

Printed Pages : 7

EEC-301

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

PAPER ID : 0322

Roll No.

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**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.  $2 \times 10 = 20$ 

1. (a) Show by a sketch that the BCC lattice can be represented by two interpenetrating SC lattice. To simplify the sketch show a  $\langle 100 \rangle$  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 an 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 photodiode. What is the significance of third and fourth quadrant operation of photodiode ?

**Section-B**

Attempt *all* parts of this question.  $6 \times 5 = 30$

- 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 photoconductivity 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  $n_i = 1.6 \times 10^{16} / \text{m}^3$  with doping level  $N_D = N_A = 10^{21} / \text{m}^3$ .
- (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  $\lambda = 0.6 \mu\text{m}$  ?

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**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 :

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

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.

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