

B.E. POWER ENGINEERING SECOND YEAR SECOND SEMESTER EXAM 2023**Subject: Materials Science****Subject Code: PE/ES/B/T/222****Time: 3 Hr****Full Marks: 100**

- 1. Chose the correct Answer (Any FIFTEEN) 1x15=15**
- i.** Usually materials with _____ crystal structure, can be easily deformed at high temperature but difficult to deform at room temperature
 (a) FCC (b) BCC (c) HCP (d) SC
- ii.** Screw Dislocation is moved by _____ stress
 (a) Tensile (b) Compressive (c) Shear (d) All of the above.
- iii.** Creep rate in Primary stage _____
 (a) Decreases (b) starts at slow rate and rapids with time
 (c) Increases (d) starts at a rapid rate and slows with time
- iv.** In a single-component condensed system, if degree of freedom is zero, maximum number of phases that can co-exist _____
 (a) 0 (b) 1 (c) 2 (d) 3
- v.** A solid phase produces two new solid phases during _____ reaction up on cooling
 (a) Eutectic (b) Eutectoid (c) Peritectic (d) Peritectoid
- vi.** Weight percentage of Carbon present in Eutectoid steel
 (a) 0.008 (b) 0.08 (c) 0.8 (d) 1.8
- vii.** Liquid- Solid-1 + Solid-2. This type of reaction is known as _____ reaction.
 (a) Peritectic (b) Eutectic (c) Peritectoid (d) Eutectoid
- viii.** Usually materials with following crystal structure fail in ductile mode
 (a) BCC (b) FCC (c) HCP (d) All of the above
- ix.** Ternary stage creep is associated with
 (a) Strain hardening (b) Recovery (c) Necking (d) None
- x.** Not a Hume-Ruthery condition:
 (a) Crystal structure of each element of solid solution must be the same.
 (b) Size of atoms of each two elements must not differ by more than 15%.
 (c) Elements should form compounds with each other.
 (d) Elements should have the same valence.

- xi.** In a single-component condensed system, if degree of freedom is zero, maximum number of phases that can co-exist _____.
- (a) 0 (b) 1 (c) 2 (d) 3
- xii.** wt.% of carbon in mild steels:
- (a) <0.008 (b) 0.008-0.3 (c) 0.3-0.8 (d) 0.8-2.11
- xiii.** Strong _____ hybridized bonds make Graphene mechanically strong
- (a) sp^1 (b) sp^2 (c) sp^3 (d) Hydrogen bond
- xiv.** CNT s are the strongest and stiffest materials in _____
- (a) Tensile strength (b) Ductility (c) Elasticity (d) Energy
- xv.** _____ is one of the most important materials is also known as solar grade silicon.
- (a) Crushed silicon (b) Crystalline silicon
(c) Powdered silicon (d) Silicon
- xvi.** _____ is a direct band gap material.
- (a) Copper Indium Gallium Selenide (b) Copper Selenide
(c) Copper Gallium Telluride (d) Copper Indium Gallium Diselenide
- xvii.** Electrical property of CNT can be define as _____
- (a) Good Conductor (b) Insulator (c) Semi conductor (d) Impure metal
- xviii.** Highest critical temp. (TC) of superconductor around _____
- (a) 0 K (b) 33K (c) 133K (d) 233K
- xix.** CNT is _____
- (a) Non toxic (b) Toxic (c) Very Safe (d) Not having graphene
- xx.** Which of the following is not a Nanotube structure
- (a) Zig-zag-type Nanotube (b) armchair type Nanotube
(c) Helical Nanotube (d) Spiral Nanotube
- xxi.** Which of the following is/are not a Solid Insulating Materials
- (a) Polyvinyl chloride (b) Ceramics (c) Rubber (d) None
- xxii.** Which of the following is/ are used as Hydrogen Storage?
- (a) Boron nitride Nanotubes (b) Silicon carbide Nanotubes
(c) Pillared Graphene (d) All of the above
- xxiii.** Which material has Lower bond strength?
- (a) Si (b) SiC (c) Ge (d) InSb

2. Match the following (Any THREE)

5x3=15

A. Column-1

- (i) Fatigue
- (ii) Creep
- (iii) Hardness
- (iv) Resilience
- (v) Impact Test

Column-2

- (a) Time dependent yield
- (b) Energy absorbed up to elastic limit
- (c) Repeated load
- (d) Ductile to Brittle transition
- (e) Shore's Scleroscope

B. Component

- (i) High-pressure steam piping
- (ii) Superheater and Reheater
- (iii) High pressure Rotor
- (iv) Waterwall tubing
- (v) Rotating buckets

