20/12/22(E)

2122
M. Tech. (Material Science and Technology)
Third Semester
MT-303: Magnetism and Superconductivity

Time allowed: 3 Hours   Max. Marks: 50

NOTE: Attempt _five_ questions in all, including Question No. I which is compulsory
and selecting two questions from each Part.

x-x-x

I.   Attempt any five of the following:
     (a) Describe the effects of magnetostriction on the properties of magnetic materials.
     (b) How does temperature affect magnetism?
     (c) What is the origin of magnetocrystalline anisotropy?
     (d) What do you understand by _energy gap_ in a superconductor?
     (e) Differentiate between type-I and type-II superconductors?
     (f) Define critical temperature, critical field and critical current density for a superconductor.

                                                                           (5*2=10)

PART-A

II. Give an account of quantum theory of paramagnetism and derive an expression for the
     susceptibility.   (10)

III. (a) What is hysteresis in ferromagnetic material and how do you understand it on the basis of
     domain theory.

     (b) What is the origin of GMR? Describe different structures of GMR.   (5,5)

IV   (a) What are the typical experimental features of a material having superparamagentism?

     (b) Briefly explain the magnetic reading and writing process.   (5,5)

PART-B

V.   (a) How are cooper pairs formed? Explain the BCS theory of superconductivity and discuss the
     energy gap based on this theory.
     (b) Estimate the intrinsic coherence length of aluminium if the size of the energy gap is 3.4×10^{-4}
     eV and Fermi velocity, $v_F = 2.02 \times 10^6$ m/s.   (7,3)

VI. (a) What does superconducting quantum interference device (SQUID) mean? Differentiate between
     DC SQUID and RF SQUID magnetometers.

     (b) London penetration depths for Pb at 3K and 7.1K are 39.6 nm and 173nm, respectively.
     Calculate its transition temperature as well as penetration depth at 0K.   (6,4)

VII. (a) What is meant by vortex pinning in superconductors. Discuss the role of artificial pinning center
     technology in superconductivity.
     (b) What is the frequency of the electromagnetic waves radiated by a Josephson junction having a
     voltage of 650 µV across its terminals?
     (c) Briefly discuss about high frequency applications of high-Tc superconductors.
                                                                           (4,3,3)

x-x-x