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SARDAR PATEL UNIVERSITY

M.Sc. Materials Science IIIrd Semester Examination

Tuesday, Date 04-12-2012

Time: 02:30 p.m. to 05:30 p.m. Maximum Marks: 70

Subject: PS03CMTS03: Optical, Magnetic and Dielectric Properties of Materials

Note: Figures on the RIGHT indicate maximum marks for the question.

- Q.1 All the questions are compulsory. (8)
- Answer the following questions by showing your correct choice against each one.
- Visible spectrum of electromagnetic radiation has the energy between
(a) 1.8 eV to 3.1 eV (b) 3.1 eV to 8.1 eV
(c) 1.2 eV to 3.7 eV (d) 1.8 eV to 8.8 eV
 - The refractive index is which function of the relative permittivity ϵ_r measured at optical frequencies?
(a) square root (b) cube root (c) cube (d) square
 - The polarization in a dielectric is
(a) the free charge per unit area of the dielectric.
(b) the free charge per unit volume of the dielectric.
(c) the bound charge per unit area of the dielectric.
(d) the bound charge per unit volume of the dielectric.
 - Pyroelectricity is only found in centro-symmetric crystals.
(a) true (b) false
 - The magnetic dipole moment of a body is measured in units of
(a) $A\ m^{-1}$ (b) $A\ m^2$ (c) $Wb\ m^{-2}$ (d) $Wb\ m^2$
 - The magnetic flux density, B , magnetic field intensity, H and intensity of magnetization, M are related by the equation
(a) $B = \mu_0(H+M)$ (b) $M = \mu_0(H+B)$ (c) $H = \mu_0(M+B)$ (d) $H = \mu_0(M-B)$
 - A piece of magnetic material has a net magnetic moment when no field is applied, it must therefore be ferromagnetic.
(a) true (b) false
 - Within each magnetic domain in a ferromagnet all the atomic magnetic moments are
(a) antiparallel (b) demagnetized (c) parallel (d) random

- Q.2 Attempt any SEVEN of the followings: (14)
- Differentiate between transparent and translucent materials.
 - Why diamond is transparent and gold is yellow to visible radiation?
 - State and write mathematical form of Coulomb's law.
 - Define 'dielectric strength' and 'dielectric loss'.
 - What are pyroelectric materials and how do they differ from piezoelectrics?
 - Define magnetization, M and magnetic susceptibility, χ_m and write their dimensions.
 - Write a few applications of magnetic materials.
 - State Hund's rule.
 - Name the two sources of magnetic moments for electrons and define Bohr magneton.

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Q.3 (a) Explain different phenomena that occur as a result of interaction of visible radiation with matter. Show that $I_0 = I_A + I_R + I_T$. (6)

(b) Explain absorption of visible radiation by nonmetals and comment on the role of energy bandgap in absorption of visible radiation by semiconductors. (6)

(OR)

(b) Explain transmission of visible radiation for nonmetals and show that $I_T = I_0 (1-R)^2 e^{-\beta x}$.

Q.4 (a) With suitable diagram explain mechanism of polarization of a dielectric material and obtain dimensions of polarizability in terms of permittivity, ϵ . (6)

(b) A parallel plate capacitor has an area of $5.45 \times 10^{-4} \text{ m}^2$ and plate separation of $1 \times 10^{-3} \text{ m}$ across which a potential of 10 volt is applied. If a material having dielectric constant of 6.0 is placed between the plates, calculate the capacitance and magnitude of charge stored on each plate.

Permittivity of vacuum, ϵ_0 is $8.854 \times 10^{-12} \text{ Far}^{-1}$. (6)

(OR)

(b) Explain piezoelectric and its converse effect. With example, comment on piezoelectric behaviour in plastics.

Q.5 (a) How can a material be magnetized? Classify magnetic materials in different groups and differentiate between paramagnetic and diamagnetic materials. (6)

(b) Based on the relationship between magnetic moment and angular momentum, derive equations for orbital and spin magnetic moments. (6)

(OR)

(b) What are ferrimagnetic materials? Comment on the effect of temperature on magnetic behavior of materials and define Curie temperature, T_c .

Q.6 (a) Using hysteresis loop explain magnetization and demagnetization of ferromagnetic/ferrimagnetic materials. (6)

(b) Sketch hysteresis loop and explain in brief about soft magnetic materials and also give examples of the same. (6)

(OR)

(b) Sketch hysteresis loop for hard magnetic materials and with example differentiate between conventional and high energy hard magnetic materials.
