1.   **Chose the correct Answer (Any SIXTEEN)**   1x16=16

i.   Repeatable entity of a crystal structure is known as
      (a) Crystal   (b) Lattice   (c) Unit cell   (d) Miller indices

ii.   α-Iron has body-centered cubic crystal structure. How many Fe atoms are in each unit cell?
      (a) 6   (b) 4   (c) 8   (d) 2

iii. 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

iv.   Screw Dislocation is moved by _____ stress
      (a) Tensile   (b) Compressive   (c) Shear   (d) All of the above.

v.   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

vi.   Izod, Charpy are the type of _____ Test.
      (a) Tensile   (b) Compressive   (c) Hardness   (d) Impact

vii. A solid phase produces two new solid phases during _____ reaction up on cooling
      (a) Eutectic   (b) Eutectoid   (c) Peritectic   (d) Peritectoid

viii. Deformation is easy at room temperature for _____ metal
      (a) BCC   (b) FCC   (c) HCP   (d) All of the above

ix.   Solid-1 = Solid-2+Solid-3This type of reaction is known as _____ reaction.
      (a) Peritectic   (b) Eutectic   (c) Peritectoid   (d) Eutectoid

x.   Usually materials with following crystal structure fail in ductile mode
      (a) BCC   (b) FCC   (c) HCP   (d) All of the above

xi.   Which one of the following test is used to determine Ductile to Brittle Transition
      (b) Tensile   (b) Compressive   (c) Hardness   (d) Impact

[Turn over

xii. Which one is 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.

xiii. 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

xiv. wt.% of carbon in mild steels:
(a) <0.008   (b) 0.008-0.3   (c) 03-0.8   (d) 0.8-2.11

xv.   Strong _____ hybridised bonds make Graphene mechanically strong
(a) sp^1 (b) sp^2 (c) sp^3 (d) Hydrogen bond

xvi. _____ 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

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 nanotube
(c) Pillared Graphene   (d) All of the above

2. **Answer the following Questions (Any FIFTEEN)**   2X15=30

i. What is low angle grain boundary?

ii. What is Burgers vector?

iii. What is DBT temperature?

iv. Explain, why tension test is not applicable for determining young modulus for small sample? Which test is preferable?

v. Write down the ranges of Carbon (%) present in (a) Hypoeutectoid Steel, (b) Low Carbon Steel.

vi. Why maximum 6.67% Carbon can be 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 phases are present in the system.

viii. Write two differences between screw and edge dislocation.

ix. Explain the significance of TTT diagram?

x. What is Magnetic hysteresis?

xi. Give definition with example of each type: (a) Soft-Magnet, (b) Ferri-Magnetic material.

xii. What is Chiral Vector?

xiii. Write down the limitations of Nanotubes.

xiv. Mention the uses of Nano-fluid.

xv. What is Amorphous Metal? Write the use of Amorphous Metal.

xvi. How CNT can be used to handle Hydrogen storage problem?

xvii. Write down the design consideration to avoid Creep.

xviii. Explain the prospect of Superconductor in near future.

xix. Write the uses of EAP.

xx. Write down advantage of Hydrogen Fuel cell over fossil fuel.

3. **Answer the following Questions (Any SIX)**   4X6=24

i. What is shore Scleroscope? Explain in brief.   2+2

ii. Explain Fracture Mechanism for Ductile Material with neat sketch.   4

iii. What is Yield point Phenomenon? Explain the reason behind it.   2+2

iv. Calculate Effective no and Packing Efficiency of FCC crystal system.   1+3

v. What is Frenkel defect and schottky defect? Explain in brief.   2+2

vi. What is Normalizing process? Write its importance.   2+2

vii. (i) Draw the Stress-Strain Diagram of Mild Steel material and illustrate the following points:(a) Elastic Limit, (b) upper yield point, (c) lower yield point (d) ultimate tensile stress   1+3

viii. Explain how Lamination decreases Eddy Current Losses.   4

ix. What is Annealing process? What are the types of Annealing?   4

x. What is Super capacitor and Superconductor? Give examples of each.   4

4. **Answer the following Questions (Any Five)**   6X5=30

i. (a) What is the Miller Indices of the point (-2, 3, 1); (2, 1, 1).

(b) Show the following plane and direction in a simple cubic system

(110), (111) [110], [$\bar{1}\bar{1}1$]   2+4

ii. (a) Which types of bond(s) is/are present in (a) Metal, (b) Ceramic and (c) Polymer.

(b) Calculate the lattice parameter of NaCl crystal, if its density is 2189 kg/m3 and Avogadro No.=6.023x10^{23}. NaCl has FCC crystal structure.   3+3

iii. Why Fatigue Fracture occurred in materials? What are the precautions to avoid fatigue? What is high cycle fatigue and what is low cycle fatigue?   2+2+2

iv. Write down the Material property required for selection of material to design the (a) Superheater and (b) high pressure Rotor of Ultra-supercritical coal generation system. Also mention the preferred material for the components. **2+2+2**

v. Explain the procedure of production of CNT with sketch for Arc Method. **6**

vi. How CNT can use for better efficiency of Lithium Ion Battery. **6**

vii. What is Dielectric Breakdown? Where the following insulators are used? (a) Rubber, (b) PVC, (c) Air, (d) Argon. **2+4**

viii. How to produce single Crystalline doped Silicon semiconductor Material using Czochralski method. **6**

ix. Explain the working principle of Hydrogen Fuel cell with neat sketch and reactions. **6**

x. Explain the working principle of Conventional Solar Cell. **6**