M.Sc.

2009

4th Semester Examination

PHYSICS

PAPER—PH-2203

Full Marks : 40

Time : 2 Hours

The figures in the right-hand margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Illustrate the answers wherever necessary.

Group—A

(Marks : 20)

Answer *Q. No. 1* and any *one* from the rest.

1. Answer any *five* bits : 2×5

(i) Find an expression of dearrier potential assuming a p–n junction under equilibrium condition.

(ii) Assuming a p+n junction with a graded n region where the doping is described by $N_d(x) = Gx^m$. The depletion layer width W extends from the junction at x = 0 to the n region. Find an expression for the maximum electric field at the junction.

(iii) What is negative differential mobility in Gads?

(iv) Show with the help of band-diagram how ohmic contact is possible in a metal and n-type semiconductor junction.

(v) In an n-type semiconductor the Fermi level lies 0.4 ev below the conduction band, If the concentration of donor atom is doubled, find the new position of Fermi level. Assuming $k_0T = 0.3$ eV.

(vi) The minority carrier life-time in p-type material is 10^{-7} sec. The mobility of electron in Si is $0.15\ m^2v^{-1}s^{-1}$ at 300K. If 10^{20} electrons/m^3 are injected at $x = 0$, what is diffusion current density just at junction.

(vii) A Si is doped with 10^{17} atoms/m^3. Find the barrier potential for a symmetric junction at room temperature $m_e^* = 1.1m$; $m_n^* = 0.56m$.

(viii) Silicon has relative permittivity 11 and band effective mess $0.1\ m_0$, where m_0 is free electron mass. Calculate the ionization energy for donor impurity.

2. (a) Find an expression for capacitance in a linearly graded junction. 7

(b) Deduce Einstein relation assuming a p–n junction under equilibrium condition. 3

3. (a) Find an expression for efficiency of a solar cell. 8

(b) What is meant by Shallow-trap and deep-trap. 2

Group—B

(Marks : 20)

Answer *Q. No. 1* and any *one* from the rest.

1. Attempt any *five* bits : 5×2

(a) What is the difference between Probe Microscopy (PM) and Electron Microscopy (EM) ?

(b) Match column A with column B properly :

(i) XPS	(i) Morphology
(ii) TEM	(ii) Crystal structure
(iii) STS	(iii) Density of state
(iv) LEED	(iv) Binding energy

(c) Why nanomaterials are much more reactive than their bulk counterpart ?

(d) What are the advantage and disadvantage of TEM over SEM ?

(e) What is the working principle of A.F.M. ?

(f) Find an expression of barrier potential assuming a p–n junction under equilibrium condition.

(g) State the different steps to attain UHV from normal atmosphere.

(h) What is the basic difference between physical and chemical vapour deposition ?

2. (a) How can you etch the surface of the sample (thin film) within and without the vacuum chamber?

   (b) Describe the uses of X-ray photo electron spectroscopy (XPS, ESCA) and mention the limitations.

   (c) What is DTA? Mention the properties of the material can be studied by using DTA. 2+5+3

3. (a) Name two methods to prepare thin film sample.

   (b) Name two compound semiconductor which are optically active.

   (c) What are the different allotropy of carbon?

   (d) Write a short note on any *one* of the followings :

   (i) Quantum Dot ;

   (ii) Sol-Gel Method ;

   (iii) UV-VIS Spectrophotometer.

   (e) Discuss different techniques of materials preparation. 1+1+1+4+3

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