

**Thapar University, Patiala (Punjab)**

[End Sem. Examination]

M. Tech. I<sup>st</sup> Year (Materials Science)

**Course: MS-105 (Electrical and Magnetic Materials)**

Time: 3 hrs.

Max. Marks: 36

Note: Attempt all the questions. *Question no. 1 is compulsory.*

1. Give the reasons in support of any *four* of the following statements? (4 × 2)

- (a) Orbital motion of electron does not play any role in deciding the magnetic behavior of transition metal ions.
- (b) Materials have low work function for utilizing them as cathode.
- (c) SQUIDS are used in detecting extremely weak magnetic field.
- (d) Dielectric strength of a dielectric material must be compatible with the operating voltage of an electrical machine for using it as an insulator.
- (e) Mn in its elemental form does not show the ferromagnetism, whereas after alloying Mn with Cu, As and Sb it becomes ferromagnetic.

2.(a) Explain the domain dynamics during the generation of technical magnetization (M-H) curve? (2)

(b) What do you understand by Weiss molecular field? Explain its importance in understanding the ferromagnetic behavior of a material? (3)

(c) Find out the term symbol and effective number of Bohr magneton for  $\text{Eu}^{2+}$  in the configuration  $4f^7 5s^2 5p^6$ ? (2)

3. (a) What is the ionic conductivity? Write down its four applications? (2)

(b) A parallel plate capacitor is filled with a material which has real part of dielectric constant 2.56 and loss tangent  $0.7 \times 10^{-4}$  at a frequency of 1 MHz. The area of plates is  $8 \text{ cm}^2$  and the separation between the plates is 0.08 mm. Calculate the capacitance and the equivalent loss resistance. (3)

- (c) Calculate the approximate value of magnetic induction for orientation energy to be comparable to thermal energy at room temperature? Given that magnetic moment =  $5 \mu_B$ . (2)
4. (a) Explain how a superconductor is different from a perfect conductor? (2)
- (b) What do you understand by type-I and type-II superconductor? Give three examples from each class?
- (c) Explain the London equations in superconductivity and hence find the expression for penetration depth  $\lambda_L = (m / \mu_0 n_s q^2)^{1/2}$ , where  $q = 2e$ ? (3)
5. (a) Enumerate the dc and ac Josephson effect in superconductor by taking example of Pb/PbO<sub>2</sub>/Pb junction? Give two application of Josephson junction? (3)
- (b) Calculate the frequency of radiation, which Josephson junction emits when the voltage across the junction is  $10 \mu V$ ? (2)
- (c) The Nb superconductor has density of charge carriers is  $5.5 \times 10^{28}/m^3$ . Calculate the value of London penetration depth in Nb in nm? (2)