Metallurgical and Materials Engineering

Course Structure and Detailed Syllabus

III YEAR
I SEMSESTER

SL. No.	CODE	SUBJECT	L – T – P	CREDITS
1.	MM3101	Mechanical Working Of Materials	4-0-0	4
2.	MM3102	Steel Making	4-0-0	4
3.	MM3103	Heat treatment	4-0-0	4
4.	MM3104	Polymer Engineering and Technology	4-0-0	4
5.	MM3105	Composite Materials and Processing	4-0-0	4
6.	BM3101	Personality Development	2-0-0	1
7.	MM3701	Mechanical Working Of Materials lab	0-0-3	2
8.	MM3702	Heat treatment Lab	0-0-3	2
9	MM3901	Seminar – II	0-0-1	1
Total			22-0-7	26

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

MM3101 MECHANICAL WORKING OF MATERIALS

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

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

Objectives:

* To understand the basic concepts of the stress and strain for different materials
* To study about the cold, warm and hot deformation processes
* To analyze the parameters affecting the deformation processes like forging, rolling, extrusion and drawing
* To study and analyze various sheet metal forming processes like bending, deep drawing, etc

UNIT – I:

Stress-strain relations in elastic and plastic deformation, concept of flow stress, deformation mechanisms, basic metal working concepts and plasticity, yield criterion, slip line fields, role of temperature and friction in metal working.

UNIT – II:

Hot and cold working, forging, rolling – types, analysis, parameters affecting the process, defects, their causes and remedial measures.

UNIT – III:

Extrusion, wire and tube drawing – types, analysis, parameters affecting the process, defects, their causes and remedial measures.

UNIT – IV:

Sheet metal working processes – Classification of metal forming processes, estimation of force and energy requirements; Metals used in press working, Lubrication, press, theory of shearing, shearing operations, blanking, piercing, bending and stretch forming.

UNIT – V:

Deep drawing, hydro forming, coining and embossing – types, parameters affecting the process, lubrication in metal forming processes, defects in various sheet metal forming processes, their causes and remedial measures

Books:

1. Mechanical Metallurgy – Dieter
2. Production Engineering – Dr. Swadesh Kumar Singh
3. Manufacturing processes – J.P. Kaushish

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MM3102 **STEEL MAKING**

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

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

Objectives:

* To study past present and future of steel making
* To study and understand thermodynamics and kinetics of the reactions during steel making
* To study and understand primary and secondary steel making operations
* To study the casting and rolling operation performed to produced final steel product.

UNIT-I

History of steel Making, Classification of Steel making Processes. Raw materials for steel making. Factors affecting efficiency of steel making, Energy in Iron and Steel Industry.

UNIT-II

Metallurgical Thermodynamics in Steel Making– Chemical Equilibrium - Activity and Equilibrium Constant G0 for Oxides - Activity Composition Relationships - Concentrated Solutions – Dilute Solutions - Chemical Potential and Equilibrium.

Fluid Dynamics - Inference of Fluid Flow in steelmaking - Force Balance Expressions and Momentum Conservation Equations – Boundary Conditions - Laminar and Turbulent Flows - Calculation of Turbulent Flows in Steelmaking.

Heat Transfer - Mechanism of Heat Transfer - Heat Conduction - Convective Heat Transfer -Radiation.

Mass Transfer and Metallurgical Kinetics -Mechanism of Mass Transfer Molecular Diffusion - Convective Mass Transfer – Chemical Reaction Kinetics.

UNIT-III

Primary Steel Making

Oxygen Steel Making: Pre - treatment of Hot Metal, Classification of Steels and the Role of Impurity Elements, Steelmaking Fundamentals – Chemical Reactions Equilibria - Carbon - Oxygen Reaction- Phosphorous - Oxygen Reaction - Manganese - Oxygen Reaction - Silicon - Oxygen Reaction - Sulphur - Oxygen Reaction (Desulphurization) - Iron-Oxygen Reaction - Slag Formation - Role of Slag - Basicity - Foaming Tendency - Oxidizing/Reducing Potential of Slag. The LD Steelmaking (Practice) process - The LD Converter - Lance - LD Shop Layout – Charge Calculations - Feed Materials - Physico - Chemical Characteristics of LD Steelmaking - Description of a Typical Heat - Exit Gases - Tapping - Modern Trends - Post Combustion - Slag Splashing, Bottom Blown Steelmaking. The Evolution of Combination Blown, Steelmaking and its Distinctive Features.

