

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

PAPER ID : 3083

Roll No.

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**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)

- With a suitable sketch describe briefly the lattice structure of Ge.
- What is Miller Indices ? Show the (432) plane and the [432] direction in a cubic crystal lattice.
- Explain briefly why the temperature coefficient of the resistivity of a doped semiconductor is negative at low and high temperature ? Explain.
- Explain why the energy levels of an atom become energy bands in a solid.
- Calculate the maximum resistivity of Si at room temperature. Derive the formula used (if any).
- Calculate the Fermi level position in Si containing  $10^{16}$  phosphorus atoms/cm<sup>3</sup> 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  $n_0 = 10^{14}/\text{cm}^3$  and  $\tau_n = \tau_p = 2 \mu\text{sec}$ . is optically excited at room temp. to create  $10^{13}$  EHP/cm<sup>3</sup>. What is the separation of the quasi-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<sup>+</sup>-n junction  $10^{-2}$  cm<sup>2</sup> in area has  $N_A = 10^{15}$  cm<sup>3</sup> doping on the n-side. Calculate the junction capacitance with a reverse bias of 10 v. Assume  $\epsilon_r$  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.