



**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
(ONLINE)  
SEMESTER I  
SESSION 2020/2021**

COURSE NAME : ENGINEERING MATERIALS  
TECHNOLOGY

COURSE CODE : BDU 10603

PROGRAMME CODE : BDC / BDM

EXAMINATION DATE : JANUARY / FEBRUARY 2021

DURATION : 3 HOURS

INSTRUCTION : ANSWERS ALL QUESTIONS

THIS QUESTION PAPER CONSISTS OF TWELVE (12) PAGES

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## PART A

(1 mark each)

**Q1** Match the following group 1 items (crystal structures) with group 2 items (average number of atoms per unit cell) and select the correct option

1. Simple cubic crystal structure ..... a. 2  
2. Body centered crystal structure ..... b. 6  
3. Face centered crystal structure ..... c. 1  
4. Hexagonal close packed structure ..... d. 4

- A. 1 - a, 2 - c, 3 - d, 4 - b  
B. 1 - c, 2 - a, 3 - d, 4 - b  
C. 1 - b, 2 - a, 3 - c, 4 - d  
D. 1 - d, 2 - a, 3 - b, 4 - c

**Q2** The unit cells

- A. contain the smallest number of atoms which when taken together have all the properties of the crystals of the metal  
B. have the same orientation and their similar faces are parallel  
C. may be defined as the smallest parallelepiped which could be transposed in three coordinate directions to build up the space lattice  
D. all the above

**Q3** Which one of these is not one of the 7 crystal types?

- A. Hexagonal  
B. Trigonal  
C. Quadrahedral  
D. Orthorhombic

**Q4** The void fraction is the ratio of unfilled volume to total volume of a structure. For ideal metallic FCC crystal, it is:

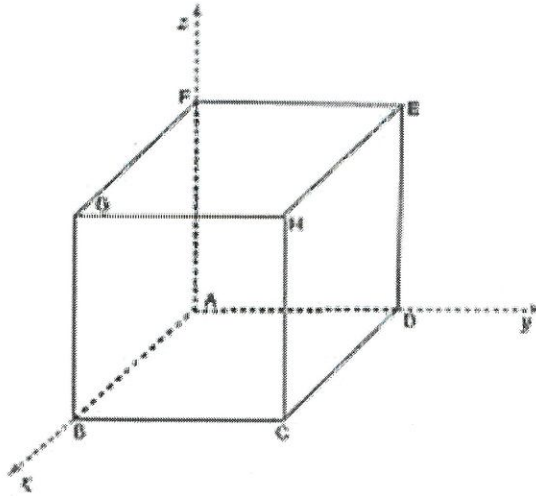
- A. 0.22  
B. 0.26  
C. 0.32  
D. 0.38

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- Q5** The edge length of an FCC lattice is X times the atomic radius. Value of X is:
- A. 2
  - B.  $2\sqrt{2}$
  - C.  $4/\sqrt{3}$
  - D.  $3/\sqrt{2}$
- Q6** Density is the ratio of the mass of crystal to its volume. For a perfect FCC metallic crystal, the mass of a unit cell is 4 times  $M_0$ .  $M_0$  is:
- A. specific mass
  - B. molar mass
  - C. atomic mass
  - D. none of the mentioned
- Q7** Which of the following quantities is larger in HCP as compared to FCC if the constituting atoms are similar?
- A. Number of particles per unit cell
  - B. Volume per unit cell
  - C. Mass per unit cell
  - D. All of the mentioned
- Q8** The point coordinate indices q, r, and s are multiples of:
- A. Unit cell edge lengths
  - B. Distance between nearest neighbours
  - C. Cosine of angles between unit cell edges
  - D. None of the mentioned

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Q9 If  $x$ ,  $y$ , and  $z$  are three positive axes of the crystallographic coordinate system with origin at point A, then which line points in the direction  $[1\ 0\ 1]$  ?



- A. AD
- B. CH
- C. FB
- D. GE

Q10 Which of the following is a property of Miller indices?

- A. They uniquely identify a plane
- B. They are always positive
- C. They are not fractions
- D. None of the mentioned

Q11 The defect which takes place due to imperfect packing of atoms during crystallization is known as

- A. Line defect
- B. Surface defect
- C. Point defect
- D. None of these

Q12 Foreign species are present in which of the following defects?

