

**VIT**Vellore Institute of Technology
(Established in the Vellore city under the name of VIT in 1984)

Course:

BCHE206L

Final Assessment Test – May 2024

Class NBR(s): 1190

Materials Science and Engineering

Time: Three Hours

Slot: C2+TC2

Max. Marks: 100

➤ KEEPING MOBILE PHONE/ELECTRONIC DEVICES EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE

➤ DON'T WRITE ANYTHING ON THE QUESTION PAPER

Answer any TEN Questions

(10 X 10 = 100 Marks)

1. a) Chromium has four isotopes. They are 5.34% of ^{50}Cr , with an atomic weight of 49.9460 amu, 82.79% of ^{52}Cr , with an atomic weight of 51.9405 amu, 8.50% of ^{53}Cr , with an atomic weight of 52.9407 amu, and 3.37% of ^{54}Cr , with an atomic weight of 53.9389 amu. Calculate the average atomic weight of Cr [5]

b) Calculate the force of attraction (F_A) between K^+ & O^{2-} ion the centers of which are separated by a distance of 1.5 nm. [5]

Details

$F = A/r^2$; K^+ and O^{2-} ions (Z_1 and Z_2) are +1 and -2, respectively, $Z_1 = 1$ and $Z_2 = 2$,

$\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$, $e = 1.602 \times 10^{-19} \text{ C}$

2. a) Calculate the radius of a V atom, given that Vanadium has body centered cubic crystal structure with a density of 5.96 g/cm^3 , and atomic weight of approximately 50.9 g/mol . [5]

b) Draw an orthorhombic unit cell [5]

3. (a) The wear resistance of a steel metal needs to be improved by hardening the shaft's surface. This can be done by increasing the N_2 content within an outer surface layer as a result of nitrogen diffusion into the steel. The nitrogen must [5]

be supplied from an nitrogen-rich gas reservoir at an elevated temperature.

The initial nitrogen content of the steel is 0.002 wt.%, whereas the surface concentration is to be maintained at 0.50 wt.%. For this treatment to be effective, nitrogen content of 0.10 wt.% must be established at a position 0.40 mm below the surface. Is it a steady or non-steady diffusion situation? Clarify.

(b) The activation energy for the diffusion of carbon in chromium is 121,000 J/mol. Calculate the diffusion coefficient at 1100 K (827°C), given that D at [5]

1400 K (1127°C) is $6.25 \times 10^{-11} \text{ m}^2/\text{s}$.

4. A cylindrical specimen of Al (Aluminum) having a diameter of 18 mm and length of 200 mm has been deformed elastically in tension with a mechanical force of 48,800 N. Determine the following

- The amount by which Al specimen that may elongate in the direction of the applied stress
- The changes in diameter of the Al.

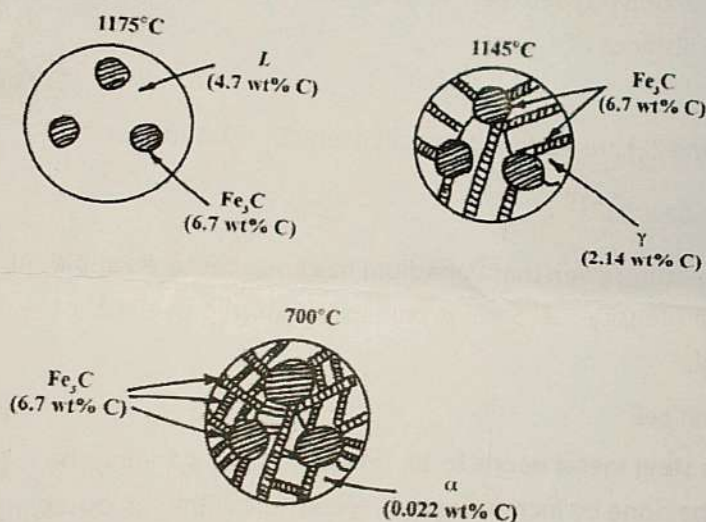
Details:

$$d_0 = 19 \text{ mm}; E = 69 \times 10^9 \text{ N/m}^2$$

For Aluminum, $\nu = 0.33$

$$\nu = -\frac{\epsilon_x}{\epsilon_z} = -\frac{\Delta d / d_0}{\Delta l / l_0}$$

5. Draw Iron-Iron carbide phase diagram and describe the following
- What do you infer from the figure below?



[3]

- Compare and contrast hypoeutectoid and hypereutectoid steels?

