[This question paper contains 4 printed pages.]

Your Roll No. .....

6014 **B**

B.Sc. (Hons.)/I

ELECTRONIC SCIENCE—Paper 1.4 (IV)

(Semiconductor and Solid State Devices)

Time : 3 *Hours* *Maximum Marks* : 38

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt any *Five* questions.

Question No. **1** is compulsory.

1. (*a*) What are the Frenkel and Schottky defects in a crystal ? 2

(*b*) Explain the difference between direct and indirect semiconductors with the help of E-R diagram. 2

(*c*) Calculate the density of states per unit volume with energies between 0 and 1 eV. 2

(*d*) Point out one constructional and one operational difference between FET and UJT. 2

(*e*) How much is the wavelength of radiation emitted by recombination of electron-hole pair in GaAs whose band gap is 1.42 eV ?

[P. T. O.

2. (*a*) Prove that the intrinsic carrier density is given by

$$n_i = \sqrt{N_C\, N_V}\, \exp\left(-\frac{Eg}{2\,KT}\right)$$

where symbols have their usual meanings. 4

(*b*) Draw schematic energy diagrams for density of states N(E) versus fermi dirac distribution function F(E) of *n*-type semiconductors and explain. 2

(*c*) Determine the probability that an energy level 3 KT above the Fermi level is occupied by an electron. 1

3. (*a*) Explain the phenomena of diffusion of change carriers in a semiconductor and show that electron current density is given by the following expression : 4

$$J_n = q\, D_n \frac{dn}{dx}.$$

(*b*) A *n*-type semiconductor has Hall coefficient 160 cm^3/ coulomb. If its resistivity is 0.16 ohm-cm, determine the electron mobility for this semiconductor. 2

(*c*) In an *n*-type GaAs semiconductor at T = 300 K, the electron concentration varies linearly from

1×10^8 cm^{-3} to 7×10^{17} cm^{-3} over a distance of 0.10 cm. Calculate the diffusion current density if the diffusion coefficient is 225 cm^2/s. 1

4. (*a*) Show that the transition capacitance of a linearly graded junction varies inversely as the cube root of the junction voltage. 4

(*b*) Calculate the built-in-potential for silicon per junction with $N_A = 10^{18}/cm^3$ and $N_D = 10^{15}/cm^3$ at room temperature (300 K). Intrinsic carrier concentration at 300 K for silicon is $1.5 \times 10^{10}/cm^3$. 3

5. (*a*) Explain the working of a Bipolar transistor in active mode operation. Show that the collector current I_C is directly proportional to the minority carriers charge stored in the base. 4

(*b*) A *npn* transistor with $\alpha = 0.98$ is operated in the common base configuration. If the emitter current is 3 mA and reverse saturation current is 10 μA. What are the base current and collector current ? 3

[P. T. O.

6. (*a*) Explain the accumulation, depletion and inversion cases for an Ideal MOS diode. 3

(*b*) Explain the construction and working of metal oxide semiconductor field effect transistor (MOSFET) what is the difference between depletion and enhancement mode MOSFET. 4

7. (*a*) Draw and explain the output characteristics of a JFET. Define transconductance (gm) and channel conductance (gd). 4

(*b*) Determine the pinch off voltage (V_P) for *n*-channel silicon JFET with a channel width of 5.6×10^{-4} cm and donor concentration of 10^{15} cm^{-3}. Given $\epsilon_s = 12 \times 8.854 \times 10^{-14}$ F/cm. 3