Subject Code: **MME-103**	Course Title: **Engineering Physical Metallurgy**	Total Contact Hours: **42**	**L: 3**	**T: 0**	**P: 0**	**C: 3**
Pre-requisite: **None**		Year: **1**	Semester: **Even**			
Type of Course**: Professional Core**						

***** L → Lectures, T → Tutorials, P → Practical C → Credit***

Learning Objective:

The objective of this course is to describe the basic elements of material science and its application to engineering fields and explain the concept of Mechanical properties, phase diagrams, alloy design, solidification principles, Heat treatment and case hardening of ferrous materials.

Course outcomes (COs):

On completion of this course, the students will have the ability to:		**Bloom's Level**
CO-1	**Understand** crystal structure, phase diagrams and their applications, principles of solidification of metal and microstructure.	**2**
CO-2	**Understand** about plastic deformation and recrystallization of metals.	**2**
CO-3	**Understand** the mechanical properties of materials.	**2**
CO-4	**Understand** the heat treatment and surface hardening of steel.	**2**
CO-5	**Understand** the Raw material for steel production and their correlation with mechanical and metallurgical properties.	**2**

Course Topics:

S. No.	**Contents**	**Hours**	**COs**

1	Crystal structure of metals	**2**	**CO-1**
2	Raw material, design and production of steel	**6**	**CO-5**
3	Solidification and metal ingot structure	**3**	**CO-1**
4	Plastic deformation and recrystallization of metals	**2**	**CO-2**
5	Methods of studying metal structures	**2**	**CO-1**
6	The Mechanical properties of Metals and wear	**4**	**CO-3**
7	Iron Carbon equilibrium diagram	**3**	**CO-1**
8	Phase transformation in iron carbon system	**3**	**CO-1**
9	Heat treatment of steel	**3**	**CO-4**
10	Surface hardening of steel	**3**	**CO-4**
11	Chemical treatment of steel	**3**	**CO-4**
12	Minor constituent and alloying element of steel	**1**	**CO-5**
13	Stainless Steel	**4**	**CO-5**
14	Cast iron and their heat treatment	**3**	**CO-5**

Textbook References:

Text Book:

1. Y. Lakhting, “Engineering Physical Metallurgy”, 6th ed., CBS Publishes.
2. V. Raghavan, “Materials science and Engineering” 5th Edition, PHI.
3. Sidney Avner, “Introduction to Physical Metallurgy” McGraw-Hill, 1964

Reference books:

1. ASM metal handbook.

Additional Resources:

1. http://www.nptel.ac.in
2. MIT Video Lectures, Web resources etc.

Evaluation Method	
Item	**Weightage (%)**
Quiz, Assignment, Project etc.	30
Midterm	30
Final Examination	40

CO and PO Correlation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	2	-	-	-	-	1	3	2	2
CO2	3	2	-	-	-	-	2	-	-	-	-	1	3	2	2
CO3	3	3	-	-	-	-	2	-	-	-	-	1	3	2	2
CO4	3	2	-	-	-	-	2	-	-	-	-	1	3	2	2
CO5	3	3	3	2	-	-	3	-	-	-	-	1	3	2	2

CO-PO Mapping Justification

These mappings illustrate how each Course Outcome connects with various Program Outcomes and Program Specific Outcomes, ensuring a comprehensive and aligned learning experience for students in the Mechanical-Mechatronics Engineering Department:

1. **CO1: Understand crystal structure, phase diagrams and their applications, principles of solidification of metal and microstructure.**

   Mapping with PO1: Students will apply the knowledge of mathematics, science, engineering fundamentals, and engineering specialization to understand crystal structure, phase diagrams and their applications, principles of solidification of metal and microstructure.

   Mapping with PO2: Students will Identify, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences

related to crystal structure, phase diagrams and their applications, principles of solidification of metal and microstructure.

Mapping with PO7: While going through crystal structure, phase diagrams and their applications, principles of solidification of metal and microstructure student will understand its impact on environment and sustainable development.

Mapping with PO12: While going through crystal structure, phase diagrams and their applications, principles of solidification of metal and microstructure student will able to Recognize the need and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Mapping with PSO1: Understanding of crystal structure, phase diagrams and their applications, principles of solidification of metal and microstructure will develop Professional skills of students.

