KATHMANDU UNIVERSITY
End Semester Examination [C]
November/December, 2023

Marks Scored:

Level : B.E.
Year : II

Course : MEEG 213
Semester : I

Exam Roll No. :   Time: 30 mins.   F. M. : 10

Registration No.:   Date 03 DEC 2023

SECTION "A"
[20 Q. × 0.5 = 10 marks]

Choose and mark [X] in the most appropriate option.

1. Epoxy resin, used to make Carbon fiber reinforced polymer (CFRP), belongs to which category of material.
[ ] Metals   [ ] Polymers   [ ] Composites   [ ] Ceramics

2. The property of a material that resists penetration or indentation by means of abrasion or scratching is known as ________________.
[ ] strength   [ ] hardness   [ ] toughness   [ ] brittleness

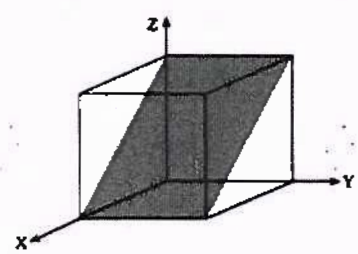
3. The packing factor for BCC, FCC and HCP unit cells are respectively:
[ ] 0.52, 0.68, 0.74   [ ] 0.52, 0.68, 1
[ ] 0.68, 0.74, 0.74   [ ] 0.68, 0.74, 0.86

4. Carbon in iron is an example of ________________.
[ ] substitutional defect   [ ] interstitial defect
[ ] Frenkel defect   [ ] Schottky defect

5. The lattice constant 'a' for BCC and FCC crystal structure are respectively given by.
[ ] $4r/\sqrt{3}$, $4r/\sqrt{2}$ [ ] $4r/\sqrt{2}$, $4r/\sqrt{3}$ [ ] $2\sqrt{2}r$, $2\sqrt{3}r$ [ ] $2\sqrt{3}r$, $2\sqrt{2}r$

6. Calculate the number of atoms in 100 g of silver. (molar mass of silver = 107.868 g/mole)
[ ] 6.023×10^{23} atoms   [ ] 6.12×10^{23} atoms
[ ] 5.58×10^{23} atoms   [ ] 5.12×10^{23} atoms

7. In the given unit cell, the shaded plane is denoted by ____.
[ ] (000)
[ ] (111)
[ ] (101)
[ ] (110)



8. If P is the number of phases, F is the degree of freedom, and C is the number of components in a system, then, the Gibbs phase rule is given by ________________.
[ ] 1 + C = P + F   [ ] 1 - C = P + F   [ ] 2 + C = P + F   [ ] 2 - C = P + F

9. A crystallographic plane and family of planes are respectively represented by.
[ ] (hkl), {hkl}   [ ] (hkl), <hkl>   [ ] [hkl], <hkl>   [ ] [hkl], {hkl}

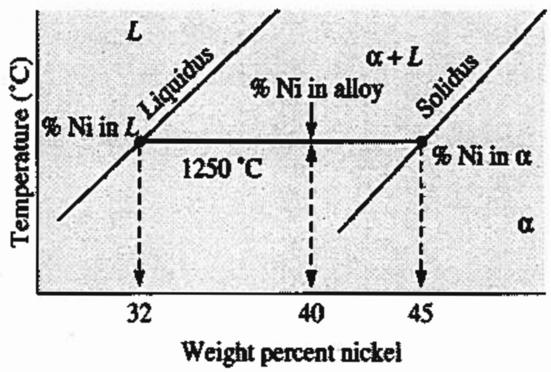
10. The Hall-Petch equation for mild steel grade is given by, $\sigma_y = 55.49 + 18.45d^{-1/2}$. Calculate the required grain size to attend the yield strength of 275 MPa.

11. A metal rod is subjected to tensile stress. The metal rod is 100 mm long and the change in length due to the tensile stress is 0.05 mm. Calculate the value of the applied tensile stress. (Given E of the metal rod is 200 GPa.)
[ ] 25 MPa [ ] 50 MPa [ ] 75 MPa [ ] 100 MPa

12. The deviation of engineering stress and true stress is significant from ________________.
[ ] elastic point [ ] yield point [ ] necking point [ ] fracture point

13. A three-phase reaction in which one solid transforms to two solids on cooling __________.
[ ] Peritectic [ ] Eutectic [ ] Peritectoid [ ] Eutectoid

14. Figure below shows part of Cu – Ni phase diagram. L represents liquid region and α represents solid region. Calculate the amounts of α and L at 1250°C in the 45% Ni alloy (Cu – 45% Ni).



