

# COURSE PLAN

Fr. CRCE (Mechanical)

Academic year: 2022-23

## Fr. Conceicao Rodrigues College Of Engineering

Father Agnel Ashram, Bandstand, Bandra-west, Mumbai-50

Department of Mechanical Engineering

S.E. (Mechanical) (Semester III) (2022-2023)

### Course Plan

Subject: Materials & Metallurgy (M&M)

Credits – 03

### Syllabus Mechanical Engineering

Module	Contents	Hrs
01	<p><b>1.1 Classification of materials:</b> Introduction to engineering materials – significance of structure property correlations in all classes of engineering materials.</p> <p><b>1.2 Concepts of crystals-</b> Crystalline and Non-crystalline Materials Unit cell, Crystal structures of metals, Crystal systems, Crystallographic planes and directions.</p> <p><b>1.3 Crystal Defects:</b> Crystal Imperfections-definition, classification and significance of imperfections -point defects, line defects, Surface defects and volume defects. Importance of dislocations in deformation and its mechanisms. Critical Resolved shear stress, Slip systems and deformability of FCC, BCC and HCP lattice systems.</p> <p><b>1.4 Cold Working and Recrystallization annealing:</b> Definition, effects and mechanism of cold work, Need for Recrystallization Annealing, the stages of recrystallization annealing and factors affecting it</p>	08
02	<p><b>2.1 Mechanism of Crystallization-</b> Nucleation-Homogeneous and Heterogeneous Nucleation and Growth. Solidification of metals and - alloys– Cooling curves</p> <p><b>2.2 Classification of Alloys based on phases and phase diagram-</b> Binary alloy phase diagram – Isomorphous, Eutectics type I and II, Peritectic</p> <p><b>2.3 Iron-Iron carbide phase diagram</b> – Invariant reactions – micro structural changes of hypo and hyper-eutectoid steel- TTT and CCT diagram-Hardenability and its tests, Graphitization in cast irons.</p>	08
03	<p><b>3.1 Heat treatment:</b> Overview – Objectives – Thorough treatments: Annealing and types, normalizing, hardening and tempering, Austempering and Martempering – microstructure changes</p> <p><b>3.2 Surface hardening processes:</b> Carburizing – nitriding – cyaniding and carbonitriding, induction and flame hardening, Laser and Electron beam hardening– principles and case depths</p> <p><b>3.3 Alloy steels-</b>Stainless steels, Tool steels, Maraging steels and Ausformed steels</p>	06

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<b>04</b>	<p><b>4.1 Strengthening mechanisms in materials</b></p> <p><b>4.2 Fracture of metals</b> – Ductile Fracture, Brittle Fracture, Ductile to Brittle Transition Temperature (DBTT), Griffith’s criteria and Orowan’s modification</p> <p><b>4.3 Fatigue</b> – Endurance limit of ferrous and non-ferrous metals -Fatigue test, S-N curves, factors affecting fatigue, structural changes accompanying fatigue;</p> <p><b>4.4 Creep</b> – mechanism of creep – stages of creep and creep test, creep resistant materials</p>	<b>06</b>
<b>05</b>	<p><b>5.1 Composites:</b> Basic concepts of composites, Processing of composites, advantages over metallic materials, various types of composites and their applications</p> <p><b>5.2 Nano Materials:</b> Introduction, Concepts, synthesis of nanomaterials, examples, applications and Nano composites</p> <p><b>5.3 Introduction to Smart materials:</b> Classification, Shape Memory Alloys and its applications</p>	<b>06</b>
<b>06</b>	<p><b>6.1 Engineering Polymers and Ceramics</b>-types and their advantages over metallic materials</p> <p><b>6.2 Processing-</b> of ceramics and composites through Injection Moulding</p> <p><b>6.3 Non destructive Testing of Materials</b>-ultrasonic testing, radiographic methods, magnetic particle testing</p>	<b>04</b>

Co No.	Course Outcomes
<b>CO1</b>	Identify the various classes of materials and comprehend their properties.
<b>CO2</b>	Apply phase diagram concepts to engineering applications.
<b>CO3</b>	Apply particular heat treatment for required property development.
<b>CO4</b>	Identify the probable mode of failure in materials and suggest measures to prevent them.
<b>CO5</b>	Choose or develop new materials for better performance.
<b>CO6</b>	Decide an appropriate method to evaluate different components in service.