[2]

- What is CCT? Is it possible to achieve CCT in steel?

[5]

6. (i) Draw the polarization curves of fuel cell and electrolyser cell. Specify the kinetic, ohmic and mass transport region in the curve

[5]

- Assess the possibility of corrosion; in the following items. if your answer is 'Yes', Justify it with a schematic and generic corrosion reaction equation

[5]

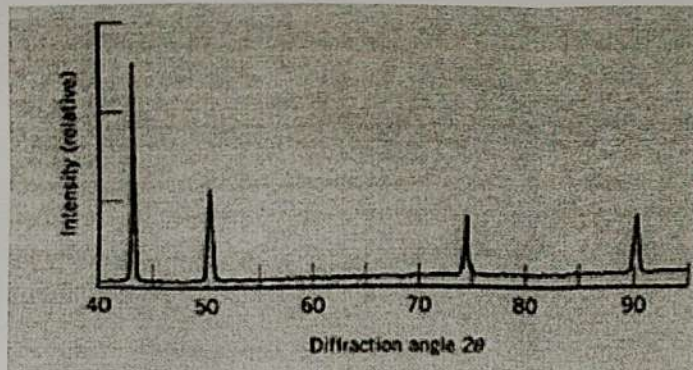
- Aluminum and magnesium
- Zinc and a low-carbon steel

7. Write short notes on

- Solgel method

- Growth of in-plane graphene and hBN hetero-structures via various techniques

Figure shows the first four peaks of the x-ray diffraction pattern for copper, which has an FCC crystal structure; monochromatic x-radiation having a wavelength of 0.1542 nm was used in the analysis. Index (i.e., give h, k, and l indices) for each of these peaks. Determine the interplanar spacing and radius for 111

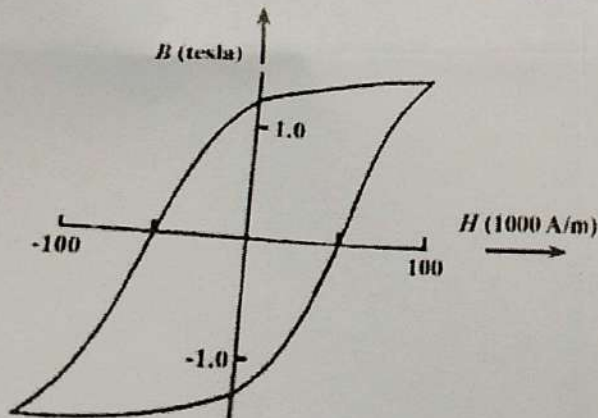


9. The polarization P of a dielectric material positioned within a parallel-plate capacitor is to be $1.0 \times 10^{-6} \text{ C/m}^2$.

a) What must be the dielectric constant if an electric field of $5 \times 10^4 \text{ V/m}$ is applied? [5]

b) What will be the dielectric displacement D ? [5]

10. a) Write your inference on the following figure: [2.5]



b) A coil of wire 0.20 m long and having 200 turns carries a current of 10 A. What is the magnitude of the magnetic field strength H ? [2.5]

c) Compute the flux density inside a bar of titanium that is positioned within the coil? [2.5]

d) Compute the magnitude of the magnetization M . [2.5]

Details: $\mu_0 = 1.257 \times 10^{-6} \text{ H/m}$; $\chi_m = 1.81 \times 10^{-4}$

11. Visible light having a wavelength of $8 \times 10^{-7} \text{ m}$ appears orange. Compute the frequency and energy of a photon of this light.

12. a) List out the techniques available to investigate the morphologies of elementary particles?

[5]

b) Why and When do you choose secondary ion spectroscopy?

[5]

⇔⇔⇔ N/E/TX ⇔⇔⇔