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

PAPER ID : 3083 Roll No. | | | | | | | | | | |

B. Tech.

(SEM. IV) THEORY EXAMINATION 2010-11

SEMICONDUCTOR MATERIALS AND DEVICES

Time : 3 Hours *Total Marks : 100*

Note : Attempt **all** questions. All questions carry equal marks.

1. Attempt any **four** parts of the following : **(5×4=20)**

   (a) With a suitable sketch describe briefly the lattice structure of Ge.

   (b) What is Miller Indices ? Show the (432) plane and the [432] direction in a cubic crystal lattice.

   (c) Explain briefly why the temperature coefficient of the resistivity of a doped semiconductor is negative at low and high temperature ? Explain.

   (d) Explain why the energy levels of an atom become energy bands in a solid.

   (e) Calculate the maximum resistivity of Si at room temperature. Derive the formula used (if any).

   (f) Calculate the Fermi level position in Si containing 10^{16} phosphorus atoms/cm^3 at 100 K assuming 50% of the impurities are ionised at this temperature. Also calculate the equilibrium hole concentration.

2. Attempt any **two** parts of the following : **(10×2=20)**

(a) What do you mean by excess carriers ? How they are created ? Explain. How do they contribute in conduction process ?

(b) What is the physical significance of diffusion length ? How is it related with mobility of the carrier ? Explain.

(c) What is IMREE ? Explain A Si sample with $n_o = 10^{14}/cm^3$ and $\tau_n = \tau_p = 2$ μsec. is optically excited at room temp. to create 10^{13} EHP/cm^3. What is the separation of the quari-Fermi levels ? Draw an energy band diagram also.

3. Attempt any **two** parts of the following : **(10×2=20)**

(a) What is diffusion potential ? Explain. Assuming equilibrium condition for an abrupt junction, derive an expression for the diffusion potential.

(b) What are the various types of capacitance associated with a p-n junction. Explain them. Derive the expressions for them also. Comment on your results.

(c) (i) Describe the physical mechanism for p-n junction breakdown. Draw a circuit which uses a break-down diode to regulate the voltage across a load ? Explain its operation.

(ii) A Si p^+–n junction 10^{-2} cm^2 in area has $N\alpha = 10^{15}$ cm^3 dopping on the n-side. Calculate the junction capacitance with a reverse bias of 10 v. Assume ε_r for Si is 11.8

4. Attempt any **two** parts of the following: **(10×2=20)**

(a) Differentiate between the following kinds of transistor :–

(i) BJT and FET

(ii) MESFET and MISFET

(iii) JFET and IGFET

(iv) NMOS and PMOS.

(b) What is photodiode ? What are its different types ? Describe the basic construction of a photodiode. Discuss the requirement of a good photodiode materials and enlist suitable materials for its construction.

(c) What is meant by population inversion ? What are the merits of semiconductor lasers on conventional lasers ? Discuss the working of semiconductor lasers.

5. Attempt any **two** parts of the following : **(10×2=20)**

(a) Explain degenerate semiconductors. What are their different types ? How do they differ from conventional semiconductors ? What are the uses of these materials ?

(b) What is meant by IMPATT ? Explain the construction and operation of an IMPATT diode.

(c) Explain the construction and working of an SCR. Describe the mechanism of firing and turning-off of an SCR. Draw the V-I characteristics of the device.