REG. No.

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

Department of Physics

IV Semester B.Tech. – END SEMESTER EXAMINATION - APRIL 2018

SUBJECT: PHYSICS OF MATERIALS (PHY3282)

Time: 3 Hrs. Max. Marks: 50

Note:

Answer ALL the questions. Each question carries 10 marks
Any missing data may suitably be assumed.
Write question number on the margin only.

---

1. (A) Which of the following semiconductors are transparent, partially transparent, non-transparent for visible light (λ = 400–700 *nm*): Si, GaAs, GaP, and GaN? Given that their energy gaps are respectively 1.12, 1.42, 2.26, 3.44 *eV*.

   (B) In a Si based p-n junction with area of cross section of 10^{-4} cm^2 and intrinsic carrier density of 1.5×10^{10} /cm^3, the following parameters are given:

   At p-side: $N_a = 10^{17}$ cm^{-3} carrier life time =0.1μs, mobility of electrons and holes are 700 and 200 $cm^2/V\text{-}s$.

   At n-side: $N_d = 10^{15}$ cm^{-3}, carrier life time =10 μs, mobility of electrons and holes respectively are 1300 and 450 $cm^2/V\text{-}s$.

   The junction is forward biased by 0.5 V. What is the forward current? Estimate the current at a reverse bias of -0.5 V.

   (C) Using the concept of Fermi energy, calculate the probability of Fermi energy level to be occupied by an electron. **[3+5+2]**

2. (A) For a pn-junction diode, derive the expression for contact potential in terms of carrier concentration densities.

   (B) Consider a metal which is joined with an n-type semiconductor. Draw the energy level diagrams of the metal and semiconductor before and after the junction is made.

   (C) What is diffusion process in the context of semiconductors? Let an electric field be applied to an n-type semiconductor. Derive the Einstein relations. **[3+3+4]**

3. (A) Consider a fiber of length L embedded in a matrix subjected to a strain. Derive the expression for fiber stress. Plot a graph of stress versus fiber direction.

(B) What is a polymer matrix composite (PMC)? Describe any one method of fabrication of PMC. Discuss any four applications of PMC.

(C) In the context of composites, what are the functions of matrix? **[4+4+2]**

4. (A) Consider a unidirectional reinforced glass fiber/epoxy composite. The fibers are continuous and 50% by volume. It is given that the specific heat of the fiber and matrix are respectively 0.65 and 0.5 J/K. The density of matrix and fiber are 1.1 and 2.6 g/cm^3 respectively. Estimate the specific heat of the composite. Assume that there are no voids.

(B) Consider a composite consisting of spherical particles dispersed in a matrix with 50% volume fraction of fiber. It is given that the volumetric expansion of the matrix and fiber are respectively 16x 10^{-6} and 7x 10^{-6} per degree Celsius. The bulk moduli of the fiber, and matrix are 100 *GPa*, 5 *GPa* and the shear modulus of the matrix is 50 GPa. Estimate the volumetric expansion of the composite.

(C) Consider a composite material which is under two modes of loading namely longitudinal and transverse. If the Young's moduli of the fiber and matrix are 650 *GPa* and 20 *GPa* respectively, estimate the Young's modulus of the composite in the two modes. Given that the composite contains 40% glass fiber. **[3+4+3]**

5. (A) Distinguish between Top Down and Bottom Up approaches of nano-fabrication.

(B) Describe the construction and working of Scanning Electron Microscope.

(C) What are quantum dots? Discuss any method of preparation of quantum dots. What are the applications of quantum dots? **[2+4+4]**