**Credits: 4**

**Sessional: 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 Garg.
2. Cost accounts by Shukla and Grewal.

**MT 317 P: MINERAL BENEFICIATION**

**Periods/week: 3P**

**Credits: 2    Sessional: 50**

**Exam: 50**

**LIST OF EXPERIMENTS:**

1. Sampling by coning and quartering, 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 318 P: TESTING OF MATERIALS**

**Periods/week: 3P**

**Credits: 2**

**Sessional: 50**

**Exam:50**

**List of Experiments:**

1. Dye-Penetrant Test.
2. Magnetic crack detector.
3. Ericksen Cupping Test
4. Tensile & Bend Testing
5. Coating thickness
6. Shore scleroscope hardness test
7. Testing of a welded joint
8. Poldi Testing
9. Cold working & annealing
10. Fatigue testing
11. Impact testing

## MT 319 P: SOFT SKILL LAB

**Periods/week: 3P**

**Credits: 1**

**Sessional: 100**

### **Communication:**

Importance of communication  
Non verbal communication  
Personal appearance  
Posture  
Gestures  
Facial expressions  
Eye contact  
Space distancing

### **Goal setting:**

Immediate, short term, long term,  
Smart goals, strategies to achieve goals

### **Time management:**

Types of time  
Identifying time wasters  
Time management skills

### **Leadership and team management:**

Qualities of a good leader  
Leadership styles  
Decision making  
Problem solving  
Negotiation skills

### **Group discussions:**

Purpose (Intellectual ability, creativity, approach to a problem, solving, tolerance, qualities of a leader)  
Group behavior, Analyzing performance

### **Job interviews:**

Identifying job openings  
Preparing resumes & CV  
Covering letter  
Interview (Opening, body-answer Q, close-ask Q),  
Types of questions

### **Reference books:**

1. 'Effective Technical Communications' by Rizvi M. Ashraf, McGraw–Hill Publication
2. 'Developing Communication Skills' by Mohan Krishna & Meera Banerji, Macmillan
3. 'Creative English for Communication' by N.Krishnaswami & T.Sriraman, Macmillan
4. 'Professional Communication Skills' by Jain Alok, Pravin S.R. Bhatia & A.M. Sheikh, S.Chand & Co.

### III YEAR- II SEMESTER

#### MTE 321: PHYSICAL METALLURGY

**Periods/week: 3L-2T**

**Credits: 4    Sessionals: 30**

**Exam: 70**

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 phases, important phase diagrams-Fe-C, Cu-Zn, Cu-Sn, Al-Si, Al-Cu, Pb-Sn, Sn-Sn, Ternary diagrams and interpretation of Structures on cooling.

Solidification: Solidification of pure metals, alloys and eutectic. Homogeneous and Heterogeneous nucleation, constitutional super cooling, segregation, porosity, Directional solidification, microstructure of solidified metals, zone refining

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

Recovery, recrystallisation and grain-growth, strengthening mechanisms – grain boundary strengthening, solid solution strengthening, deformation of two phase aggregates, strengthening from fine particles, Fibers strengthening, Martensite -strengthening, strain hardening, preferred orientation.

**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 |
|------------------------|------------------|

**MEC 322 (c) DESIGN OF MACHINE ELEMENTS**  
**(Common for Mech., and M.P.I. & Metallurgy)**

**Periods/week: 3L-2T**

**Credits: 4    Sessionals: 30**

**Exam: 70**

Mechanical Engineering Design, Traditional design methods. Design synthesis. Design considerations of standards. Engineering materials classification and selection. BIS designation of steels. Mechanical properties., Manufacturing considerations. Statistical considerations.

Design against static loads. Modes of failure. Factor of safety. Stress-strain relations. Axial, bending and torsional stresses. Stress concentration factors. Fluctuations and fatigue stresses. Endurance limit. Notch sensitivity. Soderberg, Goodman and modified Goodman diagrams, fatigue design under combined loading.

Thread and welded joints. Torque requirement for bolt tightening. Eccentrically loaded bolted joints. Fluctuating loads on bolted joints. Joints with combined stresses. Power screws and different forms of threads. Force analysis. Collar friction. Differential and compound screws design. Types and strength of weld joints subjected to bending and fluctuating loads.

Power transmission shafts. Design of hollow shafts. Keys and cotter design. Flat, square keys. Splines and proportions. Rigid and flange couplings. Flexible coupling. Flywheel designs. Torque analysis. Stresses in rimmed flywheel.

Mechanical springs, classification spring materials. Spring end formation. Design of Helical springs. Torsional springs. Laminated springs. Protective coatings. Equalized stressing spring leaves. Multi-leaf springs. Nipping and shot peening.

Text books:

1. Design of Machine Elements, V.B. Bhandari, TMH Publishing Co. Ltd., New Delhi

Reference:

1. Machine Design, R.K.,Jain, Khanna Publications.
2. Mechanical Engineering Design,J.E.Shigley.

## MTE 323: NON-FERROUS EXTRACTIVE METALLURGY

**Periods/week: 3L-2T**

**Credits: 4    Sessionals: 30**

**Exam: 70**

Introduction. 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.

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.

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

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

Zinc. Uses. Pyro-metallurgical and hydro-metallurgical extraction methods. Imperial smelting process. Nickel : Brief description of Ni extraction from sulphide ores. Magnesium. Uses. Ores. Pidgeon's process. Extraction by Dows process. Tin: Uses. Ores. Concentration, smelting and refining.

Uranium. Extraction of Uranium. Production flow sheet of Jaduguda ore zirconium. Zirconium production in India. Brief outlines of extraction of Pu and Th. Titanium. Production of Titanium chloride from Hmentite. 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 reactor.

### **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

**MEC (C) 324: INDUSTRIAL ENGINEERING & MANAGEMENT**  
**(Common for Mech., M.P.I., Metallurgy & Mech. Marine)**

**Periods/week: 3L-2T**

**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.

### **MTE 325: METAL FORMING**

**Periods/week: 3L-2T**

**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

### **MTE 326: METAL JOINING**

**Periods/week: 3L-2T**

**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 CO<sub>2</sub> 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. Weld defects. Testing , inspection and quality control welds. Weldability and its testing.

Metallurgical considerations in welding. Structure property changes. Problems during welding of high carbon steels, cast irons, alloy steels, stainless steels. Aluminum alloys, Cu-base alloys. Welding of Dissimilar metals.

#### **Text books:**

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

### **MTE 327 P: PHYSICAL METALLURGY**

**Periods/week: 3 P**

**Credits: 2    Sessional : 50**

**Exam: 50**

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



## IV YEAR-1<sup>ST</sup> SEMESTER

### MTE 411: CORROSION & PROTECTION

**Periods/week: 3L-2T**

**Credits: 4    Sessionals: 30**

**Exam: 70**

Corrosion –Theoretical aspects. Electrolysis. Principles. Faraday's laws and their application. Current efficiency. Energy efficiency. Ion conductivity. Equivalent and motor conductivities. Ionic mobilities and Transport Nos. Electrode potential, Equilibrium potentials – EMF series. Polarization, over voltage/over potential. Activation, concentration, Ohmic polarization. Effect of polarization on electrode processes. Corrosion as an irreversible electrode process. Tafels equation. Tafels slopes. Effect of Temperature, composition and concentration of the corrosive media. Kinetics of electrode process (briefly). Passivity.

Electronic processes. Cathodic Technical processes. Brief classification. Anodic technical process. 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. Displacement equilibrium and its significance in corrosion processes. Potential – pH, Fe-H<sub>2</sub>O diagram. E- I diagrams for prediction of corrosion currents. Polarization resistance, Linear polarization technique for evaluation of  $I_{\text{corr}}$ .

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.

Corrosion prevention, 1) Design aspects 2) Alteration of Environment inhibitors 3) Alteration of the material . pure metals alloys, Non-metallic as structural materials – Reinforcement of the material for reducing. Corrosion rates. 4) Surface protection. Electroplating, Principles – Throwing power and its evaluation. Commercial plating of Cu, Ni, Cr, Cd, Zn, Ag, Au. Electro-deposition of alloys plating structure of Electro deposits and testing of deposits. 5) Anodic oxidation of Aluminum and its alloys. Commercial anodizing process. Faults in the anodic coating and the remedies. Treatment after anodizing. 6) 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.

## MTE 412 (A) : HEAT & MASS TRANSFER

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

**Periods/week: 3L-2T**

**Credits: 4    Sessionals: 30**

**Exam: 70**

Introduction. Basic modes of heat transfer-Rate equations-Generalized heat conduction equation in Cartesian, Cylindrical and spherical coordinate systems.

Steady state heat conduction solution for plain and composite slabs, cylinders and spheres-Critical thickness of insulation- Heat conduction through fins of uniform and variable cross section – Fin effectiveness and efficiency.

Unsteady, steady state heat conduction- Transient heat conduction – Lumped system analysis , and use of Heisler charts.

Convection. Continuity, momentum and energy equations. Dimensional analysis- Boundary layer theory concepts-Free, and forced convection. Approximate solution of the boundary layer equations. Laminar and turbulent heat transfer correlation. Momentum equation and velocity profiles in turbulent boundary layers. Applications of dimensional analysis to free and forced convection problems. Empirical correlation.

Radiation. Black body radiation- radiation field, Kirchoff's laws-shape factor – Stefan Boltzman equation. Heat radiation through absorbing media. Radiant heat exchange, parallel and perpendicular surfaces- Radiation shields.

Heat exchangers. Types of heat exchangers. Parallel flow. Counter flow. Cross flow heat exchangers. Overall heat transfer coefficient. LMTD and NTU methods. Fouling in heat exchangers. Heat exchangers with phase change.

Boiling. Different regimes of boiling-Nucleate, Transition and film boiling.

Condensation. Laminar film condensation. Nusselt's theory. Condensation on vertical flat plate and horizontal tubes- dropwise condensation.

Mass transfer. Conservation laws and constitutive equations. Isothermal equimass, Equimolal diffusion. Fick's law of diffusion- diffusion of gases, liquids- Mass transfer coefficient.

### **Text books:**

1. Heat transfer, J.P. Holman, Int. Student edition, McGraw Hill company.
2. Analysis of Heat Transfer, Eckert and Drake, Int. Student edition, McGraw Hill Kogakusha Ltd.

## MTE 413: HEAT TREATMENT

**Periods/week: 3L-2T**

**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.

Precipitation hardening. Basic requirements. Effects of time and temperature on ageing. Mechanisms of precipitation hardening. Dispersion hardening.

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. Nuclear reactor materials.

### **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

## MTE 414: STEEL MAKING

**Periods/week: 3L-2T**

**Credits: 4    Sessionals: 30**

**Exam: 70**

History of steel making. Cementation and crucible process.

Chemistry of Steel Making processes. Principles Steel Making. Theories of slag. Oxidation of Si, Mn and C. Desulphurization, Dephosphorization and deoxidation.

Pneumatic steel making process. Converter steel making. Acid and basic Bessemer process with respect to construction, lining of various points of OHF, fuel and R.M. operation and chemistry of the process. Developments in OHP, Tilting and twin hearth process.

Developments in converter steel making process: LD, LD-AC, Kaldo, Rotor, Q-BOP processes.

Electric furnace steel making. Various electric process, their advantages and limitations. Brief EAF process, construction, lining and operation. Brief outline of manufacture of alloy steels. Production of Ferro alloys Fe-Si, Fe-Mn, Fe-V, Fe-W.

Quality of steel making. Vacuum degassing of metal. Secondary steel making,

Cast process. 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.

### **MT 415 P: HEAT & MASS TRANSFER**

**Periods/week: 3 P**

**Credits: 2      Sessional: 50**

**Exam: 50**

#### **List of Experiments:**

1. Study of conduction phenomena in the composite slab system.
2. Determination of emissivity, time constant, Fouresis Biot module and study of variation of temperature with respect to time on a circular disc.
3. Study of heat transfer by forced convection through a horizontal test section.
4. Study of heat transfer by forced convection through a vertical test section.
5. Determination of free convective heat transfer coefficient from a horizontal cylinder in air.
6. Determination of thermal conductivity of brass employing it as a fin.
7. Tests on natural convection and pool boiling.
8. Study of forced convection with turbulence promoters.
9. Study of condensation on fin.
10. Tests on film condensation.
11. Determination of COP of a vapour compression refrigeration system.

### **MT 416 P: HEAT TREATMENT**

**Periods/week: 3 P**

**Credits: 2                      Sessional: 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

### **MTE 417: 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

### MEC 421 (A) INSTRUMENTATION & CONTROL SYSTEMS

**Periods/week: 3L-2T**

**Credits: 4    Sessionals: 30**

**Exam: 70**

Instrumentations: Concepts of measurements, static performance, characteristics accuracy of measurement and its analysis. Instrumentation, for measurement: Force, torque, strain. pressure, flow, temperature and vibration.

Optical Methods of Measurement: Introduction, Laser beam as a light pointer, length/displacement measurement, temperature sensors, seismographic measurement.

Introduction to fiber optics, fiber types, properties of optical fibres and a fibre optic sensor configuration.

Introduction: Control systems, Feedback and its effects. Transfer Function, Block Diagram and Signal Flow Graph: Impulse response and Transfer functions of linear systems, Block diagrams.

