Metallurgical and Materials Engineering

Course Structure and Detailed Syllabus

II YEAR
I SEMESTER

SL. No.	CODE	SUBJECT	L-T-P	CREDITS
1.	MM2101	Physical Metallurgy	4-0-0	4
2.	MM2102	Mineral Processing	4-0-0	4
3.	MM2103	Metallurgical Thermodynamics	4-0-0	4
4.	MM2104	Foundry Technology	4-0-0	4
5.	BSBE2001/3001	Environmental Science	4-0-0	3
6.	HS2101	Soft Skills-I	2-0-0	1
7.	MM2701	Physical Metallurgy Lab	0-0-3	2
8.	MM2702	Foundry Technology Lab	0-0-3	2
9	MM2901	Seminar – I	0-0-2	1
Total			25-0-7	25

MM2101 **PHYSICAL METALLURGY**

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **4-0-0-4**

Objectives:

* To understand the basic concepts of crystal structures and geometry of different materials
* To study the possibility of formation of solid solutions, solidification process
* To plot equilibrium diagrams and analyze various binary phase diagrams including Iron – iron carbide equilibrium phase diagram
* To analyze TTT, CCT diagrams and classifications of steels and cast irons
* To study various heat treatment processes and importance of alloying

UNIT – I: Atomic structure and bonding in solids, crystal structures, crystalline and non-crystalline materials, Indexing of lattice planes and directions, Indexing of lattice directions, Co-ordination no., Atomic packing factor, Ceramic crystal structures, Imperfections in solids like point, line and interfacial defects, Diffusion: Mechanism, Steady & Non-steady diffusion, Influencing factors.

UNIT – II: Equilibrium diagrams: Basic definitions, Hume-Rothery's rules, Gibbs phase rule, Polymorphism, Solidification of a pure metal, Cricital size of nucleus, Shape of crystals, Dendritic growth, Types of cooling curves, Plotting of equilibrium diagram, Lever rule.

UNIT – III: Unary phase diagram, Binary Phase diagrams (Type-I, II, III, IV, V, VI, VII), Iron – Iron carbide equilibrium diagram, Critical temperatures, Solidification and microstructure of slow cooled steels.

UNIT – IV: Classification & Specification of steels, Transformation of austenite to pearlite, bainite, martensite, Time Temperature Transformation (TTT) diagrams, Continuous Cooling Transformation (CCT) diagrams, Precipitation and Age hardening, Recovery, Recrystallization and Grain growth, Classification of cast irons

UNIT – V: Heat Treatments: Annealing and its types, Normalizing, Hardening and Tempering, Case hardening: Carburizing, Nitriding, Carbonitriding, Flame hardening and Induction hardening, Classification and effect of alloying elements, Properties and uses of alloying elements, Types of alloy steels and its designations.

Books:

1. Materials Science and Engineering – V. Raghavan
2. Physical Metallurgy – V. Raghavan
3. Material Science and Engineering – Callister
4. Introduction to Physical Metallurgy – Avner
5. Material science and Metallurgy – V. D. Kodgire, S. V. Kodgiri

*L-T-P-C stands for number of lectures, tutorials, practices and credits

MM2102 **MINERAL PROCESSING**

Externals: 60Marks **L-T-P-C***

Internals: 40Marks **4-0-0-4**

Objectives:

* To understand the basic concepts and operations of ore dressing
* To understand the behavior of minerals in fluids for sizing and concepts of sizing operations
* To study the classification of minerals based on their density, size and shape in different mediums
* To study various concepts of separating minerals from tailings.

UNIT-I

Scope and objectives of ore dressing. Sampling of ores by different methods. Theory of liberation of minerals. Crushers: -Jaw, Gyratory, Cone, Rolls and toothed roll crushers. Types of grinding operations like batch and continuous dry and wet grinding, open circuit and closed circuit grinding. Grinding Mills: Ball mills, theory of ball mill operation, rod and tube mills. Comminution laws: - Rittinger's laws, Kick's law and Bond's law.

