53 (IE 303) EEMD

2017

ELECTRICAL ENGINEERING MATERIAL & DEVICES

Paper : IE-303

Full Marks : 100

Time : Three hours

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

*Answer **any five** questions.*

I. *(a)* Write the quantum conditions postulated by Bohr. Also find out the possible radii of the electron orbit. 5

(b) What is the group of transition elements ? 5

(c) Assume the energy of two particles in the field of each other is given by the following function of the distance r between the centers of the particles; 10

$$W(r) = -(\alpha/r) + (\beta/r^8)$$

where, α, β are constants.

(i) Show that the two particles form a stable compound for

$$r = r_0 = (8\beta/\alpha)^{1/7}.$$

(ii) Calculate the total potential energy of the two particles in the stable configuration.

2. (a) Write Gauss's theorem and its mathematical expression. 5

(b) What is elemental di electrics ? 5

(c) An electrolytic condenser consisting of an oxidized aluminium sheet with an effective surface area of $400 cm^2$ has a capacitance of $8 \mu F$; 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 total dipole moment in the oxide layer ? 10

3. (a) Derive the expression of complex polarizability. 10

(b) Consider a parallel plate condenser with a lossy dielectric between them. At an angular frequency w, let the dielectric be characterized by a complex dielectric constant $\epsilon_r^* = \epsilon_r' - j\epsilon_r''$. The area of the plate is $1 m^2$, the distance between them is $1 m$. For an applied voltage $V(t) = V_0 \cos wt$. Show that the current through the lossy condenser is given by —

$$i(t) = (\epsilon_0 \epsilon_r'' w V_0) \cos wt - (\epsilon_0 \epsilon_r' V_0 w) \sin wt$$

What is the loss tangent of the condenser ? 10

4. *(a)* Write the classification of magnetic materials. 5

(b) What are remanent flux density and saturated flux density ? Discuss these with the help of hysteresis loop for a ferromagnetic material. 5

(c) Two infinite parallel conductors carry parallel currents of 10*A* each. Find the magnitude and direction of the force between the conductors per meter length if the distance between them is 20*cm*. 10

5. *(a)* What are transducers ? How can we use a Hall-effect transducer for — 1+5+5=11

(i) Magnetic to ellectric transducers ?

(ii) Measurment of current ?

Draw necessary diagrams.

(b) What are power semiconductor devices and how are they differ from general low power semiconductor devices ? 2+5=7

Define the following terms associated with Silicon Controlled Rectifier (SCR) —

(i) Forward Current

(ii) Latching Current

(iii) Holding Current

(iv) Peak Inverse Voltage

(v) Reverse Breakdown Voltage

(c) Write the position of *Si* and *Ge* in the periodic table. 2

6. (a) What do you mean by the thermo-electric phenomena ? How can we measure temperature using a thermo-couple ? 6+4=10

(b) A potential difference of $10V$ is applied longitudinally to a rectangular specimen of intrinsic germanium of length $25mm$, width $4mm$ and thickness $1{\cdot}5mm$. Determine at room temperature — 10

(i) electron and hole drift velocities

(ii) the conductivity of intrinsic germanium if intrinsic carrier density is $2{\cdot}5\times10'9/m^3$

(iii) the total current.

7. *(a)* What do you mean by drift velocity at electrons in a conductor material ? Derive an expression for the drift velocity and also show that —

1+5+4=10

$$J = \sigma E$$

Where, J = Current density

σ = Conductivity

E = applied electric field

(b) A piece of resistance wire 15·6m long and of cross-sectional area 12mm^2 at a temperature of 0°C passes a current of 7·9A when connected to a dc supply at 240 volt. Calculate —

(i) resistivity of wire

(ii) the current which will flow when the temperature rises to 55°C. Temperature co-efficient of resistance of wire is 0·00029/°C.

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(c) Write *four* fundamental requirements to be met by high conductivity materials for use in electrical machines.

½×4=2