UNIT-IV

Primary Steel Making

Electric Steelmaking: Steelmaking in Electric Arc Furnaces (EAF) -Construction of an Arc Furnace - Operation - Steelmaking in EAF - Eccentric Bottom Tapping - Comparison with Oxygen Steelmaking - Environmental issues in Arc Furnace Steelmaking. Developments in EAF steelmaking Technology - Oxygen lancing including Co jet - Gas injection through bottom - Post Combustion – Automation and Process control.

Alloy Steelmaking in EAF with Some Example

UNIT-V

Secondary Steel Making

Impact of Slag carry over in the Ladle, Deoxidation in the Ladle: Reactions, Kinetics and products, Ladle metallurgy: Construction, Inert gas stirring, Temperature and composition control, Injection Metallurgy, vaccum Degassing, Tundish Metallurgy, Solidifaction and Continous casting.

TEXT BOOK;

1. Steel Making – A. K. chakrabarthi (PHI) 2007

2. Iron Making & Steel Making Theory and Practice - Ahindra Ghosh & Amit chatterjee

REFERENCES;

1. Modern Steelmaking – Dr. R.H. Tupkary and V.H. Tupkary

2. Steel Making – V. a. Kudrin

3. Fundamentals of Steel Making practice - Brahma Deo & Rob Boom

4. Secondary Steel Making; Principles and applications – Ahindra Ghosh

5. Physical Chemistry of Iron & Steel by Boodsworth

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MM3103 **HEAT TREATMENT**

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

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

Objectives:

* To introduce the concept of heat treatment and its classification
* To understand nucleation and growth kinetics, precipitation in age-hardening alloys, austenitic, eutectoid, pearlitic and bainitic transformations in steel.
* To analyze diffusionless transformations and hardenability
* To study different surface treatments
* To note different ferrous and non-ferrous heat treatments.

Unit 1: Introduction

Introduction, time-temperature parameters of a heat treatment process, classification of heat treatment processes, heat treatment as applied to the products of steel-making industry, machine building and automobile industry, tool making industry, etc.;

Unit 2: Diffusional transformation and principles of heat treatment:

Homogeneous nucleation in solids, heterogeneous nucleation, precipitate growth, overall transformation kinetics – TTT diagram, precipitation in age-hardening alloys, austenitic transformation, eutectoid transformation, pearlitic and Bainitic transformations in steel, continuous cooling diagrams, massive transformations, and order-disorder transformation.

Unit 3: Diffusionless transformations and hardenability:

Introduction to diffusionless transformation, martensitic transformation, martempering, Concept of critical diameter, joining-endquench test, effect of parameters viz: alloying elements, carbon content, austenic grain size, retained austenite, section size and quenching media.

Unit 4: Surface treatments:

Surface heat treatment, carburizing, cyaniding, flame and induction hardening, residual stresses, deep freezing, thermo mechanical treatments: HTMT, LTMT, Ausforming, Isoforming, Cryoformy.

Unit 5: Heat treatment processes:

Heat treatments of some important steels, cast irons (along with their classifications), Heat treatment of non-ferrous alloys: Precipitation hardening, aging treatment, study of copper and its alloys, aluminum and its alloys, nickel and its alloys.

TEXT BOOKS:

1. Rajan, T. V and Sharma, C. P., Heat treatment principles and techniques (2nd edition), Prentice hall of India, 1994.
2. Reed-Hill, R, E and Abbaschian, R., Physical Metallurgy Principles (3rd edition), PWS-Kent publishing company, 1994.
3. Raghavan, V., Physical metallurgy: principles and practice (2nd edition), Prentice hall of India, 1994.

