NATIONAL INSTITUTE OF TECHNOLOGY, JAMSHEDPUR
Department of Electronics and Communication Engineering
Mid Semester Examination, September 2024

B.Tech: 2nd year (3rd semester) ECE
Date of Exam: 03/10/2024
Time: 08:30 to 10:30 **Duration:** 2 hours
Max marks: 30

Course Code: EC1302
Course Name: Solid State Devices
Name of Faculties: Dr. Amit Kumar
Dr. Basanta Bhowmik

Note: Question paper consists of 05 questions. Marks of the question are indicated extreme right of the question. Attempt all questions.

Q.1: Write detailed notes on Energy band model and bond model of semiconducting material with proper diagram. Also give the justification why semiconducting material is used in electronics. **(5)**

Q.2:

a. Derive the expression of built in potential (Vo). **(3)**
b. Explain Fermi Dirac Probability Function and its physical significance. **(2)**

Q.3:

a. Find the value of hole concentration P_o at T=300 K if silicon sample is doped with 10^{17} As atoms/cm^3. Also find the position of E_c with respect to F_f. Assume intrinsic concentration $n_i=1.5\times10^{10}$/cm^3 and Band gap E_g=1.1 eV. **(3)**
b. In a P Type Semiconductor the Fermi level lies 0.4 ev above the valence band if the concentration of acceptor atoms tripled find the new position of Fermi level. Assume KT = 0.03 eV. **(2)**

Q.4: Give the reason why depletion width is form in PN junction diode and derive the expression for the same considering $N_D>N_A$ with proper graph of charge density and electric field intensity. Also find the value of depletion width if width in n region of diode is 0.455 μm, $N_D=5\times10^{15}$/cm^3, $N_A=10^{18}$/cm^3. **(5)**

Q.5: An abrupt junction (Si) with a cross section area A= 10^{-4} cm^2 and forward voltage across diode is 0.5 volt has following properties at 300 K. **(10)**

P side	N side
Na = 10^{17} cm^{-3}	Nd = 10^{15} cm^{-3}
τn = 0.1 μs	τp = 10 μs
μp = 200 cm^2/v-s	μn = 1300 cm^2/v-s
μn = 700 cm^2/v-s	μp = 450 cm^2/v-s

Find its contact potential Vo, Depletion Width 'W' and forward current 'I_f' where

$$Io = qA\left(\frac{Dp}{Lp}Pn + \frac{Dn}{Ln}np\right),$$

$n_i = 1.5\times10^{10}$ cm^{-3}, Relative Permittivity = 11.7, Absolute Permittivity = 8.85×10^{-12} F/m

NATIONAL INSTITUTE OF TECHNOLOGY, JAMSHEDPUR

Department of Electronics and Communication Engineering

End Semester Examination, December-2024

B.Tech: 2nd year (3rd semester) ECE
Date of Exam: 10/12/2024
Duration: 3 hours, Shift: B (2:00 to 5 PM)
Max marks: 50

Course Code: EC1302
Course Name: Solid State Devices
Name of Faculties: Dr. Amit Kumar
Dr. Basanta Bhowmik

Note: Question paper consists of 05 questions. Marks of the question are indicated extreme right of the question. Attempt all questions.

Q.1:

a. How junction capacitance is formed in PN junction diode? Also discuss its type in detail and derive the expression of transition capacitance. (5)

b. Explain the position of Fermi level in intrinsic semiconductor at 0 K by simple reasoning. Why hall measurement is performed discuss in detail? (5)

Q.2:

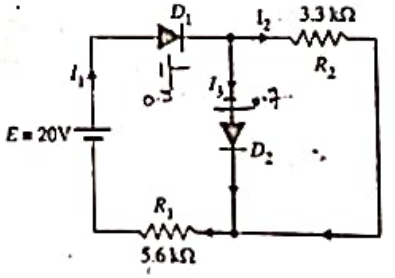
a. A germanium diode has a saturation current of 1 nA at T=20 °C. Find its current when it is forward biased by 0.4 V. Also find the current in the same diode when the temperature increased to the value of 110 °C. (5)

b. Explain the following: (5)

1. Why depletion width is formed in PN junction diode.
2. Drift and Diffusion current
3. How temperature and doping effects the position of fermi energy level.
4. Breakdown in PN junction diode
5. Different leakage currents in BJT

Q.3:

a. Determine the currents I_1, I_2 and I_3 for the network shown below. Consider practical Si diode (4)

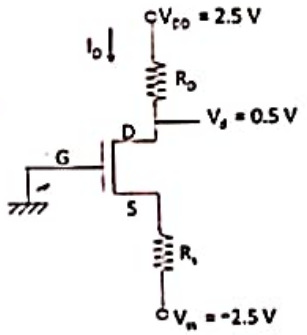


b. Discuss about the following special diodes including its IV characteristics, structure, and working (6)

1. Tunnel Diode
2. Photo Diode
3. Varactor Diode

Q.4:

a. Find the value of R_D and R_S in the circuit shown below so that operate at I_d=0.4 mA and V_d=0.5 V. The NMOS transistor has V_t = 0.7 V, $\mu_n C_{ox}$ = 100 μA/V², L = 1μm, W =32 μm. Also, classify the type of MOSFET and describe the working of enhancement type MOSFET with suitable device structure. (5)



b. Why biasing circuit is used in BJT and also explain the all three biasing circuits with its stability factor calculation. (5)

Q.5:

a. A pure semiconductor (Ge) is doped with donor impurities to the extent of 1:10^7. Calculate the following: (5)

- Donor concentration.
- Electron and Hole concentration.
- Conductivity of doped semiconductor.
- How many time the conductivity will increase in the semiconductor due to doping.

Assume: Total number of atoms = $4.421 \times 10^{22}/cm^3$

ni =2.5×10^{13}, μ_n=3800 cm^2/V-sec, , μ_p=1800 cm^2/V-sec

b. In the circuit shown in figure below, the operating point is chosen such that $I_C = 2mA, V_{CE} = 3V$. If $R_C = 2.2\,K\Omega$, $V_{CC} = 9\,V$ and $\beta = 50$, determine the values of R_1, R_2 and R_E? (Take $V_{BE} = 0.3\,V$ and $I_1 = 10\,I_B$). (5)