UNIT-II

Sizing: Study of laboratory sizing techniques and reporting of sizing data. Industrial sizing units: Types of screen surfaces. Grizzlies, trommels, vibrating and shaking screens. Movement of solids in fluids: Stokes and Newton's laws. Terminal velocity and its relation with size. Relation between time and velocity. Relation between distance traveled and velocity. Equal settling ratio, Free and hindered settling ratios. Quantifying concentrating operations: Ratio of concentration, recovery, selectivity index and economic recovery.

UNIT-III

Classification of classifiers, study of settling cones, rake classifier, spiral classifier and cyclones.Heavy media separation: Principles, flow chart, different media used. Heavy media separation using heavy liquids and heavy suspensions. Washability curves for easy, normal and difficult coal.

UNIT-IV

Jigging: Theory of jigging. Jigging machines: hand jig, harz jig, denner jig baum jig, Hancock jig, James coal jig and halkyln jig. Design considerations in a jig. Tabling: -study of stratification on a table. Shaking tables, wilfley table. Humphrey's spiral classifier.

UNIT-V

Flotation: Principles of flotation.Factors affecting flotation.Classification of collectors and frothers.Regulators factors affecting their efficiency. Flotation machines: -Pneumatic and mechanical flotation cells. Application of flotation process for Cu,Pb and Zn ores. Magnetic separation processes and electrostatic separation process.

TEXT BOOKS:

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

2. Ore Processing by S.K Jain

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MM2103 METALLURGICAL THERMODYNAMICS

Externals: 60Marks **L-T-P-C***

Internals: 40Marks **4-0-0-4**

Objectives:

* To understand the concepts of thermodynamics.
* To study and understand different laws of thermodynamics and their applications.
* To study the kinetics of thermodynamic reactions in the system.
* To study and understand Ellingham and Phase stability diagrams.

UNIT-I

Importance of thermodynamics, definition of thermodynamic terms; concept of states, systems equilibrium. Equation of states, extensive and intensive properties, homogeneous and heterogeneous systems. Gibbs phase rule, Phase diagram of a single component system. Internal energy, heat capacity, enthalpy, isothermal, and adiabatic processes.

UNIT-II

The Second law of thermodynamics, entropy and free energy, degree of reversibility and irreversibility, criteria of equilibrium, auxiliary functions, combined statements, Maxwell's relations, transformation formula, Gibbs- Helmoltz equation.

UNIT-III

Concept of Third law, temperature dependence of entropy, statistical interpretation of entropy, Deby and Einstein concept of heat capacity, relation between Cp and Cv, Consequences of third law, Fugacity, activity, equilibrium constant, chemical potential, use of Y S - functions, controlled atmospheres, homogeneous and heterogeneous equilibria.

UNIT-IV

Ellingham-Richardson diagrams, phase stability diagrams. Solution thermodynamics, Solutions, partial molal quantities, ideal and non-ideal solutions, Henry's law, Gibbs - Duhem equation, regular solution, quasi-chemical approach to solution, statistical treatment. Change of standard state. Phase relations and phase rule-its applications. Free energy composition diagrams for binary alloysystems, determination of liquidus, solidus and solvus lines.

UNIT-V

Thermodynamics of electrochemical cells, solid electrolytes. Thermodynamics of point defects in solids. Thermodynamic applications in extraction, refining of metals and materials processing.

