Total No. of Questions—**12**] [Total No. of Printed Pages—**4+2**

[3662]-143

S.E. (Electrical) (I Sem.) EXAMINATION, 2009

MATERIAL SCIENCE

(2008 COURSE)

Time : Three Hours **Maximum Marks : 100**

N.B. :— (*i*) Answers to the two Sections should be written in separate answer-book.

(*ii*) Answer Q. No. **1** *or* Q. No. **2**, Q. No. **3** *or* Q. No. **4**, Q. No. **5** *or* Q. No. **6** from Section I.

(*iii*) Answer Q. No. **7** *or* Q. No. **8**, Q. No. **9** *or* Q. No. **10**, Q. No. **11** *or* Q. No. **12** from Section II.

(*iv*) Figures to the right indicate full marks.

(*v*) Use of logarithmic tables, slide rules and electronic pocket calculator is allowed.

(*vi*) Assume suitable data, if necessary.

Physical Constants :

(1) Angstrom unit (AU) = 1×10^{-10} metres.

(2) Boltzmann's constant (k) = 1.380×10^{-23} joule-degree^{-1}.

(3) Dielectric constant of free space (ϵ_0) = 8.85×10^{-12} farad-metre^{-1}.

(4) Charge on electron (e) = 1.601×10^{-19} coulombs.

(5) Mass of electron (m) = 9.107×10^{-31} kg.

(6) Permeability of free space (μ_0) = $4\pi \times 10^{-7}$.

(7) Mass of proton (m_p) = 1.627×10^{-27} kg.

(8) Velocity of light (c) = 2.998×10^{8} metre per second.

(9) Electron volt (eV) = 1.602×10^{-19} joules.

(10) Debye unit = 3.33×10^{-30} coulomb-metre.

P.T.O.

1. (*a*) Derive Clausius-Mossotti relation as applied to dielectric materials in static field. State clearly the assumptions made. [6]

(*b*) The number of atoms in volume of one cubic metre of hydrogen gas is 9.8×10^{26}. The radius of the hydrogen atom is 0.53 AU. Calculate the polarizability and relative permittivity. [6]

(*c*) What is meant by loss tangent as referred to polar dielectrics. Hence give its significance. [4]

Or

2. (*a*) With a neat sketch explain the construction and working of photo-voltaic cell. [6]

(*b*) A parallel plate capacitor having an area of 6.45×10^{-4} m^2 and a plate separation of 2×10^{-3} m across which a potential of 10 V is applied. If a material having dielectric constant of 6.0 is positioned with in the region between the plates, calculate : [6]

(*i*) The capacitance

(*ii*) The magnitude of charge stored on each plate

(*iii*) The electric field density D

(*iv*) The polarization P.

(*c*) Write a note on Piezo-electricity. [4]

3. (*a*) State the properties and applications of : [6]

(*i*) Transformer oil

(*ii*) SF_6 gas.

(b) Define breakdown voltage in connection with dielectric materials. Explain various factors affecting breakdown strength of liquid dielectric material. [6]

(c) Discuss the insulating materials used for power and distribution transformer. [4]

Or

4. (a) State different mechanisms of breakdown in vacuum. Explain any *one*. [6]

(b) What do you mean by fibrous insulating material. What is their major drawback ? How can it be overcome ? [6]

(c) What is meant by Townsend's primary and secondary lionization coefficients ? [4]

5. (a) Define relative permeability. Show that the relative permeability $\mu_r = 1 + \chi_m$, where χ_m is the magnetic susceptibility. [6]

(b) Explain classification of magnetic material on the basis of distribution of dipole moments. [8]

(c) Calculate hysteresis loss in a specimen of iron subjected to magnetization of 50 Hz. The weight of the specimen is 40 kg and its density is 7680 kg/m^3. The hysteresis loop area is equivalent to 198 J/m^3. [4]

Or

6. (*a*) What is Curie temperature for ferromagnetic material ? Describe Curie-Weiss law. [6]

(*b*) Differentiate between : [6]

(*i*) Soft and hard magnetic materials

(*ii*) Ferromagnetism and antiferromagnetism.

(*c*) A magnetic field strength of Fe_2O_3 is 10^6 A/m. If the susceptibility of Fe_2O_3 at room temperature is 1.25×10^{-3}, calculate induced magnetization, induced field density and permeability μ. [6]

SECTION II

7. (*a*) State the properties and applications of : [12]

(*i*) Eureka

(*ii*) Tungsten

(*iii*) Kanthal.

(*b*) Annealed copper has resistivity 17.2×10^{-9} ohm-m at 20°C. With 2 atomic percent of nickel, the resistivity of alloy of copper and nickel becomes 4.06×10^{-8} ohm-m. With the addition of 3 percent atomic silver, the resistivity of alloy of copper and silver becomes 1.98×10^{-8} ohm-m. What will be the resistivity of copper alloy for addition of 0.3 atomic percent of nickel and 0.2 atomic percent of silver at 20°C. [4]

Or

8. (*a*) Why is carbon preferred for brushes in electric machines ? [4]

(*b*) What are the groups into which solders are grouped ? Give their applications. [4]

(*c*) A 230 volt filament lamp dissipates 60 watt at 2700°C. Resistivity of filament material at 20°C is 4.3×10^{-6} ohm-cm and its temperature coefficient at 20°C is 0.005/°C. Calculate the length of filament at 20°C if its diameter at 20°C is 0.028 mm. [8]

9. (*a*) What are carbon nanotubes ? Discuss their electrical, mechanical and vibrational properties. List some applications of carbon nanotubes. [10]

(*b*) Write a short note on single electron transistor. [6]

Or

10. (*a*) Discuss in brief the concepts of energy bands in insulators, semiconductors and conductors. [10]

(*b*) Write a short note on BN nanotubes. [6]

11. (*a*) With a neat connection diagram, explain a method for determining dielectric strength of transformer oil as per relevant IS code of practice. [10]

(*b*) What is tan δ of a dielectric ? Explain. Describe the method of measurement of tan δ of a dielectric by Schering bridge as per IS code of practice. [8]

Or

12. (*a*) With a neat connection diagram, explain the method for measurement of dielectric strength of air as per relevant IS code of practice. What inferences will you draw from this test ? [10]

(*b*) What is partial discharge of a dielectric ? Explain a method to determine the partial discharge of a dielectric solid in the laboratory. [8]