B.E./B.TECH. Degree Examination, December 2020

Semester - VI

EE16006 - SOLID STATE DEVICES

(Regulation 2016)

Time: Three hours Maximum : 80 Marks

Answer **ALL** questions

PART A - (8 X 2 = 16 marks)

1. Which of the following statement is correct in the context of intrinsic semiconductor.
   a)The Fermi level is close to valence band
   b) The Fermi level is close to conduction band
   c) The Fermi level is at the mid-point between conduction band and valence band
   d)Fermi energy is zero
2. When semiconductor is doped half with trivalent and half with pentavalent impurities, junction formed is known as
   a)PN junction b)barrier junction c)potential barrier d)both a and b
3. Calculate the built in potential barrier for Silicon at T=300K $n_i = 1.5*10^{10} cm^{-3}$, $N_a = 10^{16} cm^{-3}$, $N_d = 10^{15} cm^{-3}$
   a)0.635V b)0.5V c)1.1V d) 2V
4. Reverse saturation current in a Silicon PN junction diode nearly doubles for every
   a. 10° rise in temp. b. 50° rise in temp. c. 60° rise in temp. d. 100° rise in temp.
5. Sketch a graph of electron concentration (n_o) versus temperature for an n-type material.
6. Why does the breakdown voltage of a pn junction decrease as the doping concentration increases?
7. Compare the forward-biased current–voltage characteristic of a Schottky barrier diode to that of pn junction diode.
8. Draw the small signal equivalent circuit of diode.

PART B - (4 X16 = 64 marks)

9. (a) (i) Briefly explain about the degenerate and non-degenerate semiconductors **(8)**

   (ii) Calculate the thermal-equilibrium hole concentration in silicon at T = 400 K. Assume that the Fermi energy is 0.27 eV above the valence-band energy. The value of N_v for silicon at T = 300 K is $N_v = 1.04 * 10^{19} cm^{-3}$. **(8)**

(OR)

(b) Define Fermi level. Draw and Explain fermi Dirac distribution function. Explain the same for intrinsic semiconductor, n-type and p-type extrinsic semiconductors. **(16)**

10. (a) Explain the concept of carrier drift and diffusion. Derive the expression for drift and diffusion current density. **(16)**

(OR)

(b) (i) What is Hall effect? Derive the expression for finding carrier concentration in a given sample, when subjected to electric and magnetic fields. Also derive the expression for electron and hole mobility **(10)**

(ii) Determine the majority carrier concentration and mobility, given Hall effect parameters. Let L = 10^{-1} cm, W =10^{-2}cm, and d = 10^{-3} cm. Also assume that I_x= 1.0 mA, V_x=12.5 V, B_z= 500 gauss = 5 x10^{-2} tesla, and V_H=-6.25 mV. **(6)**

11. (a) Consider the PN junction at Zero bias. Derive the expression for built in potential, space charge width and maximum electric field. **(16)**

(OR)

(b) (i) Determine the ideal reverse-saturation current density in a silicon pn junction at T = 300 K. Consider the following parameters in a silicon pn junction: **(8)**

N_a= N_d=10^{16}cm^{-3}, n_i =1.5*10^{16}cm^{-3}

D_n= 25cm^2 /s , D_p= 10cm^2 /s

τ_{n0}=τ_{p0}=5x10^{-7} sec, ε_r=11.7.

(ii) Compare the Avalanche and Zener Breakdown mechanisms. **(8)**

12. (a) (i) Deduce the expression for diffusion capacitance of a PN junction. **(8)**

(ii) Describe the effects of contact potentials on carrier injection **(8)**

(OR)

(b) Express in detail about the steps involved in deriving a device model. **(16)**