TEXT BOOK:

1. Introduction to Metallurgical Thermodynamics – D.R. Gaskel
2. Text Book of Materials and Metallurgical Thermodynamics: Ahindra Ghosh (PHI)

REFERENCES:

1. Physical chemistry for Metallurgists – J. Mackowick
2. Thermodynamics of solids-R.S.Swalin
3. Physical chemistry of metals-L.S.Darken & Gurry
5. Fundamentals of thermodynamics-Sonntag et al

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MM2104 **FOUNDRY TECHNOLOGY**

Externals: 60Marks **L-T-P-C***

Internals: 40Marks **4-0-0-4**

Objectives:

* To understand the basic concepts of casting tools and equipment for mold preparation
* To design the pattern and understand the pattern and core characteristics
* To understand the designing of the gating system and riser
* To study various other casting processes suiting various applications
* To study about the melting furnaces along with the testing methods and identify the defects

UNIT – I :

Introduction: Introduction and overview of subject, Foundry processes – Molding & Casting, Casting in green sand mold, Foundry tools and equipment, Mold materials and their selection, Molding sands, Constituents of molding sand, Sand preparation and conditioning, Characteristics of molding sand, Molding sand for casting different materials

UNIT – II :

Patterns and Molds: Pattern colors, Pattern materials, Pattern allowances, Types of patterns, Cores, Types of cores, Characteristics of core, Core materials, Types of molds.

UNIT – III :

Gating System and Risers: Solidification of casting, designing gating system in sand molds, Gating ratio, Types of gates, designing of risers.

UNIT – IV :

Casting methods: Sand mold casting, Metallic mold casting, Slush casting, Pressure casting, Die casting, Centrifugal casting, Shell molding, Investment casting, Continuous casting, Chill casting and Metals and alloys used in casting.

UNIT – V :

Testing: Inspection and testing of casting, Testing of molding sands, **Metal melting furnaces:** Crucible, Electric, Cupola, Rotary; Casting defects – appearance, cause and remedies.

Books:

1. Metal casting Technology – P. N. Rao
2. Foundary Technology – O. P. Khanna
3. Manufacturing Technology – P. N. Rao
4. Production Engineering – Dr. Swadesh Kumar Singh
5. Manufacturing Processes – J. P. Kaushish

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BSBE2001/3001 ENVIRONMENTAL SCIENCES

Externals: 60 Marks **L-T-P-C**
Internals: 40 Marks **4-0-0-3**

Learning Objectives:

The syllabus aims to:

- Stimulate interest in the environment and endeavours to generate awareness about environmental concerns among students.
- Develop an understanding of how natural resources and the environment affect quality of life and the quest for sustainable development.
- Develop knowledge and understanding of environmental issues and principle and apply their knowledge to mitigate the environmental problems.
- Understand and resolve some of today's most challenging scientific and policy issues—including global climate change, pollution, biodiversity conservation, sustainability, environmental pollution and toxic waste disposal, disease control, disaster management, socio-environmental issues and balancing resource use and preservation.
- Design and evaluate strategies, technologies, and methods for sustainable management of environmental systems and for the remediation or restoration of degraded environments.
- Recognizes the global changes and responses for attaining a more sustainable environment.

UNIT 1: MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES

Definition, scope and importance, need for public awareness.

UNIT 2: NATURAL RESOURCES:

Renewable and non-renewable resources : Natural resources and associated problems.

a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.

b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

d) Food resources: World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

e) Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources.

f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

- .Role of an individual in conservation of natural resources.
- Equitable use of resources for sustainable lifestyles.

UNIT 3: ECOSYSTEMS & BIODIVERSITY

Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids.

Introduction, types, characteristic features, structure and function of the following ecosystems:-

a. Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem, d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).
b. Biodiversity- Definition : genetic, species and ecosystem diversity. Biogeographical classification of India Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values.
c. Biodiversity at global, National and local levels. Inida as a mega-diversity nation Hot-sports of biodiversity.
d. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT 4: ENVIRONMENTAL POLLUTION

Definition, Cause, effects and control measures of :- Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards

- Solid waste Management: Causes, effect s and control measures of urban and industrial wastes.
- Role of an individual in prevention of pollution
- Pollution case studies.
- Disaster management: floods, earthquake, cyclone and landslides.
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies.
- Environment Protection Act., Air (Prevention and Control of Pollution) Act. Water Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act .