Material used

- (a) 1.25%Cr, 0.5Mo Steel
- (b) Ferritic steels 12%Cr steels
- (c) Ferritic/martensitic steels
- (d) Ferritic/martensitic steels
- (e) 422 stainless steel

C. Method of Production

- (i) Czochralski Method
- (ii) Solid-state reaction
- (iii) Catalyzed Chemical Vapor Deposition
- (iv) Arc Method with 1% Y, 4.2% Ni
- (v) Arc Method

Product

- (a) Amorphous Metal
- (b) Single walled Nanotubes
- (c) Crystalline Silicon
- (d) MWNT
- (e) SWNT

D. Type of Materials

- (i) Lower bond strength materials
- (ii) High bond strength materials
- (iii) Semiconductor
- (iv) Insulator
- (v) Super conductor

Example

- (a) Diamond
- (b) Germanium
- (c) Nitrogen
- (d) Niobium-titanium
- (e) CNT

3. Answer the following Questions (Any TEN)

2X10=20

- i. What is the Miller Indices of the points: (2, 3, 6); (-2, 1, 2).
- ii. What is low angle grain boundary?

- iii. Define Yield Strength.
- iv. What is Larson Miller parameter?
- v. Write down the ranges of Carbon (%) present in (a) Hypoeutectoid Steel, (b) Low Carbon Steel.
- vi. Why maximum 6.67% Carbon is dissolved in Iron- Carbon system?
- vii. What is the Degree of Freedom (F) for two component (C) system? Only Temperature is variable in the system and three phase is present in the system?
- viii. What is Frenkel defect and schottky defect?
- ix. What is Magnetic hysteresis?
- x. Give definition with example of each type: (a) Ferro-Magnetic, (b) Ferri-Magnetic
- xi. What is Chiral Vector?
- xii. What is Amorphous Metal? Write the use of Amorphous Metal.
- xiii. How Nanotubes used for Hydrogen Storage?
- xiv. What is CRGO and CRNO material?
- xv. Write down advantage of Hydrogen Fuel cell over fossil fuel.

4. Answer the following Questions (Any FIVE)

4X5=20

- i. Define with neat sketch: (i) Stacking faults, (ii) Twin Boundary 2+2
- ii. What is Yield point Phenomenon? Explain the reason behind it. 2+2
- iii. Calculate Effective no and Packing Efficiency of BCC crystal system. 1+3
- iv. What is Pearlite and Cementite? Draw the diagrams of microstructure of each. 2+2
- v. What is Normalizing process? Write its importance. 2+2
- vi. What is Nanofluid? Write the Application of Nanofluid. 1+3
- vii. Explain the working principle of Hydrogen Fuel cell with neat sketch and reactions. 4
- viii. Explain how Lamination decreases Eddy Current Losses. 4
- ix. Define with example: (a) Supercapacitor (b) Superconductor. 2+2

5. Answer the following Questions (Any Five)

6X5=30

- i. (a) What is the Miller Indices of the point (2, 3, 4); (-2, 1, 3).
 (b) Show the following crystal planes and crystal directions in a simple cubic system:
 (110), (111) [110], $[\bar{1}\bar{1}1]$ 2+4
- ii. (a) If the atomic radius for Ni 0.163nm, find the volume of the unit cell. It has FCC crystal structure.
 (b) Calculate the lattice parameter of Potassium Chloride (KCl) Crystal. It has FCC crystal structure. $[\rho_{\text{KCl}} = 1.98\text{g/cm}^3]$ [Avogadro No.= 6.023×10^{23}] 3+3
- iii. Tensile test was conducted on a mild steel specimen. Initial Dimensions are as follows: Diameter: 12.5 mm, Gauge length: 50mm. Final Dimensions: Diameter: 8mm, Gauge length: 62.5mm. Load: Yield: 4500kg, Maximum: 7500, Fracture load: 5000kg. At load 1200kg, $\Delta l = 0.035\text{mm}$.
 Find out: (a) Yield Stress (σ_y), (b) Ultimate Tensile stress (UTS) (σ_u), (c) Fracture Stress (σ_f), (d) Young Modulus (E), (e) Modulus of Resilience, (f) Percentage of Elongation, 6
- iv. Consider 1.0 kg of Austenite containing 1.15 wt% C, cooled to below 727°C. (a) How many kilograms each of total ferrite and cementite form? (b) How many kilograms each of Pearlite and the Proeutectoid phase form? 6
- v. Explain the production procedure of CNT with sketch for Chemical Vapor Deposition. 6
- vi. How CNT can use for better efficiency of Lithium Ion Battery. 6
- vii. How to produce single Crystalline doped Silicon semiconductor Material using Czochralski method. 6
- viii. Explain the working principle of Hydrogen Fuel cell with neat sketch and reactions. 6
- ix. Write down brief description of Dye-sensitized solar cell. 6