

DEPARTMENT OF MECHANICAL ENGINEERING

ME 8491 ENGINEERING METALLURGY

Regulation: 2017

Year and Semester: II and IV

OBJECTIVES:

□ To impart knowledge on the structure, properties, treatment, testing and applications of metals and non-metallic materials so as to identify and select suitable materials for various engineering applications.

UNIT I ALLOYS AND PHASE DIAGRAMS 9

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, Iron – carbon equilibrium diagram. Classification of steel and cast Iron microstructure, properties and application.

UNIT II HEAT TREATMENT 10

Definition – Full annealing, stress relief, recrystallisation and spheroidising – normalising, hardening and Tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram CCR – Hardenability, Jominy end quench test - Austempering, martempering – case hardening, carburizing, Nitriding, cyaniding, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening. .

UNIT III FERROUS AND NON-FERROUS METALS 9

Effect of alloying additions on steel- α and β stabilisers – stainless and tool steels – HSLA, Maraging steels – Cast Iron - Grey, white, malleable, spheroidal – alloy cast irons, Copper and copper alloys – Brass, Bronze and Cupronickel – Aluminium and Al-Cu – precipitation strengthening treatment – Bearing alloys, Mg-alloys, Ni-based super alloys and Titanium alloys.

UNIT IV NON-METALLIC MATERIALS 9

Polymers – types of polymer, commodity and engineering polymers – Properties and applications of various thermosetting and thermoplastic polymers (PP, PS, PVC, PMMA, PET, PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE, Polymers – Urea and Phenol formaldehydes)- Engineering Ceramics – Properties and applications of Al_2O_3 , SiC, Si_3N_4 , PSZ and SIALON – Composites- Classifications- Metal Matrix and FRP - Applications of Composites.

UNIT V MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS 8

Mechanisms of plastic deformation, slip and twinning – Types of fracture – Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), hardness tests, Impact test Izod and Charpy, fatigue and creep failure mechanisms.

TOTAL: 45 PERIODS

OUTCOMES:

□ Upon completion of this course, the students can able to apply the different materials, their processing, heat treatments in suitable application in mechanical engineering fields.

TEXT BOOKS:

1. Avner, S.H., —Introduction to Physical Metallurgy, McGraw Hill Book Company, 1994.
2. Williams D Callister, —Material Science and Engineering, Wiley India Pvt Ltd, Revised Indian Edition 2007

REFERENCES:

1. Raghavan.V, —Materials Science and Engineering, Prentice Hall of India Pvt. Ltd., 1999.
2. Kenneth G. Budinski and Michael K. Budinski, —Engineering Materials, Prentice Hall of India Private Limited, 4th Indian Reprint 2002.
3. Upadhyay. G.S. and Anish Upadhyay, —Materials Science and Engineering, VivaBooks Pvt. Ltd., New Delhi, 2006.

9. Draw a typical creep curve for ductile metal and explain the regions.
10. Draw a typical load versus percentage elongation curve for ductile material and explain the tensile properties.

PART B — (5 × 16 = 80 marks)

11. (a) Neatly sketch labeled Iron-Carbon equilibrium diagram. Name, write and explain the reactions involved.

Or

- (b) Explain the procedural steps for constructing the binary phase diagram where the components show complete liquid and solid solubility. Draw the labeled diagram and name the system. Give one example for the alloy system showing above mentioned behavior.
12. (a) Draw a neat sketch of the Isothermal Transformation diagram for Eutectoid steel and explain the constructional procedure. Label all the salient features on it. Superimpose on it a cooling curve to obtain bainitic phase.

Or


- (b) Differentiate hardness and hardenability. Explain with a neat sketch, the procedure to plot the hardenability curves for eutectoid steel in Jominy End Quench Test.
13. (a) Classify Stainless steel and tool steels and explain the following :
- (i) Maraging steel (5)
 - (ii) Spheroidal graphite iron (5)
 - (iii) High speed steel in terms of composition, property and use. (6)

Or

- (b) With part of phase diagram and relevant graphs explain precipitation hardening treatment of Al-Cu alloy.
14. (a) Name, explain the properties and application of any eight varieties of polymers used as engineering materials.

Or

- (b) Name, explain the properties and application of any four types of ceramics.

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15. (a) Name and explain the different types of hardness tests with respect to the procedure, relative advantages and disadvantages.

Or

- (b) With geometry and arrangement of impact test specimens explain Charpy and Izod test with relative advantages and disadvantages.
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Reg. No. :

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Question Paper Code : 27362

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2015.

Third Semester

Manufacturing Engineering

ME 6403 — ENGINEERING MATERIALS AND METALLURGY

(Common to Fourth Semester Automobile Engineering, Mechanical and Automation Engineering and Mechanical Engineering)

(Regulations 2013)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Draw a typical cooling curve of pure metal and a solid solution.
2. What do you mean by invariant reaction?
3. What do you mean by hardenability?
4. Which type of surface hardening process that does not involve composition change?
5. Which type of stainless steel is used for surgical instruments?
6. What is the typical constituent microstructure of bearing alloy?
7. What are the outstanding properties of PMMA?
8. List the typical applications of Al_2O_3 .
9. What are the characteristic features of fracture surface of creep rupture component?
10. State the advantages of Rockwell hardness testing over other techniques.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Draw Iron–Iron carbide phase diagram, name the various field, line and reactions. (10)
- (ii) Draw the typical microstructure of 0.5% C steel at 920° C, 780° C and 200° C. (6)

