CBCS SCHEME

USN | | | | | | | | | | 18EC33

Third Semester B.E. Degree Examination, July/August 2022
Electronic Devices

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. In a filled band, what is the net current density and if a hole is created, what is the net current generated? Describe the superposition of the (E,K) band structure for a semiconductor in an electric field. **(10 Marks)**

b. A Si bar 4 cm long and 500 μm^2 in cross sectional area is doped with $2.5\times10^{18}/cm^3$ phosphorus. Find the current at 300°K with 22 V applied voltage. How long it take an average electron to drift 4 cm in pure silicon at an electric field of 70 V/cm. Calculate the time required at 10^5 V/cm. Assume mobility of the electrons is 0.1675 m^2/Vsec and scattering limited velocity (V_S) in 10^7 cm/sec. **(10 Marks)**

OR

2 a. Show the random thermal motion of an electron in a solid and what happens when electric field is applied? Derive the equation which relates the current density and mobility in a semiconductor in an applied electric field. **(10 Marks)**

b. Consider a semiconductor bar with width = 0.02 cm, thickness = 15 μm and length = 8 mm. For B_Z = 15 kg and a current of 3.5 mA, $V_{AB} = -5$ V, $V_{CD} = 400$ mV, find the type, concentration and mobility of the majority carrier. **(10 Marks)**

Module-2

3 a. Analyze the effect of a bias at a pn junction on electric field, potential particle flow and current direction at (i) Equilibrium (ii) Forward bias (iii) Reverse bias. **(12 Marks)**

b. Explain the operation of pin photodetector. **(08 Marks)**

OR

4 a. What type of breakdown occurs in a lightly doped pn junction? Show the energy band diagram of a pn junction in a reverse bias, single ionizing collision by an incoming electron in the depletion region and primary, secondary and tertiary collisions. **(10 Marks)**

b. Obtain the relationship between the open circuit voltage and optical generation rate starting from the expression for the optically generated illuminated pn junction. **(10 Marks)**

Module-3

5 a. Derive the Ebers-Moll equations for the thermal currents in a transistor and represent the same. **(14 Marks)**

b. When the base narrowing effect occur in a transistor? **(06 Marks)**

OR

6 a. Illustrate the hole and electron flow in a pnp transistor with proper biasing. **(10 Marks)**

b. Show the switching effects in a common emitter transistor circuit. **(10 Marks)**

Module-4

7 a. Show the electric field direction, charge flow and induced charge region in a MOS capacitor with P-type substrate and n-type substrate when a moderate positive gate bias is applied. **(08 Marks)**

b. Represent the energy-band diagram through a MOS capacitor structure with P-type as a semiconductor and differential charge distribution for a differential change in gate voltage in the depletion and inversion mode. **(12 Marks)**

OR

8 a. Represent the energy band diagram of a MOS capacitor for the following cases :
   (i) Negative gate bias in a MOS capacitor with ptype substrate.
   (ii) Positive gate bias in a MOS capacitor with ntype as substrate.
   (iii) Large negate gate bias in a MOS capacitor with n type as substrate. **(10 Marks)**

b. Show the channel formation in the MOS structure and I_D versus V_{DS} curve for the following cases :
   (i) $V_{gs} > V_t$ and small V_{DS} value.
   (ii) $V_{gs} > V_t$ and large V_{DS} value.
   (iii) $V_{gs} > V_t$ and $V_{DS} = V_{DS}$ (sat). **(10 Marks)**

Module-5

9 a. Write the names of the different fabrication steps in a pn junction. **(08 Marks)**

b. Explain the evolution of ICs over the years. **(12 Marks)**

OR

10 a. Draw a neat sketch showing the ion implantation system in the fabrication of a pn junction and explain. **(10 Marks)**

b. Write the structure of a CMOS inverter and show the formation of p-channel and n-channel devices together. **(10 Marks)**

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