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	2										
<b>CO2</b>	3	2	3									
<b>CO3</b>	3	2	3									
<b>CO4</b>	3	3	3	3								
<b>CO5</b>	3	2	3									
<b>CO6</b>	3	2		3								

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CO-PSO Mapping	PSO1	PSO2
CO1	2	
CO2	3	
CO3	2	
CO4	3	
CO5		3
CO6	2	

*Target = 2 for all COs*

FINAL CO	=	$(0.8 * \text{Direct}) + (0.2 * \text{Indirect})$
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<b>Direct</b>	CO1	$(0.7 * \text{Test}) + (0.3 * \text{Univ Exam})$
	CO2	$(0.7 * \text{Test}) + (0.3 * \text{Univ Exam})$
	CO3	$(0.7 * \text{Test}) + (0.3 * \text{Univ Exam})$
	CO4	$(0.7 * \text{Test}) + (0.3 * \text{Univ Exam})$
	CO5	$(0.7 * \text{Test}) + (0.3 * \text{Univ Exam})$
	CO6	$(0.7 * \text{Test}) + (0.3 * \text{Univ Exam})$

<b>Indirect</b>	CO1	$(1 * \text{Exit Survey})$
	CO2	$(1 * \text{Exit Survey})$
	CO3	$(1 * \text{Exit Survey})$
	CO4	$(1 * \text{Exit Survey})$
	CO5	$(1 * \text{Exit Survey})$
	CO6	$(1 * \text{Exit Survey})$

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## LESSON PLAN

Note: - Content beyond syllabus (CBS) is in **bold**

<b>Weekly Plan</b>	<b>Topic</b>	<b>Module</b>	<b>Hours</b>
<b>Week 1</b> (25/07/22 – 27/07/22)	Introduction, Classification of materials, Introduction to engineering materials – significance of structure property correlations in all classes of engineering materials. Introduction to Metal, Ceramics, Polymers, Composites, Advanced materials. Biomaterials and Semiconductors. Smart Materials, Nanomaterials.	1	3
<b>Week 2</b> (01/08/22 – 05/08/22)	Concepts of crystals, Solidification of metals. Nucleation & Growth. Structure of Ingots and Casting. Ingot defects and remedies (Shrinkage, Porosity). Ingot defects and remedies (Gas porosity). Single & Polycrystals.	1,2	3
<b>Week 3</b> (08/08/22 – 12/08/22)	Intro to Crystal imperfection–Vacancy & Interstitial. Crystal imperfection – Vacancy & Interstitial. Substitution/Interstitial Solid Solution. Theory of alloying. Classification of alloys. Edge Dislocations. Screw and Mixed dislocations. Grain boundary and Stacking fault. Frank-Reed Mechanism. Dislocation interaction. Deformation (Elastic and Plastic) Crystal structure (FCC, BCC, and HCP). Slip system – BCC, FCC, HCP.	1	3
<b>Week 4</b> (15/08/22 – 19/08/22)	Critical Resolved Shear Stress. Deformation of Single crystal & Polycrystals. Dislocation motion and Grain boundary. Reducing grain size for strengthening, Solid solution strengthening, Precipitation strengthening, Strain hardening, Recovery. Recrystallization, Grain Growth. Factors affecting the recrystallization temperature. Types of Fracture.	1, 4	3
<b>Week 5</b> (22/08/22 – 26/08/22)	Evolution to failure in ductile materials. Types of Brittle fracture, Ductile-to-brittle transition. Fatigue, Fatigue cycles. Fatigue testing, S-N curve, Stages of fatigue. Factors that affect fatigue life. Creep. Effect of temperature on creep, Creep test. Creep curve.	4	3
<b>Week 6</b> (29/08/22 – 02/09/22)	Alloy Phase Diagrams–Component, Phases. Solubility limit. Effect of temperature & composition on the Alloy Phase Diagrams. Lever rule. Microstructure development. Binary Eutectic Phase diagram. Hypoeutectic and Hypereutectic composition. Formation of Eutectic structure. Eutectic reactions. Eutectoid and Peritectic reactions. The Iron-Iron Carbide Phase Diagram.	4, 2	3
<b>Week 7</b> (05/09/22 – 09/09/22)	<b>UNIT TEST – 1</b>		
<b>Week 8</b> (12/09/22 –	Creep test. Creep curve. Alloy Phase Diagrams–Component, Phases. Solubility limit. Effect of temperature & composition	2, 3	3