[ ] 50% *α* solid and 50% Liquid [ ] 38% *α* solid and 62% Liquid
[ ] Mostly liquid phase [ ] Mostly solid *α* phase

15. Which of the following is not true about dispersion strengthening?
[ ] Dispersed phase particles should be round
[ ] Hard dispersed phase should be continuous
[ ] Dispersed phase particles should be small and numerous
[ ] Higher concentrations of the dispersed phase increase the strength

16. Which of the following is not a solidification defect in metal casting?
[ ] shrinkage cavity [ ] columnar grains
[ ] interdendritic shrinkage [ ] gas porosity

17. Ductile fracture in metals is represented by ______________________________.
[ ] cup and cone formation [ ] transgranular fracture
[ ] microvoids formation [ ] all of the above

18. A Heat treated Cu-40%Zn brass alloy is stronger than pure copper. If the solubility limit of Zn in Cu is 30%, what are the active strengthening mechanisms in brass?
[ ] Solid-Solution strengthening [ ] Dispersion strengthening
[ ] Grain size strengthening [ ] All of the above

19. Tempering of martensitic steel is done to impart the following property.
[ ] Toughness [ ] Strength [ ] Hardness [ ] Wear resistance

20. Aluminum alloys with the addition of Mg alloying element is labeled as _____________.
[ ] 2xxx series [ ] 3xxx series [ ] 4xxx series [ ] 5xxx series

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SECTION "B"

Attempt *ALL* questions. Assume suitable data if necessary.

1.

a. Explain Material science and engineering tetrahedron. [1.5]

b. What do you understand by ferrous alloys? Explain the reasons behind extensive use of ferrous alloys in various applications. [1.5]

c. Give one application of each of the materials: Ceramics, Polymers, Composites. And state two major properties of each of the materials to explain the choice of materials for the stated applications. [3]

2.

a. What is perfectly aligned crystal structure in materials? Define dislocation defects. Explain the effects of dislocations in such perfectly aligned crystal structure. [3]

b. Carbon in diamond is crystalline whereas carbon in graphite is amorphous. Explain the differences between diamond form of carbon and graphite form of carbon. [2]

c. Iron changes from BCC to FCC metal structure at 912 °C (1673 °F). At this temperature, the atomic radii of the iron atoms in the two structures are 0.126 nm and 0.129 nm, respectively. Determine the lattice parameters for the BCC and FCC structure of the iron. What is the percentage volume change, as the structure changes? [3]

d. Indicate the crystallographic direction [120] and plane (101) in crystal structure. [1]

3.

a. A steel rod of 12 mm diameter and 120 mm long is stretched under tension. At the peak load of 12 kN, the diameter of the rod is noted to be 10.55 mm. Given, E = 200 GPa. Considering the given case, answer the following questions
   i. Define engineering stress and calculate the engineering stress. [1.5]
   ii. Define true stress and calculate the true stress. [1.5]
   iii. The rod was further loaded to final fracture and the maximum load recorded was 15.5 kN. Given the UTS of the steel is 210 MPa, calculate the ductility of the steel rod used. [2]

b. Explain the differences between ductile and brittle fracture in metallic materials. [2]

c. Explain impact loading with two examples. Discuss how impact loading is different from tensile loading in a material. [2]

4.

a. Explain planar and dendritic growth mechanisms observed in solidification process. Illustrate the heat transfer observed at the interface in each growth mechanisms. [3]

b. Describe Gibbs phase rule for phase diagram. Interpretate degree of freedom, F = 1 obtained from Gibbs phase rule for a given phase diagram. [2]

c. Explain two commonly observed solidification defects in metal casting. [2]

5.

a. Explain with illustration the eutectoid region of the iron – iron carbide phase diagram. Indicate the eutectoid point with corresponding temperature and composition where eutectoid transformation occurs. Label all the relevant lines in the phase diagram. [3]
b. With respect to the eutectoid region of the phase diagram, explain Annealing, Normalizing and Tempering heat treatment processes for hypo – eutectoid steels. [3]
c. What do you understand by surface treatment processes? Explain carburizing of low carbon steels. [2]
d. Define the terms: [2Q × 0.5 = 1]
   i. Intermetallic compound,
   ii. Metallic glass,