[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1395 **I**

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.
2. **First** Question is Compulsory.
3. **All** questions carry equal marks.
4. Use of Scientific Calculator is allowed.

1. (a) Which of the charge carriers (electrons or holes) in a semiconductor has greater mobility? Why? (3)

   (b) How does the mobility depend on the doping. Explain. (3)

   (c) Sketch the doping profile of an abrupt junction and linearly graded junctions. (3)

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(d) Draw the energy band diagrams of a p-type semiconductor, a n-type semiconductor and a p-n junction at thermal equilibrium. (3)

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

(f) Draw the schematic diagram of a n-channel MOSFET. (3)

2. (a) Explain the difference between the rest mass and the effective mass of a carrier? Explain the concept of effective mass using energy-momentum relationship and explain the change in its value using suitable diagram. (6)

(b) Derive an expression for electron density in an intrinsic semiconductor. Explain the change in expression when the semiconductor is doped with phosphorus atoms. (6)

(c) For an intrinsic semiconductor, determine the band-gap energy at 300K for given parameters as follows: $n_i = 9.65\times10^9$ cm^{-3}, Nc = 2.86×10^{19} cm^{-3} and $N_v = 2.66\times10^{19}$ cm^{-3} at 300 K. Also, determine band-gap energy at 600K and discuss the change in variation. (6)

3. (a) Explain the phenomena of drift of charge carriers in a semiconductor. Derive the expression of resistivity of charge carriers in an extrinsic semiconductor. (6)

(b) Explain the various methods to determine the resistivity of semiconductor using suitable diagrams. (6)

(c) An extrinsic semiconductor sample with carrier mobility of 1300 $cm^2/V\text{-}s$ and resistivity of 0.048Ω cm is place in Hall setup. Find the Hall coefficient and Hall voltage for the sample with its width=500μm, cross-section area=2.5×10^{-3} cm^2. The current flowing through the sample is 1mA and it is under the influence of 10^{-4} Wb/m^2 magnetic field intensity in z direction. (6)

4. (a) For an abrupt p-n junction under no bias condition, explain the variation of charge density, electric field and potential profile along the depletion width. (6)

(b) In case of a p-n junction at thermal equilibrium, the value of Fermi level remains unaltered while traversing along device dimensions. (6)

(c) Calculate the built-in potential for a silicon abrupt p^+-n junction with $N_B = 2.5\times10^{15}$ cm^{-3} at 300 K. Also, calculate the depletion layer width. Assume ni equal to 1.5×10^{10} cm^{-3}. (6)

5. (a) Explain the various breakdown mechanism in a p-n junction. (6)

(b) Explain the dependence of capacitor on applied voltage of a varactor diode for abrupt and linearly graded junctions. (6)

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(c) The p-n junction diode cross-sectional area $A = 2\times10^{4}\,cm^{2}$ offers saturation current density $J_s = 5.26\times10^{-12}Acm^{-2}$ then determine the current at applied voltage equal to 0.5V in forward bias condition. (6)

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

(b) For an ideal p-n-p transistor, the current components are given by $I_{Ep} = 2.5$ mA, $I_{En} = 0.005$ mA, $I_{Cp} = 2.495$ mA, and $I_{Cn} = 0.001$ mA. Determine (a) the emitter efficiency γ, (b) the base transport factor α_T, (c) the common- base current gain α_0 and (d) I_{CBO}. (6)

(c) Explain the energy band diagram of bipolar junction transistor (BJT) in thermal equilibrium and active mode of operation using suitable diagrams. (6)

7. (a) Draw the structure of JFET. Using characteristics, explain the significance of the terms Pinch-off and Saturation voltage in JFET. (6)

(b) Explain the schematic diagrams and output characteristics for depletion-mode MOSFETs and enhancement-mode MOSFETs. (6)

(c) Differentiate between the DIAC and TRIAC based upon their structure and characteristics. (6)