- A. Interstitial
- B. Vacancy
- C. Substitution
- D. All of the mentioned

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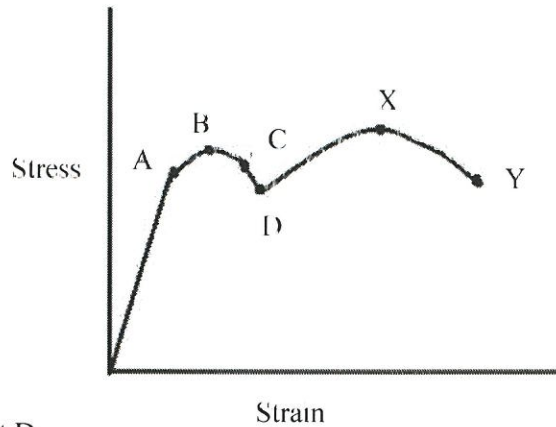
- Q13** The solubility of solute in a solvent in a solid solution is governed by Hume-Rothery rules. The solubility is more if:
- A. radii of solute are much smaller than that of solvent
  - B. solute and solvent have a similar crystal structure
  - C. solute has low valence
  - D. all of the mentioned
- Q14** What is the relative orientation of dislocation lines for edge dislocation?
- A. Parallel
  - B. Perpendicular
  - C. Circular
  - D. Both parallel and perpendicular
- Q15** Which of the following statement is false?
- A. Burger vector is the right angle to edge dislocation
  - B. In screw defect the line defect is parallel to the displacement vector
  - C. Grain boundary defect is a type of line defect
  - D. Line defect occurs during the recrystallization process or during slip
- Q16** Interstitial diffusion is generally faster than diffusion by vacancy mode. This is because:
- A. Number of interstitial sites is greater than vacancies
  - B. Vacancy diffusion requires more energy than interstitial diffusion
  - C. Interstitial species are smaller than substitution species
  - D. All of the mentioned
- Q17** How is the rate of diffusion affected by the weight of diffusing atom?
- A. Lighter atoms diffuse faster
  - B. Heavier atoms diffuse faster
  - C. Lighter atom diffuses slower
  - D. Rate of diffusion does not depend on weight of diffusing atom

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- Q18** How is the diffusion rate affected by concentration difference?
- A. Diffusion rate is not affected
  - B. Higher the concentration difference, higher the diffusion rate
  - C. Lower the concentration difference, higher the diffusion rate
  - D. Higher the concentration difference, lower the diffusion rate
- Q19** If we increase the temperature, how is the diffusion rate affected?
- A. Diffusion rate increases
  - B. Diffusion rate decreases
  - C. Diffusion rate decreases drastically
  - D. Diffusion rate is not affected
- Q20** You want to demonstrate the phenomenon of diffusion to a group of school kids using two colored gases. For this, you need to slow down the process. Which of the following tricks will help you achieve this feat?
- A. Cooling the gases
  - B. Using gases of large molecular weights
  - C. Decreasing the size of orifice
  - D. All of the mentioned
- Q21** The ability of a material to resist fracture due to high impact loads, is called
- A. Strength
  - B. Stiffness
  - C. Toughness
  - D. Brittleness

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Q22 Up to which point in the graph shown below, Hooke's Law is obeyed?



- A. Up to point D
- B. Up to point A
- C. Up to point B
- D. Up to point X

Q23 In stress strain curve, beyond yield point, metal undergoes

- A. less elastic deformation and more plastic deformation
- B. only elastic deformation
- C. more elastic deformation and less plastic deformation
- D. only plastic deformation

Q24 Which of the following property cannot be determined by a tensile test?

- A. Yield strain
- B. Yield stress
- C. Elastic limit
- D. Limit of proportionality

Q25 Up till which point will a body regain its original shape?

- A. Yield point
- B. Elastic limit
- C. Fracture limit
- D. Ultimate tensile strength point

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- Q26** How is brittleness related to impact strength?
- A. Brittleness is directly proportional to impact strength
  - B. Brittleness is inversely proportional to impact strength
  - C. Brittleness is directly proportional to a square of impact strength
  - D. Brittleness is inversely proportional to a square of impact strength
- Q27** What can understand by the factor of safety equal to one?
- A. It means that the structure will fail under load
  - B. It means that the structure will only support the actual load
  - C. it means that the structure will support more than the actual load
  - D. There is no relation between factor safety and load application
- Q28** Which of the following is false?
- A. Notch is a sudden change in section of a material
  - B. Stress concentration is produced due to notches
  - C. Notches change the stress applied to the body
  - D. Smaller the tip of the notch, less the increase in stress
- Q29** Necking occurs in which of the following fractures?
- A. Ductile fractures
  - B. Brittle fracture
  - C. Fatigue
  - D. It does not occur during fracture
- Q30** Which of the following is true?
- A. The slope of the strain-time graph increases with temperature and stress
  - B. The slope of strain-time graph decreases with temperature
  - C. The slope of strain-time graph decreases with stress
  - D. The slope of strain-time graph does not depend on temperature or stress

