

B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2025

Second Semester

Mechanical and Automation Engineering
20BSPH202 - PHYSICS OF MATERIALS

Regulations - 2020

Duration: 3 Hours

Max. Marks: 100

PART - A (MCQ) (10 × 1 = 10 Marks)

Answer ALL Questions

	<i>Marks</i>	<i>K- Level</i>	<i>CO</i>
1. A binary alloy system shows complete solid solubility between two metals A and B. During solidification, you are asked to estimate the percentage of phase α and phase β at a particular temperature using a binary phase diagram. Which rule will you apply? (a) Hume-Rothery's Rules (b) The Phase Rule (c) Lever Rule (d) Tie-Line Rule	1	K2	CO1
2. Gibbs phase rule is applied to the systems which are in _____. (a) Saturation (b) Equilibrium (c) Critical state (d) Supercritical state	1	K1	CO1
3. What is the eutectoid composition of carbon in the iron-carbon equilibrium diagram? (a) 0.2% (b) 0.76% (c) 2.14% (d) 4.3%	1	K1	CO2
4. Why does the addition of alloying elements like chromium and nickel affect the iron-carbon equilibrium diagram? (a) They increase the hardness of pure iron. (b) They lower the melting point of iron. (c) They shift the phase boundaries and stabilize specific phases. (d) They completely eliminate the eutectoid point.	1	K2	CO2
5. Eutectoid steel is slowly cooled from 800°C. What microstructure will primarily form at room temperature? (a) Ferrite and Cementite in pearlite form (b) Ferrite and Pearlite (c) Cementite and Austenite (d) Martensite	1	K1	CO3
6. How does strain hardening increase the strength of a metal? (a) By refining the grain structure (b) By increasing the number of dislocations and making their movement more difficult (c) By dissolving alloying elements into the crystal lattice (d) By precipitating hard particles within the grains	1	K1	CO3
7. What is the primary difference between hard and soft magnetic materials in terms of their hysteresis behavior? (a) Hard magnetic materials have a low coercivity and soft ones have high coercivity (b) Soft magnetic materials have wide hysteresis loops (c) Hard magnetic materials retain magnetization longer due to a large hysteresis loop (d) Both have identical hysteresis loops but different compositions	1	K2	CO4
8. A transformer core is required to minimize energy loss due to hysteresis. Which type of magnetic material would be most appropriate for this application? (a) Hard magnetic material (b) Paramagnetic material (c) Soft magnetic material (d) Ferrimagnetic material	1	K2	CO4
9. The _____ process is commonly used to produce metallic glasses. (a) Sand casting (b) Die Casting (c) Melt spinning (d) Powder metallurgy	1	K1	CO5
10. _____ SMA is used in artificial hip joints, bone plates, pins for healing bones-fractures and also connecting broken bones. (a) Ti-C (b) Ni-Mg (c) Ni-Ti (d) Fe-C	1	K2	CO6

PART - B (12 × 2 = 24 Marks)

Answer ALL Questions

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|--|---|----|-----|
| 11. Define a solid solution. | 2 | K1 | CO1 |
| 12. In a binary isomorphous alloy system of metals A and B, an alloy contains 70% A and is held at a temperature where the liquidus is at 80% A and the solidus at 50% A. Use the lever rule to calculate the percentage of the solid phase present at this temperature. | 2 | K2 | CO1 |
| 13. Recall the three main invariant reactions in the iron-carbon equilibrium diagram. | 2 | K2 | CO2 |
| 14. What are the effects of alloying elements such as nickel and chromium on the Fe-C system? | 2 | K2 | CO2 |
| 15. Difference between brittle and ductile fracture. | 2 | K2 | CO3 |
| 16. Explain the term tempering. | 2 | K2 | CO3 |
| 17. Define spontaneous magnetization. | 2 | K1 | CO4 |
| 18. What are soft magnetic materials? | 2 | K1 | CO4 |
| 19. Compare top-down and bottom-up approaches for the preparation of nanomaterials. | 2 | K2 | CO5 |
| 20. List the various dielectric breakdowns. | 2 | K1 | CO5 |
| 21. Mention some applications of composite materials. | 2 | K1 | CO6 |
| 22. Write few applications of shape memory alloys. | 2 | K1 | CO6 |

PART - C (6 × 11 = 66 Marks)

Answer ALL Questions

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|---|----|----|-----|
| 23. a) Explain Hume-Rothery's rules for the formation of substitutional solid solutions and discuss why these rules are important in designing alloys. | 11 | K2 | CO1 |
| OR | | | |
| b) Explain Eutectic phase diagram with an example. | 11 | K2 | CO1 |
| 24. a) List the main phases present in the iron-carbon equilibrium diagram and the typical carbon content range for each phase. | 11 | K2 | CO2 |
| OR | | | |
| b) Recall the three main types of microstructures formed in eutectoid steel during phase transformations, and identify the transformation temperature at which the eutectoid reaction occurs. | 11 | K2 | CO2 |
| 25. a) How hardness of the material determined using Brinell hardness test? | 11 | K2 | CO3 |
| OR | | | |
| b) Discuss elaborately the various strengthening methods. | 11 | K2 | CO3 |
| 26. a) Describe the four energies involved in the formation of domain in ferromagnetic materials. | 11 | K2 | CO4 |
| OR | | | |
| b) Explain the structure, properties and applications of ferrites. | 11 | K2 | CO4 |
| 27. a) Write short notes on (i) Meissner effect (ii) isotope effect (iii) effect of magnetic field. | 11 | K2 | CO5 |
| OR | | | |
| b) Explain the preparation and properties of metallic glass. | 11 | K2 | CO5 |
| 28. a) Explain in detail about the applications of nanomaterials. | 11 | K2 | CO6 |
| OR | | | |
| b) Discuss elaborately the various applications of composites. | 11 | K2 | CO6 |