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TEC – 403

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

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

B.Tech.

(SEM IV) EVEN SEMESTER THEORY EXAMINATION, 2009-2010

SEMICONDUCTOR MATERIALS & DEVICES

Time : 3 Hours *Total Marks : 100*

Note : *(i) Attempt **all** the questions.*

*(ii) All the questions carry **equal** marks.*

1. Attempt **any four** parts of the following : **(4x5=20)**

(a) Give the electronic configuration of Ge and sketch the lattice structure of GaAs.

(b) What do you understand by Miller indices ? How is this obtained that describes a plane in a crystal ?

(c) Sketch the following planes and directions in cubical unit cell.

(100), <100>, {100}, [100]

(d) What do you mean by effective mass of carriers ? How does it depend on energy bands ? What is the kinetic energy of an hole at the top of the valence band ?

(e) Define Fermi level and plot the Fermi function at 0°C. Calculate the probabilities of finding electron at the energy level of 0.1 eV above and below the Fermi level at room temperature.

(f) Define mobility of a carrier. How does mobility depends on doping concentration and temperature ?

2. Attempt **any two** parts of the following : **(2x10=20)**

(a) What are the direct and indirect recombination ? Derive an expression for minority carrier life time.

(b) Define the explain quasi-Fermi level. A Ge sample with 10^{17} Sb atoms per cm^3 is optically excited at 300 K such that $g_{op} = 10^{20}$ EHP per cm^3-sec and $\tau_n = \tau_p = 10$ micro second. What is the separation of the quasi-Fermi levels ? Draw an energy band diagram also.

(c) What do you mean by excess carriers ? Derive an expression for diffusion equation for steady state distribution of excess electrons.

3. Attempt **any two** parts of the following : **(2x10=20)**

(a) What is contact potential ? Explain. Derive an expression for it assuming step junction at equilibrium condition.

For Si p-n junction, donor and acceptor impurities at room temperature are 10^{16} cm^{-3} and 3×10^{18} cm^{-3} respectively. Calculate the contact potential and draw an equilibrium band diagram for the junction if intrinsic carrier concentration of Si is 1.5×10^{10} cm^{-3} at room temperature.

(b) Find an expression for the electron current in the n-type material of a forward biased p-n junction.

(c) Assume that an ideal Schottky barrier is formed on n-type Si having 10^{15}As atoms per cm^3. The metal work function is 4.3 eV and Si electron affinity is 4 eV. Draw the equilibrium band diagram with values calculated for appropriate barriers and describe the contact.

4. Attempt **any two** parts of the following : **(2x10=20)**

(a) What are the advantages and disadvantages of Field Effect Transistor over a BJT ? Discuss briefly the operation of normally-on and normally-off GaAs MESFET with suitable diagram and characteristics.

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

(c) What is light emitting diode ? Explain the operation of an LED. What are the suitable material for it ? Explain.

5. Attempt **any two** parts of the following : **(2x10=20)**

(a) What is transferred electron effect ? Describe a device based on this effect with suitable diagram in detail.

(b) Find an expression for the electron current in the n-type material of a forward biased p-n junction.

(c) Assume that an ideal Schottky barrier is formed on n-type Si having 10^{15}As atoms per cm^3. The metal work function is 4.3 eV and Si electron affinity is 4 eV. Draw the equilibrium band diagram with values calculated for appropriate barriers and describe the contact.

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5. Attempt **any two** parts of the following : **(2x10=20)**

(a) What is transferred electron effect ? Describe a device based on this effect with suitable diagram in detail.

(b) Explain the conditions for electron tunneling in a tunnel diode with the help of suitable energy band diagrams. Explain the operation and I-V characteristics of the diode.

(c) Discuss the switching mechanism of the p-n-p-n diode with the help of the two transistor analogy.

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