(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 2483 Roll No. [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]

B. Tech.

(SEM. VI) THEORY EXAMINATION 2010-11

ADVANCE SEMICONDUCTOR DEVICES

Time : 2 Hours

Total Marks : 50

Note : (1) Attempt all questions.

(2) Assume the missing data if any.

(3) Marks are indicated at the end of each section.

1. Attempt any **four** parts of the following : $(4 \times 3 = 12)$

   (a) Discuss the main advantages and disadvantages of using amorphous semiconductors in various electronic device applications.

   (b) Explain why the absorption coefficient in indirect-gap semiconductors is generally lower as compared to the direct-gap materials.

   (c) Find the resistivity of intrinsic Si at 300 K.

   $(\mu_n = 1350 \text{ cm}^2 \mid V - s \text{ and } \mu_p = 480 \text{ cm}^2 \mid V - s)$ and $(n_i = 1.5 \times 10^{10} \text{ cm}^{-3})$

   (d) Find the position of the Fermi level (relative to E_i) at 300 K in Si doped with 10^{16} cm^{-3} donors and 10^{15} cm^{-3} acceptors that are fully ionized.

(e) Outline the main advantages and applications of wide energy-gap semiconductors.

2. Attempt any **three** parts of the following : (3×4=12)

(a) A Si sample is doped with 10^{16} cm^{-3} Sb. How many Zn atoms/cm^3 must be added to exactly compensate this material $(n_0 = p_0 = n_i)$?

(b) Describe the procedure for distinguishing in luminescence spectra the features due to excitor's and those due to the donor-acceptor recombination.

(c) How is free electron theory different from energy-band theory ?

(d) A $p^+ - n$Si diode $(V_0 = 0.956$ V) has a donor doping of 10^{17} cm^{-3} and n-region width = 1 μm. Does it breakdown by avalanche or punchthrough ?

3. Attempt any **two** parts of the following : (6×2=12)

(a) Assume that a photoconductor in the shape of a bar of length L and area A has a constant voltage V applied, and it is illuminated such that g_{op} EHP/cm^3-s are generated uniformly throughout. If $\mu_u \gg \mu_p$, we can assume the optical induced change in current ΔI is dominated by the mobility μ_n and life time τ_n for the electrons. Show that $\Delta I = qALg_{op}\tau_n / \tau_i$ for this photoconductor, where τ_i is the transit time of electrons drifting down the length of the bar.

(b) Draw a schematic diagram of TRAPATT diode and discuss its working principle. Calculate the avalanche-zone velocity for a TRAPATT diode having the following parameters :

Doping concentration : $N_a = 2 \times 10^{15}$ cm^{-3}

Current density : J = 20 kA/cm^2.

(c) Consider the I-V characteristics curve of a practical p-n junction diode. In which quadrant of this curve does the following operates :

(i) Photodiode

(ii) Solar Cell.

Give suitable reasons in support of your answer.

4. Attempt any **two** of the following : (7×2=14)

(a) Differentiate between the working principle of Transistors and TEDs. How is LSA diode different from Read diode ?

(b) Describe the operating principle of IMPATT diode. A Ku-band IMPATT diode has a pulsed operating voltage of 100 V and a pulsed operating current of 0.9 A. The efficiency is about 10%. Calculate the :

(i) Output Power

(ii) The duty cycle if the pulse width is 0.01 ns and the frequency is 16 GHz.

(c) Discuss the term short-channel effects, Hot electron effects and DIBL effects commonly used in present day MOS transistors.