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MM3104 **Polymer Engineering & Technology**

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

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

Objectives:

- ✓ To introduce the characteristics which distinguish polymers from their analogous class in materials engineering – with study of definition, classification, structure-&-properties relations & Processing for engineering & technical aspects.
- ✓ To discuss the reactions of polymers that are useful of modifying or synthesizing new polymers for structural, functional applications.
- ✓ To discuss characterization & fundamental testing methods of polymers & polymer blends.
- ✓ To discuss advances in polymers with conductive, smart, power polymer, etc. And environmental aspects of polymers.

UNIT-I

Introduction: Basic concepts, classification of polymers, structure and size & molecular weight relations, tacticity & isomerism and morphology relations in polymers.

UNIT-II

Chemistry of polymerization & properties: Condensation & addition polymers – types & their engineering, copolymerization & their techniques, control of polymer structure and molecular weights.

UNIT-III

Polymer characteristics and polymer characterizations: Elastomeric and Visco-elastic behaviours, glassy state, characterization techniques of polymers.

UNIT-IV

Plastics & Rubbers, Polymer blends & composites: Plastics & rubbers – materials & processing techniques.

UNIT-V

Miscellaneous polymers, polymers & their environmental impacts: Conductive and dendritics, inorganic and power polymers, nanotechnology. Recovery & recrystallization of polymers. Polymer – waste management.

Suggested References:

1. 'Polymer Science and Technology' - by - P.Ghosh
2. 'Polymer Science' – by - VR Gowariker, N V Viswanathan, Jayadev Sreedhar.
3. 'Textbook of Polymer science' – by – Fred W. Billmeyer Jr.

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MM3105 COMPOSITE MATERIALS AND PROCESSING

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

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

Objectives:

- ✓ To study the fundamentals, classifications and properties of composites.
- ✓ To study various methods of producing Metal Matrix, Ceramic Matrix and Polymer Matrix composites.
- ✓ To Characterize and analyse MMC's, CMC's, PMC's prepared.
- ✓ To study advanced methods of producing composites

UNIT –I

Fundamentals of composites; Need for composites – Enhancement of properties; Classification of composites – Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC); Reinforcements– introduction, glass fibers, boron fibers, carbon fibers, organic fibers, ceramic fibers, whiskers, nonoxide reinforcements, effect of high temperature exposure on the strength of ceramic fibers, comparison of fibers; Matrix materials – polymers, metals and ceramic materials; Interfaces. Iso Strain condition, Iso Stress condition, Load friction shared by the fibers.

UNIT – II

Polymer matrix resins – Thermosetting resins, thermoplastic resins – Reinforcement fibers – Rovings – Woven fabrics – Non woven random mats – various types of fibers. Processing of PMCs - Hand lay up processes – Spray up processes – Compression moulding – Reinforced reaction injection moulding - Resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fiber reinforced plastics (FRP), Glass fiber reinforced plastics (GRP); Structure & properties of PMCs; Applications.

UNIT – III

Characteristics of MMCs; Various types of MMCs; Alloy vs. MMC; Advantages & limitations of MMCs; Important Metallic Matrices; Reinforcements – particles, fibers; Processing of MMCs – liquid state, solid state & in-situ; interfaces in MMCs; Properties & applications.

UNIT – IV

Processing of CMCs – cold pressing & sintering, hot pressing, reaction bonding, infiltration, direct oxidation, in-situ chemical reaction, solgel, polymer infiltration & pyrolysis, electrophoretic deposition, selfpropagating high temperature sysnthesis; Interface in CMCs;

Properties of CMCs, Toughness of CMCs; Thermal shock resistance; Applications of CMCs.

UNIT – V

Forging and extrusion of composites – critical issues, dynamic recovery and dynamic recrystallization, mechanical properties; Induction Heating, Fusion Bonding, Ultrasonic welding, Gas tungsten arc welding, Gas metal arc welding, Resistance spot & seam welding, Resistance brazing, Resistance spot joining, Resistant spot brazing, Resistance welding of thermoplasticgraphite composite, Weld bonding, Brazing of MMC.

TEXT BOOKS;

1. Mathews F.L. and Rawlings R.D., Composite materials: Engineering and Science, Chapman and Hall, 1st edition.
2. Composite Materials science and Application –Deborah.D.L.Chung
3. Composite materials, K.K. Chawala, 2nd ed., (1987) Springer-Verlag, New York.

