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

PAPER ID : 2483 Roll No. | | | | | | | | | | |

B. Tech.

(SEM. VI) THEORY EXAMINATION 2011-12

ADVANCE SEMICONDUCTOR DEVICES

Time : 2 Hours *Total Marks : 50*

Note : (1) Attempt ***all*** questions.

(2) Marks are indicated for each question.

(3) Assume the missing data, if any.

(4) Useful Physical constants :

Boltzmann's constant, $K = 1.38 \times 10^{-23}$ J/K

Electronic rest mass, $m_o = 9.11 \times 10^{-31}$ Kg

Planck's constant, $h = 6.63 \times 10^{-34}$ J-s

Electronic charge, $q = 1.60 \times 10^{-19}$ C

Permittivity of free space, $\epsilon_o = 8.85 \times 10^{-12}$ F/m

Electron effective mass, $m^*_n = (1.1\ m_o)_{Si}, (0.067\ m_o)_{GaAs}$

Hole effective mass, $m^*_p = (0.56\ m_o)_{Si}, (0.48\ m_o)_{GaAs}$

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

(a) (i) What do you mean by effective mass of carrier ? What is the kinetic energy of a hole at the top of the valence band ?

(ii) Calculate the relaxation times for electrons and holes in Si.

(b) Define and derive the expression for minority carrier life time.

(c) A photon of monochromatic light of wavelength 5000 Å is absorbed in GaAs and excites an electron from the valence band into conduction band. Calculate the velocity of electron.

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

(a) Show that the depletion region capacitance of a p-n junction for any arbitrary doping on the two sides can always be expressed by

$$C_j = \epsilon_s A/W$$

where, ϵ_s is the permittivity of the semiconductor,

A and W are the cross sectional area and depletion width of the junction.

(b) A Si sample with doping concentration of 10^{17} phosphorus atoms/cm^3 is optically excited at 300 K such that $g_{op} = 10^{20}$ EHP/cm^3-sec and $\tau_n = \tau_p = 10$ μsec. What is the separation of the quasi-Fermi levels ? Draw the energy band diagram of the sample.

(c) Assume that an ideal Schottky barrier is formed on n-type Si having 10^{16} As atoms/cm^3. The metal work function is 4.5 eV and Si electron affinity is 4 eV.

(i) Draw the equilibrium diagram and describe the contact.

(ii) Draw the forward and reverse biased diagram and explain.

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

(a) With a suitable diagram describe the working principle of a photodiode. Explain how the various quadrants of its V-I characteristics are used in different applications ?

(b) Explain degenerate semiconductors. What are their

different types ? How do they differ from conventional semiconductor ? What are the uses of these materials ? Explain the device operation with characteristics.

(c) What is meant by IMPATT ? Describe briefly the principle of operation of IMPATT diode.

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

(a) Discuss briefly the principle of operation of a GaAs MESFET. Also derive an expression for I-V characteristic of the device. Enumerate special features of MESFETs.

(b) Sketch approximate distribution of charge, electric field and electrostatic potential in the ideal MOS diode using n-type Si in inversion condition and explain them.

(c) Describe briefly the principle of operation of charge coupled devices. With suitable schematics show the input and output arrangements for a CCD and explain charge transfer efficiency of the device.