

Course Code	Course Name	Credits
<b>MEC304</b>	<b>Materials and Metallurgy</b>	<b>03</b>

**Objectives:**

1. To familiarize the structure -property correlation in materials
2. To acquaint with the processing dependency on the performance of the various materials
3. To study the role of alloying in the development of steels.
4. To familiarize with the advances in materials development

**Outcomes:** Learner will be able to ....

1. Identify the various classes of materials and comprehend their properties
2. Apply phase diagram concepts to engineering applications
3. Apply particular heat treatment for required property development
4. Identify the probable mode of failure in materials and suggest measures to prevent them
5. Choose or develop new materials for better performance
6. Decide an appropriate method to evaluate different components in service

Module	Contents	Hrs.
<b>1</b>	<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>	<b>08</b>
<b>2</b>	<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 – microstructural changes of hypo and hyper-eutectoid steel- TTT and CCT diagram-Hardenability and its tests, Graphitization in cast irons.</p>	<b>08</b>

3	<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
4	<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>	06
5	<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>	06
6	<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>	05

**Assessment:**

**Internal Assessment for 20 marks:** Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

**End Semester Examination:** Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

**Textbooks:**

1. Callister's Materials Science and Engineering, 2nd edition by R. Balasubramaniam  
Wiley India Pvt. Ltd

**References:**

1. Introduction to Materials Science for Engineers; 8th Edition by James F. Shackelford  
Pearson
2. Introduction to Physical Metallurgy, 2nd edition by Sidney Avner, TataMcGrawHill
3. Mechanical Metallurgy, 3rd edition by GH Dieter, TataMcGraw Hill
4. Fundamentals of Materials Science and Engineering: An Integrated Approach, 5th Edition by  
William D. Callister, Jr., David G. Rethwisch, Wiley & Sons.
5. Materials Science and Engineering, 5th edition by V. Raghavan, Prentice Hall India

**Links for online NPTEL/SWAYAM courses:**

1. <https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-mm09/>
2. <https://nptel.ac.in/courses/113/102/113102080/>
3. <https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-mm09/>
4. [https://nptel.ac.in/content/syllabus\\_pdf/113104074.pdf](https://nptel.ac.in/content/syllabus_pdf/113104074.pdf)
5. [https://nptel.ac.in/content/storage2/courses/112108150/pdf/PPTs/MTS\\_09\\_m.pdf](https://nptel.ac.in/content/storage2/courses/112108150/pdf/PPTs/MTS_09_m.pdf)
6. [https://nptel.ac.in/content/storage2/courses/112108150/pdf/PPTs/MTS\\_08\\_m.pdf](https://nptel.ac.in/content/storage2/courses/112108150/pdf/PPTs/MTS_08_m.pdf)
7. <https://nptel.ac.in/courses/112/104/112104229/>
8. <https://nptel.ac.in/courses/118/104/118104008/>
9. [https://nptel.ac.in/content/storage2/courses/112104173/Mod\\_1\\_smart\\_mat lec\\_6.pdf](https://nptel.ac.in/content/storage2/courses/112104173/Mod_1_smart_mat lec_6.pdf)  
<https://nptel.ac.in/courses/112/104/112104229/>
10. <https://nptel.ac.in/courses/118/104/118104008/>
11. [https://nptel.ac.in/content/storage2/courses/112104173/Mod\\_1\\_smart\\_mat lec\\_6.pdf](https://nptel.ac.in/content/storage2/courses/112104173/Mod_1_smart_mat lec_6.pdf)