REFERENCE;

1. Hand Book of Composite Materials-ed-Lubin
2. Composite Materials Science and Applications – Deborah D.L. Chung
3. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi
4. Mechanics and Analysis of Composite Materials, V.V. Vasiliev and E.V. Morozov, (2001), Elsevier Science Ltd,
5. Advances in composite materials, G. Piatti, (1978) Applied Science Publishers Ltd., London

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BM3101 PERSONALITY DEVELOPMENT -I

Guidelines: Learning approach is based on Real time case studies with class room activities

Course Objectives:

1. To develop interpersonal skills and be an effective goal oriented team player.
2. To develop professionals with idealistic, practical and moral values.
3. To develop communication and problem solving skills.
4. To re-engineer attitude and understand its influence on behavior.
5. To enhance holistic development of students and improve their employability skills.

UNIT I-SELF ANALYSIS (6 hours)

SWOT Analysis, Who am I, Personality Traits, Importance of Self Confidence, Self Esteem.

UNIT II-GOALS SETTINGS (6 hours)

Short term , Long term goal settings, SMART concept
Diversifying Risk and Optimizing Opportunities

UNIT III- TEAM DYNAMICS WITH INTERPERSONAL SKILLS (8 hours)

Team Dynamics, Team Work, Interpersonal Skills

Behavioral Skills GD, PI, Body Language Public Speaking, Verbal, Non Verbal Communications

UNIT II-CREATIVITY and Rationality (8 hours)

Out of Box thinking, Idea Generation with creativity

Brain Storming, Effective group meetings, Rationalization of ideas and way to effective implementation

.Class room and team activities coupled with group tasks depending upon time availability

MM3701 MECHANICAL WORKING OF MATERIALS LAB

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

Internals: 40Marks **0-0-3-2**

Objectives:

- To understand the designing of tool setup and simulate in realistic conditions for various deformation processes
- To analyze the simulated deformed material at various stages during the deformation process
- To conduct the experiment and compare the experimental and simulated results

List of experiments:

1. To design the setup and analyze the deep drawing process in simulation software.
2. To design the setup and analyze the die bending process in simulation software.
3. To design the setup and analyze the air bending process in simulation software.
4. To determine the spring back and thickness variations of dual phase steel sheet in air bending by comparing the simulation and experimentation results.
5. To determine the spring back and thickness variations of aluminum sheet in air bending by comparing the simulation and experimentation results
6. To determine the spring back and thickness variations of copper sheet in air bending by comparing the simulation and experimentation results.
7. To determine the bend allowances for different materials.
8. To design the setup for extrusion in simulation software for bulk deformation.
9. To design the setup for forging in simulation software for bulk deformation.

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MM3702 **HEAT TREATMENT LAB**

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

Internals: 40Marks **0-0-3-2**

Objectives:

* To provide hands on experience of different heat treatment processes
* To understand the transformations associated with these heat treatments and their influence on mechanical properties of materials being tested.
* To analyze results and draw conclusions from the results of the tests

List of Experiments:

1. Annealing of medium carbon steel and observation of microstructure.
2. Normalizing of medium carbon steel and observation of microstructure.
3. Hardening of medium carbon steel and observation of microstructure.
4. Study of tempering characteristics of water quenched steel.
5. Study of age hardening phenomena in duralumin.
6. Spheroidizing of a given high carbon steel.
7. Determination of hardenability of medium carbon steel by Jominy end Quench Test.

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Suggested References:

1. Rajan, T. V and Sharma, C. P., Heat treatment principles and techniques (2nd edition), Prentice hall of India, 1994.
2. Reed-Hill, R, E and Abbaschian, R., Physical Metallurgy Principles (3rd edition), PWS-Kent publishing company, 1994.
3. Raghavan, V., Physical metallurgy: principles and practice (2nd edition), Prentice hall of India, 1994.

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MM3901 **SEMINAR – II**

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

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

Objectives:

• To improve the presentation skills

• To prepare PPT more effectively

Student has to choose a topic related socio-economic matter to give a power point presentation**.**