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**Question Paper Code : 11655**

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2026.

Third Semester

Mechanical Engineering

ME3392 — ENGINEERING MATERIALS AND METALLURGY

(Common to : Manufacturing Engineering/Mechanical Engineering (Sandwich)/  
Mechanical Engineering (Specialised in Automobile)/Mechanical Engineering  
(Specialised in Smart Manufacturing)

(Regulations 2021)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is the maximum number of phases possible in a ternary system?
2. Distinguish between eutectic reaction and peritectic reaction.
3. What is the effect of carbide forming elements in steels during tempering?
4. What is the significance of case hardening?
5. What is the effect of Vanadium on the mechanical properties and behavior of steels?
6. Differentiate between Black heart process and White heart process in malleabilisation.
7. Mention one property and use of polypropylene (PP).
8. State two important applications of PEEK.
9. State Griffith's theory of fracture.
10. Define Hardness.

PART B — (5 × 13 = 65 marks)

11. (a) Explain in detail the different types of invariant reactions in binary phase diagrams – eutectic, eutectoid, peritectic, and peritectoid with neat sketches and examples.

Or

- (b) Compare and contrast steel and cast iron in terms of composition, microstructure, properties, and applications.

12. (a) (i) Discuss the Time-Temperature-Transformation (TTT) diagram for eutectoid steel with a neat diagram. (6)  
(ii) Explain the formations of pearlite, bainite, and martensite with suitable sketches. (7)

Or

- (b) Describe the Jominy end-quench test with a neat sketch and explain how hardness distribution indicates hardenability.

13. (a) Describe the Al-Cu alloy system and explain the precipitation hardening (age hardening) process with diagrams showing the sequence of precipitation.

Or

- (b) Discuss the composition, properties, and uses of Ni-based superalloys and shape memory alloys (SMAs) with examples.

14. (a) (i) Classify polymers based on the structure and thermal behavior. (3)  
(ii) Give a detailed comparison of thermoplastics and thermosetting polymers with examples and uses. (10)

Or

- (b) (i) What are intermetallic compounds? (3)  
(ii) Explain their structure, bonding, and significance of intermetallic compounds in advanced materials. (10)

15. (a) (i) Explain in detail the mechanisms of plastic deformation by slip and twinning. (10)  
(ii) Discuss the influence of crystal structure on deformation behavior. (3)

Or

- (b) Discuss the mechanisms of fatigue and creep failure in metals with respect to the different stages and prevention methods.

PART C — (1 × 15 = 15 marks)

16. (a) (i) Explain the Hume-Rothery rules governing the formation of substitutional solid solutions. (7)
- (ii) Using Cu-Ni and Fe-Cr systems as examples, discuss how atomic size, valency, and electronegativity influence solubility. (8)

Or

- (b) (i) Discuss in detail the microstructural changes that take place when a eutectoid composition of austenite is slowly cooled to room temperature. (8)
- (ii) Explain how nucleation and growth mechanisms govern the formation of pearlite and its impact on hardness and ductility. (7)
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