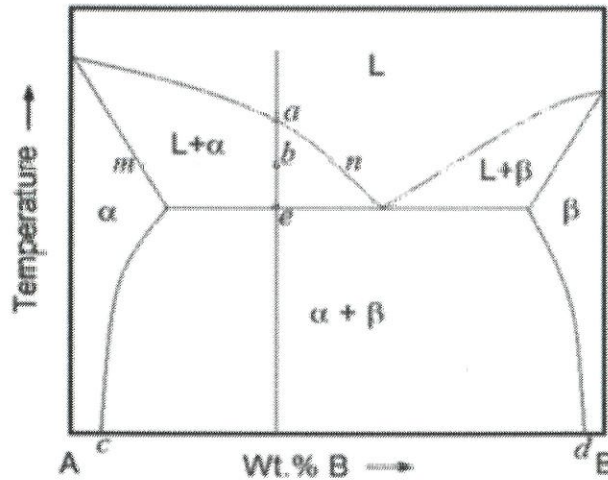
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- Q31** At certain temperature the maximum concentration of solute atoms that dissolve in solvent to form solid solution, this condition is called
- A. Solubility
  - B. Formation of phase
  - C. Solubility limit
  - D. Formation of super saturated solution
- Q32** Which of the following are examples of unary phase diagrams?
- A. Cu-Ni phase diagram
  - B. Water phase diagram
  - C. Cu-Pd phase diagram
  - D. Mg-Db phase diagram
- Q33** What are the external parameters that affect the phase structure?
- A. Temperature, Pressure
  - B. Temperature, Composition
  - C. Pressure, Composition
  - D. Temperature, Pressure, Composition
- Q34** What is Gibbs phase rule for metallurgical system?
- A.  $F = C - 1 - P$
  - B.  $F = C + 1 - P$
  - C.  $P + F = C - 2$
  - D.  $P + F = C + 2$
- Q35** Which of the following statements are true about the Eutectic point on a two-component (compounds A and B) phase diagram?
- A. Both compounds are solid
  - B. The melting point of the mixture is lower than the melting points of either of the individual compounds
  - C. One compound is in the liquid phase whilst the other is in the solid phase
  - D. It always occurs when the ratio of compound A to compound B is 50:50

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Q36 At point b, the  $\alpha$  fraction is given by the lever rule as



- A.  $mn/bn$
- B.  $bn/mn$
- C.  $ab/be$
- D.  $be/ab$

Q37 Which is false statement about annealing? Annealing is done to

- A. Relieve stresses
- B. Harden steel slightly
- C. Improve machining characteristic
- D. Soften material

Q38 Which of the following phase will be resulted when the transformation temperature of steel is more than  $750\text{ }^{\circ}\text{C}$ ?

- A. Austenite
- B. Pearlite
- C. Bainite
- D. Martensite

Q39 Which of the following statement is true?

- A. Fine pearlite is harder than coarse pearlite
- B. Fine pearlite is softer than coarse pearlite
- C. Fine pearlite is more ductile than coarse pearlite
- D. Toughness of steel decreases with increase in carbon percentage

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**Q40** Which of the following is true about a TTT diagram.

- A. It gives information on transformation rates.
- B. Relative amount of different phases can be found under given equilibrium conditions.
- C. It indicates the temperature at which different phases start to melt.
- D. Solid solubility limits are depicted by it

**PART B**

**Q1** (a) List four (4) metals used in aircraft manufacturing (4 marks)

(b) Corrosion is one of the greatest enemies of airframes, and the culprit in some of aviation's most serious accidents. When two dissimilar metals make a contact and with the presence of electrolyte, the metals have tendency to corrode. State and explain the measures to prevent this type of corrosion. (8 marks)

(c) Differentiate between thermoset and thermoplastic materials. (8 marks)

**Q2** (a) Define the composite terms. (3 marks)

(b) Describe the importance of a strong bonding between fiber and matrix at their boundary. (4 marks)

(c) A continuous and aligned glass fiber-reinforced composite consists of 40 vol% of glass fibers having a modulus of elasticity of 69 GPa and 60 vol % of a polyester resin that, when hardened, displays a modulus of 3.4 GPa. Calculate and truncate at one decimal place only.

(i) Calculate the modulus of elasticity of this composite in the longitudinal direction (isostrain). (3 marks)

(i) If the cross-sectional area is 250 mm<sup>2</sup> and a stress of 50 MPa is applied in this longitudinal direction (isostrain), compute the magnitude of the load carried by each of the fiber and matrix phases. (10 marks)

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- Q3** (a) Calculate the electrical conductivity of a 5.1mm diameter cylindrical silicon specimen 51mm long in which a current of 0.1A passes in an axial direction. A voltage of 12.5V is measured across two probes that are separated by 38mm.  
(5 marks)
- (b) Based on your calculation in Q3(a), determine the resistance over the entire 51 mm of the specimen.  
(5 marks)
- (c) During the left no. 1 pilot's windshield installation, you have noticed two windshield bolts are missing. Then, your partner gives two stainless steel bolts to replace the missing bolts. Evaluate the situation and defend your judgment in completing the installation.  
(10 marks)

- END OF QUESTION -