COURSE CONTENT

PROGRAMMING FOR PROBLEM SOLVING								
II Semester: ME								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
2520316	**Foundation**	3	0	0	3	40	60	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisites: Basic Engineering Physics and Basic Engineering Chemistry								

Course Overview:

The course on *Metallurgy and Material Science* provides a fundamental understanding of the structure, properties, and behaviour of engineering materials. It covers crystal structures, imperfections, and strengthening mechanisms, along with the necessity of alloying and solid solution formation. Phase diagrams, solid-state transformations, and Fe–Fe_3C equilibrium with TTT diagrams are emphasized. Heat treatment processes and surface hardening methods are explained alongside advanced techniques such as age hardening and cryogenic treatment. The course also explores cast irons, steels, non-ferrous alloys, and ceramics. Finally, students learn material testing methods including tensile, hardness, impact, creep, and fatigue, linking theory with engineering applications.

Course Objectives:

1. Understand crystal structures, imperfections, and strengthening mechanisms.
2. Learn phase diagrams, transformations, and Fe–Fe_3C equilibrium.
3. Study heat treatment and surface hardening processes.
4. Know the classification and properties of ferrous, non-ferrous, and ceramic materials.
5. Gain knowledge of testing and characterization of materials

Course Outcomes: After Completion of the Course, Students should be able to

1. Explain structures, defects, and strengthening in metals and alloys.
2. Interpret phase diagrams and TTT diagrams.
3. Apply heat treatment to improve material properties.
4. Identify properties of ferrous, non-ferrous alloys, and ceramics.
5. Conduct material tests and analyze mechanical behaviour.

UNIT - I: Crystal Structure: Unit cells, Metallic crystal structures, **Imperfections in solids:** point, line, surface and volume defects. **Strengthening mechanisms:** Grain Boundary Strengthening, Solid Solution Strengthening, Strain Hardening, Precipitation (Particle) Strengthening, Dispersion Strengthening. **Hume Rotherys rules:** Necessity of alloying, types of solid solutions.

UNIT - II: Equilibrium diagrams: Experimental methods of construction of equilibrium diagrams, Isomorphous alloy systems, equilibrium cooling and heating of alloys, Lever rule. Eutectic, Peritectic, eutectoid, peritectoid reactions, phase rule. Transformations in the solid-state allotropy, Study of Fe-Fe3C equilibrium phase diagram, TTT diagram.

UNIT - III: Heat treatment: Annealing, normalizing, Hardening, tempering, Spheroidising, Harden ability. **Surface hardening methods:** Case hardening, Carburizing, Nitriding, Cyaniding, Carbo Nitriding, Age hardening treatment, Cryogenic treatment of alloys

UNIT - IV: **Cast irons and steels**: Structure and properties of White Cast iron, Malleable Cast iron, grey cast iron, Spheroidal graphite cast iron. Classification of steels, structure and properties of plain carbon steels, tool steels.**Non-ferrous metals and alloys**: Structure and properties of copper and its alloys, Aluminium and its alloys. Titanium and its alloy. **Ceramic materials**: Definition, properties of ceramic materials.

UNIT - V: Material testing and characterization, **Material testing**: Tensile testing, Hardness–Brinell, Rockwell test and micro hardness. Impact test - Charpy and Izod, Creep – creep test, creep curve, Mechanism of creep. Fatigue – fatigue test, S-N curve. **Material Characterization**: Working principle and applications of Optical microscopy (OM), Scanning electron microscopy (SEM).

TEXT BOOKS:

1. Introduction to Physical Metallurgy: Avner,2nded., TataMcGraw-HillEducation,2010.
2. William D. Callister, Jr, Materials Science and Engineering –An introduction, sixth edition, John Wiley & Sons, Inc. 2004.
3. Materials Science and Metallurgy: Kodgire V. D. 25th ed., Everest Publishing House, 2009

REFERENCE BOOKS:

1. Physical Metallurgy: RaghavanV.,2nded., PHI,2006
2. Materials Science and Metallurgy: Khanna O.P.5thed., Dhanpat Rai andSons,2009
3. Lawrence H. Van Vlack, Elements of Materials Science and Engineering, sixth edition, Addison Wesley Longman, Inc. New York, 1998.

ELECTRONIC RESOURCES:

1. https://archive.nptel.ac.in/courses/113/102/113102080/
2. https://archive.nptel.ac.in/courses/113/105/113105024/
3. https://archive.nptel.ac.in/courses/113/104/113104096/
4. https://archive.nptel.ac.in/courses/113/106/113106101/
5. https://archive.nptel.ac.in/courses/113/106/113106032/

MATERIALS ONLINE:

1. Course template
2. Tech talk and Concept Video topics
3. Assignments
4. Model question paper – I
5. Model question paper – II
6. Lecture notes
7. E-Learning Readiness Videos (ELRV)