UNIT 5 : SOCIAL ISSUES & THE ENVIRONMENT

Human Rights. Value Education. HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.

Field work: Visit to a local area to document t environmental assets river/ forest/grassland/hill/mountain Visit to a local polluted site-Urban/Rural/Industrial/Agricultural . Study of common plants, insects, birds. Study of simple ecosystems-pond, river, hill slopes, etc.

REFERENCES :

a). Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.

b). Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad- 380 013, India, Email:mapin@icenet.net (R)

c). Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p

d) Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)

e). Cunningham, W.P. Cooper, T.H. Gorhan i, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 116p .

HS2101 **Soft Skills- I**

Externals: **L-T-P-C***
Internals: **2-0-0-1**

Objectives:

- To implement practically the skills needed for employment.
- To deal with the society in an acceptable way.
- To make them competent to attempt and qualify in various tests.
- To make them proficient in using vocabulary in various situations.

UNIT-I

Vocabulary Building – Teaching Root words – Word association - How to talk about Personality Type - How to talk about Doctors - How to talk about Various Practitioners - How to talk about Science and Scientists - How to talk about various Speech Habits - How to insult your enemies - How to flatter your friends - How to talk about a variety of personal characteristics - How to talk about actions

UNIT-II

Common Errors in English

UNIT-III

Twenty -four seven - L for gist - NDTV debates - L for specific information - Ted Talks - L for detail - Devils' Advocate - **Picture perception** – Describing people, paintings, cartoons etc.

UNIT-IV

Read between the lines – R for Pleasure - Reading Newspaper - Movie Reviews **- R for Specific information –** Essays - Textbooks

UNIT-V

Now you are talking - Giving Opinions - Stating Facts - Agree and disagree - Decisions and Intentions - Raising Questions - Giving and receiving effective feedback

UNIT –VI

Writing Dailogue

Suggested References:

1. **Word Power Made Easy**
2. **Ted Talks**
3. **NDTV Talks**
4. **Newspapers (The Hindu, Times of India)**

MM2701 **PHYSICAL METALLURGY LAB**

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **0-0-3-2**

Objectives:

* To provide hands on experience of different metallographic operations
* To study and understand microstructures of different metals
* To analyze results and draw conclusions from the results of the tests

List of experiments:

1. Study of optical microscopes.
2. Sample preparation for microscopy
3. To study the annealed and normalized microstructures of ferrous materials
   Steels (Low, Medium and High carbon steels)
   Stainless steel
   Cast irons (Gray, White and Nodular cast irons)
4. To study the microstructures of non – ferrous materials
   Aluminium
   Copper
   Brass
5. To study the effect of cold working (0-90%) and annealing on metallic materials; 50% cold worked metals (Cu, Brass) with respect to temperature and time.
6. Metallography analysis of microstructures.
7. Demo of sampling by electro polishing method.

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MM2702 **FOUNDRY TECHNOLOGY LAB**

Externals: 60Marks **L-T-P-C ***
Internals: 40Marks **0-0-3-2**

Objectives:

* To provide hands on experience of foundry operations
* To design patterns and sand moulds
* To simulate and analyse the results of casting operation.

List of experiments:

Testing of molding sands

1. To test the size of sand grains and the distribution of grains of different sizes in a molding sand.
2. To prepare a sand mold and produce an aluminum casted product.
3. To determine the permeability number of the sand specimen.
4. To determine the green, dry and shear strength of the sand mold.
5. To determine the moisture content in the sand mold.
6. To determine the hardness of the mold.
7. To design a pattern by considering pattern allowances.
8. To design a gating system for minimum pouring time.
9. To design a riser for optimum solidification time.
10. Simulations using PRO CAST software.

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MM2901 **SEMINAR – I**

Externals: 60Marks **L-T-P-C***

Internals: 40Marks **0-0-2-1**

Objectives:

- To improve the presentation skills
- To prepare PPT more effectively

Student has to choose a general topic to give a power point presentation