Mathematical Modeling of Physical Systems: Equations of electrical networks, Modeling of mechanical system elements, Equations of mechanical systems. State-variable Analysis of Linear Dynamic Systems: Matrix representation of state equations, State transition matrix, State transition equation, relationship between state equations and high-order differential equations, relationship between state equations and transfer functions, Characteristic equation, eigen values and eigen vectors.

Time-Domain Analysis of Control Systems: Typical test signals for the time response of control systems, Time-domain performance of control systems- The steady- state error, Time-domain performance of control systems- Stability of control systems- stability, Characteristic equation and the state transition matrix, Methods of determining stability of linear control systems, Routh- Hurwitz criterion.

Frequency-domain Analysis of Control Systems: Introduction, Nyquist stability criterion, Application of the Nyquist criterion, Stability of multi loop systems, Stability of linear control systems with time delays.

#### **Text Books:**

1. Automatic Control Systems, by Benjamin C. Kuo.
2. Mechanical Measurements, by R.S.Sirohi, H.G. Radha Krishna, Wiley Eastern, New Delhi.

#### **References:**

1. Experimental Methods for Engineers, by J.P.Holman, McGraw-Hill.
2. Instrumentation for Engineering Measurements, by R.H. Cerni and L.E.Foster, J.Wiley & Sons, New York.
3. Mechanical and Industrial Measurement, by R.K.Jain, Khanna publishers, Delhi.
4. Control Systems Engineering by Nagrath/Gopal ,New age international.

## MEC 422 (A) COMPUTER AIDED DESIGN

**Periods/week: 3L-2T**

**Credits: 4    Sessionals: 30**

**Exam: 70**

Fundamentals of CAD - Introduction - The design process - Application of computers for design - Operating systems - Hardware in CAD: The design work station - I/O Devices - CAD system configuration - Creating database for manufacturing - Benefits of CAD.

Interactive Computer Graphics - Graphic display devices- Graphics system- Graphics standards - Graphical user interface- Transformation systems- windowing - clipping - 2D and 3D transformations - Linear transformation- Display files for 3D data - Geometric Modeling - Modeling Techniques - Wire frame Modeling - Surface Modeling - 3 D Solid Modeling.

Introduction to Finite Element Analysis - CAD techniques to finite element data preparation- Automatic mesh generation- presentation of results - 3-dimensional shape description and mesh generation- CAD applications of FEM.

CAD applications and exposure to CAD packages: Simple examples of computer aided drafting, design and analysis - Introduction to simple machine elements - Analysis of cross sectional area, centroid & moment of inertia- Kinematics of crank- slider mechanism and other simple design applications. Introduction to CAD packages like ANSYS, NASTRON, NISA-II.

Introduction to Artificial Intelligence Introduction to Artificial Intelligence - Applications of AI in design and CAD.

### **Text Books:**

1. CAD/CAM- Computer Aided Design & Manufacturing, by M.D.Groover & E.W.Zimmer.
2. Computer Aided Design and Manufacturing, by Dr.Sadhu Singh, Khanna Publishers.

### **References:**

1. Computer Aided Design in Mechanical Engineering, by V.Rama Murthy.
2. Elements of Computer Aided Design & Manufacturing, by Y.C.Pao.
3. Computer Aided Kinetics for Machine Design, by D.L.Ryan.
4. Computer Aided Design and Manufacturing, by C.B.Besant & C.W.K.Lui.
5. Computer-Aided Analysis & Design by S. Ghosal, Prentice Hall of India.
6. CAD/CAM/CIM by Radhakrishna, New age international.

## MT 424P ELECTRO METALLURGY

**Periods/week: 3 P**

**Credits: 2**

**Sessional: 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.

## **MT 425 P COMPUTER AIDED DESIGN LAB**

**Periods/week: 3 P**

**Credits: 2**

**Sessional: 50**

### **CAD experiments:**

1. Initiating the graphics package; Setting the paper size, space; setting the limits, units; use of snap and grid commands.
2. Drawing of primitives (line, arc, circle, ellipse, triangle etc.)
3. Drawing a flange.
4. Drawing a Bushing assembly.
5. Dimensioning the drawing and adding text.
6. Setting the layers and application of the layers.
7. Isometric and orthographic projections.
8. Viewing in Three dimensions.
9. Removal of hidden lines - Shading and rendering.

### **CAM experiments:**

1. Preparation of manual part programming for CNC turning/Milling.
2. Part programming preparation through AutoCAD.
3. APT part programming for 2D - contour.
4. Machining of one job on CNC machine tool.
5. Robot programming through Teaching Box method.
6. Robot programming through computer.

## **MT 426 P: DISSERTATION**

**Periods/week: 8**

**Credits: 8**

**Exam: 100**

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