

II B.Tech II Semester Supplementary Examinations, Apr/May 2008
METALLURGY AND MATERIAL SCIENCE

**(Common to Mechanical Engineering, Mechatronics, Production
Engineering and Automobile Engineering)**

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks

1. (a) Differentiate between a crystal, a dendrite, a grain and a grain boundary. [6]
(b) Copper is FCC and has an atomic diameter of 2.555°A . Calculate its lattice parameter. [6]
(c) Explain the terms Lattice Constant and Co-ordination number. [4]
2. (a) What do you mean by electron atom ratio in electron compounds. What are the various Electron atom ratios generally observed in electron compounds and what are their corresponding crystal structures. Explain with suitable examples. [10]
(b) Explain the general properties of solid solutions. [6]
3. (a) Draw a neat sketch of $Fe - Fe_3C$ diagram and label all important points, lines and phases in it. [10]
(b) Explain the solidification of hypo eutectic cast Iron. [6]
4. (a) Give at least 3 advantages of steels over the family of cast irons. [6]
(b) What are the various heat treatments given to cast irons? Explain them in brief. [10]
5. (a) What are the effects of alloying elements on $Fe-Fe_3C$ diagram. [8]
(b) Compare the processes of annealing, normalizing and hardening giving the important features of different microstructures obtained. [8]
6. (a) Explain why copper is a suitable material for Automobile radiators. [5]
(b) What is dezincification? How it may be minimized. [5]
(c) How does the addition of lead to brass improve its machinability. [6]
7. (a) What is powder Metallurgy? [4]
(b) When is powder metallurgy preferred over conventional methods. [6]
(c) What are the advantages and limitations of power metallurgy. [6]
8. (a) Name the properties of composite materials which are making them more attractive for engineering applications. [3×4=12]
(b) Define and explain the following terms:
i. Whisker

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- ii. Specific strength
- iii. Specific modulus
- iv. Yarn.

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1. (a) Express the edge, face diagonal and body diagonal of the unit cell in terms of the atomic radius 'r' for simple cube, BCC and FCC crystal structures. [6]
(b) The lattice constant of Iron is $2.86^{\circ}\text{\AA}$. What is the density of Iron taking the atomic weight of Iron as 55.85 a.m.u. [6]
(c) Find the Miller indices of a plane that makes an intercept of 1 on X-axis; 2 on Y-axis; and is parallel to Z-axis. [4]
2. (a) Distinguish between electron compounds & valence compounds with suitable examples. [8]
(b) How are the alloys classified with respect to microstructure? Explain them fully. [8]
3. (a) Explain the meaning of the term 'Cored dendritic structure' as applied to solid solution alloys. Describe how the cored structure is formed when such an alloy is cooled. What are the disadvantages if any, of this type of structure? [9]
(b) Explain the methods used to eliminate dendritic coring. [7]
4. What is a stainless steels? What are the various types of stainless steels? Give an account of the composition, Microstructure, properties and applications of stainless steels. [16]
5. (a) Discuss the principles and procedure in the hardening and tempering of a hyper eutectoid steel. [8]
(b) Discuss briefly the microstructural changes associated with martensetic transformation. [8]
6. (a) Explain the various heat treatments and surface treatments to be done on aluminium and it's alloys to improve their performance. [8]
(b) Explain heat treatment, properties and applications of Ti - 6Al - 4V alloys. [8]
7. (a) What is powder Metallurgy? [4]
(b) When is powder metallurgy preferred over conventional methods. [6]
(c) What are the advantages and limitations of power metallurgy. [6]
8. (a) Define composite materials. [2]

- (b) What unique properties have they over the conventional materials? [4]
- (c) How do the composite materials differ from metallic alloys? [5]
- (d) Mention some composite materials with their applications. Give their properties. [5]

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1. Explain in detail about the characteristic properties of [4×4=16]
 - (a) Ionic crystals
 - (b) Covalent solids
 - (c) Metallic solids
 - (d) Amorphous solids.
2. (a) Describe with the help neat sketches the following: [4+4]
 - i. Substitutional solid solutions
 - ii. Interstitial solid solutions.
(b) Explain what is meant by intermetallic compound and intermediate phase. [8]
3. (a) Explain the importance and applications of the following: [3×3=9]
 - i. Phase rule
 - ii. Lever rule
 - iii. Composition rule.
(b) Distinguish between steels and cast irons and highlight the importance of each of them as Engineering Materials. [7]
4. (a) Explain the Malleabilizing treatment given to white iron castings. Sketch the typical microstructure of malleable cast iron label the phases in it. [8]
(b) What is High speed steel? Give the typical composition of High speed steel. Explain the part played by each of the alloying elements in tool steels. Explain the heat treatment process of High speed steel. [8]
5. (a) What are the limitations of Austempering? [4×4=16]
(b) What are the limitations of Martempering?
(c) 'Normalized steels are stronger than annealed steels'. Explain.
(d) Discuss the necessity and importance of surface hardening.
6. (a) Why do aluminium alloys respond to age hardening? Give some examples? [4×4=16]
(b) Why do alloy 2017 rivets have to be refrigerated until used?

- (c) What are the important properties of Aluminium - silicon alloys? Give some typical applications?
- (d) What is meant by anodizing aluminium?
- 7. (a) Giving reasons, describe the treatments given to metal powders before compaction. [8]
- (b) Explain the process of powder rolling. [8]
- 8. (a) Derive an equation relating the elastic modulus of a layered composite of unidirectional fibers and a plastic matrix, which is loaded under isostrain conditions. [8]
- (b) Derive an equation relating the elastic modulus of a layered composite of unidirectional fibers and a plastic matrix, which is loaded under isostress conditions. [8]

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1. (a) Draw the close packed planes and directions in simple cube, BCC and FCC crystals and find out the Miller indices of the planes. [8]
(b) Explain briefly about the various types of crystal imperfections, with the help of neat sketches. [8]
2. (a) How are alloys classified according to the microstructures. Explain them fully with suitable examples. [6]
(b) Explain the term 'Equilibrium conditions'. [3]
(c) What do you mean by intermediate alloy phase? Explain any one type of intermediate alloy phase with suitable examples. [7]
3. (a) Describe completely the changes that take place during the slow cooling of a 0.5% carbon steel from the Austenetic range. [4]
(b) Calculate the relative amounts of the structural constituents present in furnace cooled steels containing. [8]
 - i. 0.3%C
 - ii. 0.6% carbon
 - iii. 0.8%C
 - iv. 1.2%C.
(c) Explain the limitations on the use of Iron-Iron carbide diagram. [4]
4. (a) Explain the difference in Microstructure and properties of white and gray cast Iron. [8]
(b) Assume that a C clamp is to be made up of cast Iron. Select a suitable type of cast Iron and explain the reasons for the selection. [8]
5. (a) What are the requirements of an age-hardenable alloy. [4]
(b) Give a typical heat treatment schedule for duralumin and explain the relevant microstructural changes. [12]
6. Give the chemical composition; structure; properties and applications of the following: [4×4=16]
 - (a) Y-alloy
 - (b) Al-Mg alloy

- (c) SILLUMIN
 - (d) Red Brass.
7. (a) What is powder Metallurgy? [4]
- (b) When is powder metallurgy preferred over conventional methods. [6]
- (c) What are the advantages and limitations of power metallurgy. [6]
8. (a) What is delamination? Explain how delamination at the fiber-matrix interface can enhance the fracture toughness of composites. [8]
- (b) Explain why carbon-reinforced polymer composites find wider applications in aircraft and sports equipment than in automobiles. [8]