Mapping with PSO2: Understanding of crystal structure, phase diagrams and their applications, principles of solidification of metal and microstructure will upgrade student's skill for Research and higher learning.

Mapping with PSO3: Understanding of crystal structure, phase diagrams and their applications, principles of solidification of metal and microstructure will provide Career opportunities in industry and academia.

2. **CO2: Understand about plastic deformation and recrystallization of metals.**

Mapping with PO1: Students will apply the knowledge of mathematics, science, engineering fundamentals, and engineering specialization to understand about plastic deformation and recrystallization of metals.

Mapping with PO2: Students will Identify, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences related to plastic deformation and recrystallization of metals.

Mapping with PO7: While going through plastic deformation and recrystallization of metals student will understand its impact on environment and sustainable development.

Mapping with PO12: While going through plastic deformation and recrystallization of metals student will able to recognize the need and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Mapping with PSO1: Understanding of plastic deformation and recrystallization of metals will develop Professional skills of students.

Mapping with PSO2: Understanding of plastic deformation and recrystallization of metals will upgrade student's skill for Research and higher learning.

Mapping with PSO3: Understanding of plastic deformation and recrystallization of metals will provide Career opportunities in industry and academia.

3. CO3: Understand the mechanical properties of materials.

Mapping with PO1: Students will apply the knowledge of mathematics, science, engineering fundamentals, and engineering specialization to understand about the mechanical properties of materials.

Mapping with PO2: Students will Identify, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences related to understand the mechanical properties of materials.

Mapping with PO7: While going through the mechanical properties of materials student will understand its impact on environment and sustainable development.

Mapping with PO12: While going through the mechanical properties of materials student will able to recognize the need and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Mapping with PSO1: Understanding of mechanical properties of materials will develop Professional skills of students.

Mapping with PSO2: Understanding of mechanical properties of materials will upgrade student's skill for Research and higher learning.

Mapping with PSO3: Understanding of mechanical properties of materials will provide Career opportunities in industry and academia.

4. **CO4: Understand the heat treatment and surface hardening of steel.**

Mapping with PO1: Students will apply the knowledge of mathematics, science, engineering fundamentals, and engineering specialization to understand the heat treatment and surface hardening of steel.

Mapping with PO2: Students will Identify, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences related to the heat treatment and surface hardening of steel.

Mapping with PO7: While going through heat treatment and surface hardening of steel student will understand its impact on environment and sustainable development.

Mapping with PO12: While going through heat treatment and surface hardening of steel student will able to recognize the need and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Mapping with PSO1: Understanding of heat treatment and surface hardening of steel will develop Professional skills of students.

Mapping with PSO2: Understanding of heat treatment and surface hardening of steel will upgrade student's skill for Research and higher learning.

Mapping with PSO3: Understanding of heat treatment and surface hardening of steel will provide Career opportunities in industry and academia.

5. **Understand the Raw material for steel production and their correlation with mechanical and metallurgical properties.**

Mapping with PO1: Students will apply the knowledge of mathematics, science, engineering fundamentals, and engineering specialization to understand the Raw material for steel production and their correlation with mechanical and metallurgical properties.

Mapping with PO2: Students will Identify, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences related to the Raw material for steel production and their correlation with mechanical and metallurgical properties.

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Mapping with PO7: While going through the Raw material for steel production and their correlation with mechanical and metallurgical properties students will understand its impact on environment and sustainable development.

Mapping with PO12: While going through the Raw material for steel production and their correlation with mechanical and metallurgical properties students will able to recognize the need and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Mapping with PSO1: Understanding of Raw material for steel production and their correlation with mechanical and metallurgical properties will develop Professional skills of students.

Mapping with PSO2: Understanding of Raw material for steel production and their correlation with mechanical and metallurgical properties will upgrade student's skill for Research and higher learning.

Mapping with PSO3: Understanding of Raw material for steel production and their correlation with mechanical and metallurgical properties will provide Career opportunities in industry and academia.

Prepared By: Dr. Manoj Kumar

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Approved By: