53 (IE 303) EEMD

2013

(December)

ELECTRICAL ENGINEERING MATERIAL AND DEVICES

Paper : IE 303

Full Marks : 100

Pass Marks : 30

Time : Three hours

The figures in the margin indicate full marks for the questions.

Answer ***any five*** *questions.*

1. *(a)* Make comparisons between ionic crystals and valence crystals. 5

(b) Write the name of the *three* quantum numbers. Also write the relation between them. What is the electronic configuration of potassium $(Z = 19)$? 6

(c) According to wave mechanics, the wavelength λ of an electron is related to the momentum p of the electron by means of the so-called de Broglie formula $\lambda = h/p$, where h is Planck's constant. Show that the wavelength of an electron with kinetic energy of V electron volts is given by $\lambda = (150/v)^{1/2}$ angstroms. Value of h is 6.62×10^{-34} *joule sec.* 9

2. (a) What is the difference between ionic and electronic polarization ? 2

(b) Derive the expression for orientational polarization. 8

(c) An electrolytic condenser consists of an oxidized aluminium sheet with an effective surface area of $400 cm^2$ has a capacitance of 8 microfarads; the dielectric constant of Al_2O_3 is $\epsilon_r = 8$. A potential difference of 10 *volts* is applied between the aluminium and the electrolyte. What is the field strength and what is the total dipole moment induced in the oxide layer ? 10

3. *(a)* State Bio Savart's law with an example. 3

(b) Compare Circular Bohr Orbit model and spherical charge cloud model. 4

(c) Derive the expression of orbital magnetic dipole moment. 3

(d) Show by means of Biot Savart's law that the flux density produced by an infinitely long straight wire, carrying a current I, in a point at a distance 'a' normal to the wire is given by $\mu_o \mu_r I/2\pi a$. 10

4. *(a)* Derive the expression of complex polarizability. Derive the Maximum and Minimum value of the real part of complex polarizability. 7+3=10

(b) Consider a parallel plate condenser with a lossy dielectric between them. At an angular frequency ω let the dielectric be characterized by a complex dielectric constant $\in_r = \in_{r'} - j \in_{r''}$. The area of the plate is $1m^2$, the distance between them $1m$. For an applied voltage $V(t) = V_o \cos wt$ show that the current through the lossy condenser is given by $i(t) = \left(\in_o \in_{r''} \omega V_o\right) \cos \omega t - \left(\in_o \in_{r''} wV_o\right) \sin \omega t$ 10

5. *(a)* What is electrical conductivity of the material ? Define relaxation time of the electrons. 2+4=6

(b) Derive the expression of total energy dissipated per m^3 per second in a current-carrying conductor. 6

(c) A copper wire has a resistivity of 1.8×10^{-8} *ohm m* at room temperature (300°*K*). Assuming the copper is very pure, estimate the resistivity at 700°*C* and the percentage change in the resistivity from room temperature to 700°*C*. 8

6. *(a)* Write the positions of the silicon and germanium in the periodic table. 2

(b) Write the differences between metals and semiconductors. 3

(c) What is the difference between intrinsic semiconductors and extrinsic semiconductors. 3

(d) Compare valence level and conduction level. 4

(e) The resistivity of intrinsic silicon at $27°C$ is $3000 ohm\ m$. Assuming electron and hole mobilities of respectively 0.17 and $0.035 m^2\ volt^{-1} sec^{-1}$, calculate the intrinsic carrier density ni at $27°C$. 8

7. (a) Show that an electron with a velocity perpendicular to the direction of a homogeneous magnetic field of flux density B describes a circular path with an angular velocity of rotation equal to eB/m. 10

(b) A uniform silver wire has a resistivity of $1.54 \times 10^{-8} ohm\ m$ at room temperature. For an electric field along the wire of 1 $volt\ cm^{-1}$ compute the average drift velocity of the electrons, assuming there are 5.8×10^{28} conduction electrons per m^3. Also calculate the mobility and relaxation time of the electrons. 10