MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

Paper Code : EC301 Electronic Devices

UPID : 003460

Time Allotted : 3 Hours *Full Marks :70*

The Figures in the margin indicate full marks.
Candidate are required to give their answers in their own words as far as practicable

Group-A (Very Short Answer Type Question)

[1 x 10 = 10]

1. Answer any ten of the following :
   (I) Which depletion layer of a BJT is wider?
   (II) The speed of switching is less in MOSFETs.
   (III) Absorption coefficient of a semiconductor is a strong function of _____
   (IV) Ionic and covalent bonding are generally _____ than metallic bonding
   (V) Total potential barrier of a pn junction diode is reduced in _____ mode
   (VI) Which region of a BJT is most heavily doped? → Emitter
   (VII) _____ is the highest filled energy level of the electron at 0K.
   (VIII) In a Schottky diode, normally negative charged donor atoms remain in the space charge region.
   (IX) Write the range of values for Common-Base current gain α.
   (X) In which MOSFET the channel becomes depleted of majority carriers for $-V_{GS}$? (Enhancement p-channel)
   (XI) How the slope of the current–voltage characteristic of a pn diode is related to the small signal model of the same?
   (XII) What is Early effect?

Group-B (Short Answer Type Question)

Answer any three of the following [5 x 3 = 15]

2. Explain the current density for an ideal pn junction and derive it equations. [5]
3. Draw the output characteristics of a transistor in common emitter (CE) mode. Show the different regions on the output characteristics. Write the name/s of the region/s in which the transistor can be used as an amplifier and the corresponding biasing conditions. [5]
4. Describe the process of formation of energy bands in crystals. [5]
5. From the one dimensional Poisson's equation for electric field E, obtain the expression for E in the n region of a schottky diode. [5]
6. Draw the energy-band diagram in a p-type semiconductor at the threshold inversion point and explain the formation of the inversion layer in the MOS capacitor. [5]

Group-C (Long Answer Type Question)

Answer any three of the following [15 x 3 = 45]

7. (a) Derive the expression for total drift current density in a semiconductor. [5]
   (b) What are mobility and conductivity? Write the effects of temperature and doping on mobility. [5]
   (c) Derive the one dimensional continuity equation for holes in a semiconductor. [5]
8. (a) Draw the ideal energy-band diagram of a pn junction under no bias, forward bias and reverse bias. Explain all the energy band diagrams. [3+4+4]
   (b) Draw the ideal energy-band diagram of a metal–semiconductor junction under forward bias. Write the advantage of Schottky diodes. [4]
9. (a) Write the differences between zener breakdown and avalanche breakdown. [6]
   (b) Draw the circuit diagram of a simple voltage regulator circuit using a zener diode and explain how the regulation is obtained against variation in load current. [5]
   (c) Describe the planar process for formation of a pn junction diode. [4]

10. (a) Draw the circuit diagrams for obtaining the input and output characteristics of an npn transistor in common emitter (CE) mode. Discuss the steps to operate those circuits and plot the characteristics. [4+5]

(b) What are the current gains of a transistor? Derive the relation between them. [6]

11. (a) Derive and explain the expressions for excess minority carriers in a pn junction as functions of distance. [5]

(b) From the expression for built in potential of a pn junction diode find the expression for width of the space charge region under reverse bias. [5]

(c) Consider a silicon pn diode at T=300 K with doping concentrations of Na=1016 cm-3 and Nd=1015 cm-3. Calculate the space charge width and electric field in the same. [5]