

VIT

Vellore Institute of Technology

Continuous Assessment Test - I

Programme Name & Branch: B.Tech - ECE

Course Code & Name: ECE1003 - Semiconductor Devices and Circuits

Class Number: VL2019205004767, 4770, 4771, 4772, 4773, 4774, 4775

Slot: C1-TC1

Date: 04/04/2020
Max. Marks: 50 Marks

General Instructions: Use the below mentioned constant values if it is not specified in the questions.

Constants: Silicon: $n_i = 1.5 \times 10^{10} \text{ cm}^{-3}$, $E_g = 1.12 \text{ eV}$, relative permittivity $\epsilon_r = 11.8$, $\mu_n = 1350 \text{ cm}^2/\text{V}\cdot\text{s}$, $\mu_p = 480 \text{ cm}^2/\text{V}\cdot\text{s}$, $D_n = 35 \text{ cm}^2/\text{V}\cdot\text{s}$, $D_p = 12.5 \text{ cm}^2/\text{V}\cdot\text{s}$. Others: $kT = 0.026 \text{ eV}$ at 300K, Boltzmann's constant $k = 8.66 \times 10^{-5} \text{ eV/K}$, $e = 1.6 \times 10^{-19} \text{ C}$, $q = 1.6 \times 10^{-19} \text{ C}$.

S.No. Question Marks

1. a) In a solid, consider the energy levels lying 0.01 eV and 0.03 eV below Fermi level. What is the probability of these energy levels are not being occupied by an electron at $T = 300 \text{ K}$?
b) For a P-type Silicon, What must be N_A at $T = 300 \text{ K}$, if the electron concentration drops below the intrinsic level by a factor of 10^4 ? 10

A Silicon sample is doped with Arsenic with number density $N_d = 8 \times 10^{16} \text{ cm}^{-3}$ and as well as Boron with number density $N_A = 3 \times 10^{16} \text{ cm}^{-3}$. Find Electron concentration, hole concentration and position of Fermi level at 300K. Show Fermi level on suitable band diagram.

A P-N junction has $N_d = 10^{20} \text{ cm}^{-3}$ and $N_A = 10^{17} \text{ cm}^{-3}$. (a) What is its built-in potential, V_{bi} ? (b) A Si p-n junction is formed from p-material doped with 10^{22} acceptors/ m^3 and n-material doped with 1.2×10^{21} donors/ m^3 . Find the thermal voltage and barrier voltage at 30°C . 10

A silicon crystal having a cross-sectional area of 0.001 cm^2 and a length of $10 \mu\text{m}$ is connected at its end to a 10V battery. A current of 100mA is required at 300K. Calculate (a) the required resistance, (b) the required conductivity, (c) the density of donor atoms to be added to achieve this conductivity, and (d) the concentration of acceptor atoms to be added to form a compensated p-type material with the conductivity from part (b) if the initial donor concentration is $N_d = 10^{15} \text{ cm}^{-3}$. Given $\mu_n = 1350 \text{ cm}^2/\text{V}\cdot\text{s}$ and $\mu_p = 480 \text{ cm}^2/\text{V}\cdot\text{s}$. 10

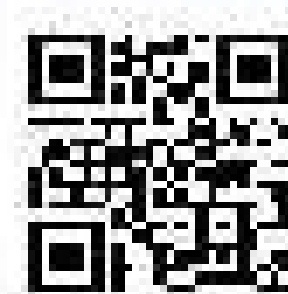
5. (a) A silicon PN junction at $T = 300 \text{ K}$ is doped at $N_d = 10^{17} \text{ cm}^{-3}$ and $N_A = 10^{18} \text{ cm}^{-3}$. The junction capacitance is to be $C_j = 0.9 \text{ pF}$ when a reverse bias voltage of $V_R = 4 \text{ V}$ is applied. Find the zero-biased junction capacitance C_{j0} .
(b) Find the change in diode voltage drop if the current changes from 0.1 mA to 10 mA. 6

$$C_j = \frac{q N_A N_D}{2 E V_0 (N_A + N_D)}$$

$$C_{j0} = \frac{q N_A N_D}{2 E V_0 (N_A + N_D)}$$

$$W = \sqrt{\frac{2 E V_0 (N_A + N_D)}{q N_A N_D}}$$

$$W = 2 E$$



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