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16/09/22)	on the Alloy Phase Diagrams. Lever rule. Microstructure development. Binary Eutectic Phase diagram. Hypoeutectic and Hypereutectic composition. Formation of Eutectic structure. Eutectic reactions. Eutectoid and Peritectic reactions. The Iron-Iron Carbide Phase Diagram.		
<b>Week 9</b> (19/09/22 – 23/09/22)	Annealing, Spheroidizing, Process annealing, Stress relieve annealing, Normalizing, Hardening, Quenching. Tempering, Allotrope of Iron. Hypoeutectoid and Hypereutectoid steel. Growth of eutectic pearlite. The Iron-Iron Carbide Phase Diagram. Hypoeutectoid & Hypereutectoid steel.	3	3
<b>Week 10</b> (26/09/22 – 30/09/22)	Heat treatment – Definition, Time-Temperature-Transformation (TTT) Time-Temperature-Transformation (TTT), Heat treatment curve superimposed on TTT diagram. Bainite. Gave seminar topic. Martensite, Spheroidite, Continuous Cooling Curve (CCT). Martempering, Austempering, Ausforming, Maraging, Carburizing, Nitriding, Cyaniding, Flame & Induction Hardening. Heat treatment defects. Effect of Alloying Elements in Steels. Composites – Classifications, Particle-reinforced Fibers-reinforced composites. MMC, CMC & PMC. Composite manufacturing processes.	3, 5	3
<b>Week 11</b> (03/10/22 – 07/10/22)	Composite manufacturing processes. Composites: Basic concepts of composites, advantages over metallic materials, various types of composites and their applications, Manufacturing Processes for Thermoset Composites – Hand Lay Up, Spray Up, Filament Winding, Pultrusion, Resin Transfer Molding, Structural Reaction Injection Molding, Compression Molding. Nanostructure Material. Nano Materials: Introduction. Classification of Nano materials. Fabrication methods: Top down processes - Milling, Lithographics, machining process. Bottom-up process Nano materials: Introduction. Classification of Nano materials. Fabrication methods: Top down processes - Milling, Lithographics, machining process. CVD, PVD, Sol-Gel. Bottom-up process. Ceramics.	5, 6	3
<b>Week 12</b> (10/10/22 – 14/10/22)	Ceramics processing, Non destructive Testing of Materials, Ultrasonic testing, radiographic methods, magnetic particle testing, Jominy end quench test, Sample preparation. Ultrasonic testing, Tensile testing, Compression testing, Bending test, Effect of alloying elements on steel, Stainless steel, Tool steel	6	3
<b>Week 13</b> (17/10/22 – 21/10/22)	<b>UNIT TEST – 2</b>		
<b>Shared via Google classroom</b>	<b>Smart materials: SMA, Characteristics, properties of NiTi alloy, application, advantages and disadvantages of SMA.</b>		