2022

(February)

ELECTRONICS

(Elective/Honours)

(Semiconductor and P-N Junction Diode, Network Theorem, Measuring Instruments, DC and AC Analysis)

[ELEC–101 (T)]

Marks : 75

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer **one** question from each Unit

UNIT—I

1. *(a)* Draw the energy band diagram of a conductor, semiconductor and insulator. Mention also the value of energy gap in electron volt (eV). What is the value of 1 eV in joules?

(b) Draw the two-dimensional bonding diagram of *(i)* pure silicon, *(ii)* pure silicon doped with trivalent impurity and *(iii)* pure silicon doped with pentavalent impurity.

(c) Draw a two-dimensional neat diagram showing the movement of holes and also hole current.

(d) Name one trivalent and one pentavalent impurity.

(e) An electric field of 100 volts per metre is applied to a silver wire. Assuming that silver has $5{\cdot}8 \times 10^{28}$ conduction electrons per $(\text{metre})^3$ and resistivity (ρ) of $1{\cdot}54 \times 10^{-8}$ ohm-metre at 300 K, calculate the mobility (μ) and the drift velocity (v_d) of electrons (charge of electron is $1{\cdot}6 \times 10^{-19}$ coulombs).

3+3+3+2+6=17

2. *(a)* Draw the energy band diagram of an *n*-type and a *p*-type semiconductors showing clearly the donor and acceptor levels. Mention in few lines why the impurity levels are called the donor and acceptor levels.

(b) What do you understand by 'Mass Action Law'?

(c) An intrinsic sample of germanium crystal has a hole density of 10^{13} per cm^3 at the room temperature. When doped with pentavalent impurity, the hole density is decreased to 10^{11} per cm^3 at the same temperature. Calculate the majority carrier density.

(d) Discuss in brief the concept of Fermi level in relation to the probability $F(E)$ of a state corresponding to energy E. Plot E versus $F(E)$ for two different temperatures namely $T = 1000$ K and $T = 300$ K. 4+4+5+4=17

UNIT—II

3. *(a)* Draw the energy band diagram of a *p-n* junction diode showing clearly the Fermi level and width of the depletion layer for *(i)* no biasing, *(ii)* reverse biased and *(iii)* forward biased.

(b) Discuss in brief barrier potential. What is the value of barrier potential of a silicon diode and a germanium diode?

(c) Write down the *I-V* equation of a *p-n* junction diode (no deduction).

(d) Explain in detail how a Zener diode is used as a voltage regulator. 6+4+2+5=17

4. *(a)* Draw the circuit diagram of a full-wave rectifier using *(i)* two diodes and *(ii)* four diodes.

(b) Deduce the expression for *(i)* average d.c. current and *(ii)* r.m.s. value of the current for a full-wave rectifier.

(c) Draw the circuit diagram of a positive and a negative clamper circuit. 6+6+5=17

UNIT—III

5. *(a)* Define a node and a branch.

(b) State reciprocity theorem and maximum power transfer theorem.

(c) Solve the network of Fig. 1 by the mesh current method :

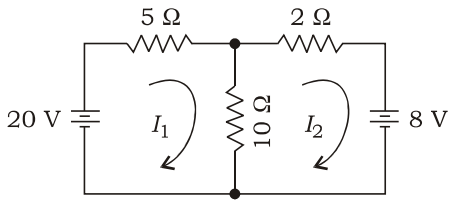

Fig. 1

(d) Using Norton's theorem, find the current through the load $R_L = 20\ k\Omega$ as shown in Fig. 2 :

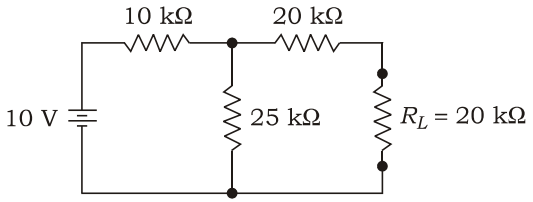

Fig. 2

2+4+5+6=17

6. (a) With the help of a neat diagram, show the conversion of a galvanometer into a voltmeter and an ammeter with proper equations.

(b) Draw a diagram showing the conversion of a galvanometer into an ohmmeter.

(c) Define sensitivity of a multimeter.

(d) Draw a simple circuit showing the components used for metre protection.

(e) In an oscilloscope, 400 V, 60 Hz signal produces a deflection of 4 cm corresponding to a certain setting of vertical gain control. If another voltage produces 8 cm deflection, what is the value of this voltage? 6+3+2+3+3=17

UNIT—IV

7. (a) Write down the unit of *(i)* R, *(ii)* ωL and *(iii)* $\frac{1}{\omega C}$ and also write down the expression for impedance of (1) *R-L*, (2) *R-C* and (3) *R-L-C* circuits.

(b) Draw the phasor diagram of series *R-L*, *R-C* and *R-L-C* circuits and write the expression of the phase difference in terms of $\tan\phi$ for *R-L*, *R-C* and *R-L-C* circuits.

(c) Draw the waveform of input, $V = V_0 \sin(\omega t)$ and also draw the corresponding current for a network having *(i)* only *R*, *(ii)* only *L* and *(iii)* only *C*.

(d) A sinusoidal voltage, $V(t) = 40\sin(2000)t$ is applied across a pure capacitor of 200 μF. Find the current in the circuit.

4+8+4+8=24

8. (a) Analyse the DC transient response of an *R-L* circuit shown in Fig. 3 when the switch t moves from a to b :

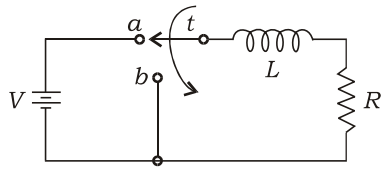

Fig. 3

Define time constant.

(b) Draw the frequency response curve of a circuit having *(i)* L and C in parallel, *(ii)* L and C in series and *(iii)* L, C and R in series.

(c) A pure inductive coil allows a current of 10 A to flow from a 230 V, 50 Hz supply. Find *(i)* inductive reactance, *(ii)* inductance of the coil and *(iii)* equation for voltage and current.

8+6+10=24

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