EEC-301

B. Tech.

(Semester-III) Theory Examination, 2011-12
FUNDAMENTALS OF ELECTRONIC DEVICES

Time : 3 Hours]   *[Total Marks : 100*

Note :   This question paper contain three Sections. Attempt questions from each section as per directions.

Section-A

Attempt *all* parts of this question.   2×10=20

1.   (a)   Show by a sketch that the BCC lattice can be represented by two interpenetrating SC lattice. To simplify the sketch show a <100> view of the lattice.

   (b)   Find the maximum fractions of the unit cell volume that can be filled by hard spheres in the SC, BCC and diamond lattices.

   (c)   Sketch the photocurrent I vs retarding voltage V that you would expect to measure for a given electrode material and configuration. Make the sketch for several intensities of light at a given wavelength.

(d) Explain why holes are found at the top of the valence band whereas electrons are found at the bottom of the conduction band.

(e) What is meant by carrier life time ? Why does direct recombination life time differ from indirect recombination life time ?

(f) Explain, why a contact potential is developed across and open-circuited P-N junction. Specify the parameters on which the contact potential depends.

(g) State and explain the characteristics of a Zener diode. Explain, how it is used in meter protection.

(h) Derive an expression for maximum power delivered by a solar cell.

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(i) What do you mean by optoelectronic devices ? How are they classified and what are the various types of photoelectronic devices ?

(j) Explain the V-I characteristics of a photo-diode. What is the significance of third and fourth quadrant operation of photodiode ?

Section-B

Attempt *all* parts of this question.   6×5=30

2. (a) (i) What do you mean by mobility of a carrier ? How does it depend on temperature and doping concentrations ?

(ii) Obtain the volume density of Si atoms with its lattice constants of 5.3 Å.

(b) (i) Obtain relationship between photo-conductivity and mobility of carriers.

(ii) Draw the physical structure, symbolic representation and I-V characteristics of the majority charge carrier diode.

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(c) What is contact potential ? Obtain the value of contact potential of an abrupt junction at room temperature of intrinsic concentration $n_i = 1.6 \times 10^{16} / m^2$ with doping level $N_D = N_A = 10^{21} / m^2$.

(d) Explain different components of currents flow through the structure of a N-P-N transistor. How the emitter injection efficiency and base transport factor influences the amplifications factor ?

(e) Enumerate the special feature of MESFET. Explain its working and discuss difference in its characteristics from the characteristics of the MOSFET.

Section-C

Attempt *all* questions.   10×5=50

3. Why p-i-n diode detector does not provide gain ? How can it be made more sensitive to low level intensity of light ? What material should be used to detect light of wavelength $\lambda = 0.6 \, \mu m$?

Or

Let the donor and acceptor concentrations in a semiconductor be N_a and N_d respectively. Show that the electron concentration in the semiconductor can be given by :

$$n_0 = \frac{N_d - N_a}{2} + \sqrt{\left(\frac{N_d - N_a}{2}\right)^2 + n_i^2} ,$$

where n_i is the intrinsic carrier concentration.

4. What is the difference between homojunction and heterojunction ? Explain them with neat sketches.

Or

Define the following terms with suitable examples :

(i)   Photoluminescence

(ii) Cathodoluminescence

(iii) Electroluminescence

(iv) Carrier life time.

5. Show that the total depletion width in a P-N junction at thermal equilibrium condition can be given by :

$$W = \sqrt{\frac{2\varepsilon V_B}{e}\left(\frac{1}{N_a} + \frac{1}{N_d}\right)} \; ,$$

where symbols have their usual meaning.

Or

Explain the working of GUNN and IMPATT diode with neat sketches. Mention the main difference between them.

6. What is recombination ? Derive the expression for minority carrier life time.

Or

What is IGBT ? Draw its equivalent circuit and enumerate its special features ?

7. Write short notes on any two of the following :

   (i)   Tunnel diode

   (ii) Solar cell

   (iii) Schottky diodes.