This question paper contains 3 printed pages.]

Your Roll No. .....

1395 **A**

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 ***five*** *questions in all, including* Q. No. **1** *which is compulsory.*

1. (a) What are Miller indices? Draw the cubic crystal planes represented by Miller indices (110) and (111).

   (b) How does the mobility vary with temperature for (i) lightly doped; (ii) heavily doped semiconductors.

   (c) Draw the depletion layer width and energy band diagrams of a *p-n* junction under various biasing conditions.

   (d) Explain Base Width Modulation for a common emitter configuration of a BJT.

   (e) Compare advantages and disadvantages of FET over BJT. $2 \times 5 = 10$

2. (a) Show that the Fermi level of an intrinsic semiconductor lies very closed to the middle of the bandgap. How does the intrinsic carrier density depend upon the bandgap. 5

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(b) Obtain expression for electron and hole densities in terms of intrinsic carrier concentration n_i and intrinsic Fermi level E_i. 2

3 (a) An intrinsic S_i sample is doped with donors from one side such that donor density $N_d = N_o e^{-\alpha x}$. Find an expression for the electric field E (x) at equillibrium over the range for which $N_d >> n_i$. n_i is intrinsic carrier concentration. 2

(b) Show that diffusion current is proportional to the spatial derivative of the electron density. 2

(c) A sample of S_i is doped with 10^{17} phosphorus atoms/ cm^3. What would you expect to measure for its resistivity? What Hall voltage would you expect in a sample 100 μm thick if I = 1 mA and $B_z = 10^{-5}$ Wb/cm^2. (μ_n = 700 cm^2/V – s) 3

4. (a) Discuss the two important junction breakdown mechanisms : 2

(b) The contact potential cannot be measured by placing a voltmeter across the $p - n$ junction. Why? 1

(c) Derive equation for built in potential and the junction capacitance of a linear graded junction. 4

5. (a) Starting from the continuity equation, derive the expression for emitter terminal current for a bipolar junction transistor in active mode of operation. 4

(b) Explain the working of a SCR using two transistor models. What is function of the gate? 3

6. (a) Explain I-V characteristics of UJT. Explain its use as relaxation oscillator. 3

(b) Derive an expression for the drain current of JFET. Find expression for its channel conductance in linear region. 4

7. (a) What are ohmic and rectifying contancts? 2

(b) Draw energy band diagram of a Metal Oxide Semicanductor (MOS) diode. Describe accumulation depletion and inversion cases for ideal MOS diode. 3

(c) Explain the working of enhancement and depletion mode MOSFETs. 2