Or

- (b) (i) Discuss on substitutional solid solution. (8)
- (ii) Compare the microstructure, properties and application of any TWO kind of cast iron. (8)
12. (a) (i) Brief on hardening and tempering of steel with respect to rate of cooling and tempering temperature respectively. (8)
- (ii) Compare Austempering and Martempering. (8)

Or

- (b) (i) Brief on Jominy end quench test and interpretation of results. (8)
- (ii) Brief on the types of carburizing and need for post carburizing heat treatments. (8)
13. (a) (i) Brief on the influence of alloying elements in steel under classification of carbide former and non carbide former. (8)
- (ii) List the types and their typical applications of stainless steel. (8)

Or

- (b) (i) What are the types of titanium alloy, their composition, properties and applications? (8)
- (ii) Brief on the precipitation hardening and ageing treatment of Al-Cu alloy. (8)
14. (a) (i) Classify composite materials and list TWO properties and application of them. (12)
- (ii) State the properties and applications of PSZ or SiC. (4)

Or

- (b) (i) Classify engineering ceramics and list properties and applications of any TWO of them. (8)
- (ii) Brief on properties and applications of any TWO polymers from the list: PTFE, PC, PET, ABS and PS. (8)

15. (a) (i) Compare Charpy and Izod Impact test. (4)
(ii) List the applications of impact test. (4)
(iii) Draw a typical creep curve and brief on the mechanism. (8)

Or

- (b) (i) Discuss the role of slip and twinning in plastic deformation of materials. (8)
(ii) Draw a typical S-N curve of fatigue testing and brief on the mechanism. (8)
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PART - B (5 × 16 = 80 Marks)

11. (a) Explain with a neat sketch of iron-iron carbide equilibrium diagram and indicate all the phases. Also write the three important invariant reactions. (16)

OR

- (b) Explain the various classification of steels and Cast Iron with microstructure, properties and applications. (16)

12. (a) What is hardenability ? How is Jominy end quench test used to measure hardenability ? (16)

OR

- (b) Explain TTT diagram with neat sketch and indicate all the phases with microstructure. (16)

13. (a) Discuss the properties and the applications of the following :
(i) Tool steels (ii) HSLA (8 + 8)

OR

- (b) Explain age hardening of Al-Cu with the help of phase diagram. (16)

14. (a) What is polymerization ? Explain addition polymerization and condensation polymerization with examples. (16)

OR

- (b) What is strengthening mechanism ? Explain the strengthening mechanism of fiber-reinforced composites. (16)

15. (a) Define hardness. Explain Brinell and Rockwell hardness test with neat sketches. (16)

OR

- (b) Explain the mechanism of plastic deformation by slip and twinning with neat sketches. (16)

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Question Paper Code : 80658

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Third Semester

Manufacturing Engineering

ME 6403 — ENGINEERING MATERIALS AND METALLURGY

(Common to Fourth Semester Automobile Engineering, Mechanical and Automation Engineering and Mechanical Engineering)

(Regulations 2013)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define the term solid solutions.
2. How will you classify steels?
3. When will you prefer annealing?
4. Define the term Cementite.
5. List the important properties of HSLA.
6. What are Bronzes? List the uses of Bronzes.
7. Define the term degree of polymerization.
8. State any four applications of Bakelite.
9. Define the term Fatigue.
10. List any four mechanical testing methods of metals.

PART B — (5 × 13 = 65 marks)

11. (a) (i) Explain the various micro constituents present in steel. (8)
(ii) With a neat sketch, label the reactions of Fe-Fe₃C diagram. (5)

Or

- (b) (i) Discuss the classification of cast iron and draw its microstructure. (9)
- (ii) State the properties and applications of plain carbon steel. (4)
12. (a) (i) Distinguish between annealing and tempering. (4)
- (ii) Explain in detail the flame and induction hardening with neat sketches. (9)

Or

- (b) Explain the principle and procedure of Jominy end quench test with a diagram. Also sketch the graph hardness Vs distance from quenched end. (13)
13. (a) (i) With a neat sketch, explain precipitations hardening. (8)
- (ii) State the compositions, properties and uses of bearing alloys. (5)

Or

- (b) Write short notes on the following :
- (i) Maraging steels (4)
- (ii) SS (5)
- (iii) HSS. (4)
14. (a) Explain the following.
- (i) Engineering ceramics. (5)
- (ii) Formaldehydes (4)
- (iii) PMMA. (4)

Or

- (b) (i) Explain the Engineering polymers in detail. (7)
- (ii) State the properties and uses of reinforced composites. (6)
15. (a) (i) What are the different hardness tests performed in metallic natural? Specify the indenter and hardness measurement scale of the same. (4)
- (ii) Explain the procedure of tensile test for metals. (9)

Or

- (b) (i) Explain the mechanism of plastic deformation with suitable illustrations. (8)
- (ii) Discuss about the creep test with a typical creep curve. (5)



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PART C — (1 × 15 = 15 marks)

16. (a) Discuss the effects and characteristics of alloying elements in steel. (15)

Or

- (b) Name the suitable alloys, polymers and ceramics for manufacturing the following items. (15)

- (i) Bush
- (ii) Furnaces heating element
- (iii) Lathe bed
- (iv) Coins
- (v) Girders for Airship
- (vi) Big end bearing
- (vii) Turbine blades
- (viii) Conduit pipes
- (ix) Knobs
- (x) Windshields
- (xi) Touch screens
- (xii) Furnace linings
- (xiii) Grinding (abrasive) wheels
- (xiv) Coatings on cutting inserts
- (xv) Cutting inserts for ferrous alloys.