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MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

IV SEMESTER B.TECH. (Open Elective)

END SEMESTER EXAMINATIONS, April/May 2017

SUBJECT: PHYSICS OF MATERIALS [PHY 3282]

REVISED CREDIT SYSTEM

(02/05/2017)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A. Explain the construction and working of Scanning Electron Microscope. Distinguish between top down and bottom up approaches of preparing nanomaterials. [4]

1B. Classify magnetic materials in terms of dimensions. What are quantum dots? Describe the method of production of quantum dots. Discuss the size effect on optical properties of quantum dots. Give any two applications of quantum dots. [4]

1C. What are carbon nano-tubes? Discuss its any two mechanical properties. [2]

2A. What are composite materials? Give examples of composite materials. Compare the properties like weight, thermal expansion, stiffness and strength of typical composite materials with steel and aluminum. [3]

2B. Consider a uni-directional composite material. Derive the rule of mixtures for Young's modulus when a force is applied in (i) fiber direction and (ii) transverse direction. [4]

2C. 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 16×10^{-6} and 7×10^{-6} per degree Celsius. The bulk moduli of the fiber, and matrix are respectively 100 *GPa*, 5 GPa and the shear modulus of the matrix is 50 *GPa*. Estimate the volumetric expansion of the composite. [3]

3A. Consider a fiber of length, *L* embedded in a matrix subjected to a strain. Derive the expression for shear stress along the matrix interface. [4]

3B. A unidirectional fiber composite with axial stress of the fiber and matrix of 100*MPa* and 20 *MPa* respectively has 40% volume fraction of fiber. Given that the matrix stress at the strain corresponding to the fiber ultimate tensile strength is 15*MPa*, calculate the minimum and critical volume fractions. [3]

3C. What are metal matrix composites? Give examples of three important metal matrices stating their applications. [3]

4A. Derive the expression for density of charge carriers in intrinsic semiconductors. [3]

4B. What is diffusion of charge carriers in the context of semiconductors? Using drift as well as diffusion currents, derive Einstein relation. [3]

4C. 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-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-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. [4]

5A. Discuss the Bridgeman method and Czochralski method of crystal growth. [4]

5B. Which of the following semiconductors are transparent, partially transparent, non-transparent for visible light (λ = 0.4–0.7 μm): Si, GaAs, GaP, and GaN? Given that their energy gaps are respectively 1.12, 1.42, 2.26, 3.44 eV. [3]

5C. Describe the method of magnetic sorting using nano-magnets. [3]