(b) Explain the structure of semiconductor-controlled rectifier (SCR) and further explain its characteristics. (6)

(c) Explain the structure and working of IGBT (Insulated Gate Bipolar Transistor). (6)

[This question paper contains 6 printed pages.]

Your Roll No..............

Sr. No. of Question Paper : 1059 **C**

Unique Paper Code : 22512011103

Name of the Paper : Semiconductor Devices

Name of the Course : **B.Sc. (H) Electronics**

Semester : I

Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. There are **seven** questions in all, out of which you have to attempt any **five** questions.
3. **All** questions carry equal marks.
4. **First** Question is Compulsory.
5. Use of Scientific Calculator is allowed.

1. (a) What are direct and indirect band semiconductors? Explain them with their energy band diagrams and two examples. (3)

(b) Explain the difference between intrinsic and extrinsic semiconductor. Draw energy band diagrams of n type and p type semiconductor. (3)

(c) Draw the energy band diagrams of a forward and reverse bias junction. (3)

(d) What is the difference between ohmic and rectifying contacts? Explain in brief. (3)

(e) Draw the doping profile along the block diagram of a p-n-p transistor. Also draw its symbol. (3)

(f) Draw the structure of a p-channel MOSFET. (3)

2. (a) Derive an expression for electron and hole densities in an intrinsic semiconductor. Show that the Fermi level is close to middle of the band gap. (6)

(b) A silicon ingot is doped with 10^{18} arsenic atoms per cm^3. Find the carrier concentration and the Fermi level from the bottom of the conduction

(c) Explain the working of a solar cell give its circuit symbol and characteristics give one application of solar cell. (6)

6. (a) Draw and explain the energy band diagram of bipolar junction transistor (BJT) in thermal equilibrium. (6)

(b) For a BJT working under Common Base configuration. Determine the various currents flowing in it.

(i) $\beta=150$, $I_C=3mA$

(ii) $\beta=250$, $I_B=2\mu A$ (6)

(c) Explain the phenomena of Early effect in the transistor using suitable diagrams. Draw the input and output characteristics of the common-base configuration and explain its variation. (6)

7. (a) Draw the structure of MOSFET. Based upon biasing of controlling terminal, explain the different regions of operation of the MOSFET. (6)

band at room temperature (300 K). The value of K_BT at 300 K is 0.026eV and $N_C = 2.86 \times 10^{19}$ cm^{-3} and $n_i = 9.65 \times 10^9 cm^{-3}$. (6)

(c) Describe various generation and recombination processes with suitable diagrams. How will you explain the lifetime of excess number of carriers? (6)

3. (a) Explain the phenomena of drift and diffusion of charge carriers in semiconductors. Derive Einstein relationship. (6)

(b) What is Hall effect? Explain its physical significance. (6)

(c) Express conductivity and resistivity of an intrinsic semiconductor in terms of mobility. Find the room temperature resistivity of an n type silicon doped with 10^{17} phosphorus atoms per cm^3 with drift velocity equals to 1.95×10^6 cm/s and applied electric field of 1.5kV/cm. (6)

4. (a) Draw the necessary diagrams for charge density, depletion width in the depletion region of p-n junction and one-sided abrupt p-n junction under no bias condition. (6)

(b) Show that show that the Fermi level remain constant (independent of x) in case of a p-n junction at thermal equilibrium. (6)

(c) A p-n junction has doping density N_A equal to 5×10^{18} cm^{-3} and N_D equal to 5×10^{15} cm^{-3} in the two regions. Assume ni equal to 1.5×10^{10} cm^{-3}, calculate the built in potential at 300K. (6)

5. (a) Give ideal diode equation and explain the current voltage characteristics of a diode qualitatively. (6)

(b) What is depletion capacitance in a p-n junction diode? How does it vary with the applied voltage for and abrupt and linearly graded junctions? Name a device which functions on this effect. (6)