

Exam.Code:1029
Sub. Code: 7853

1129
M. Tech. (Material Science and Technology)
First Semester
MST-103: Physics of Nanomaterials

Time allowed: 3 Hours

Max. Marks: 50

NOTE: Attempt five questions in all, including Question No. 1 which is compulsory and selecting two questions from each Unit.

x-x-x

- I. Answer the following briefly:-
- Explain the effect on band gap of the material when its size decreases.
 - Explain the localized surface Plasmon resonance in metal nanoparticles.
 - Which is more effective in preventing tunneling, the barrier potential height or the barrier width? Why?
 - Prove mathematically that the surface-to-volume ratio of a nanoparticle is much higher than that of the bulk particle of the identical material.
 - Explain why the behavior of the Boltzmann distribution is intermediate to that of the Bose and Fermi distributions. (5x2)

UNIT - I

- II. a) Explain Heisenberg uncertainty principle and prove that it is a consequence of de-Broglie's duality hypothesis.
- b) Obtain an expression for the thermodynamic probability of a system obeying Bose-Einstein statistics and hence evaluate the Bose-Einstein distribution function. (2x5)
- III. a) Explain the meaning of a well-behaved eigenfunction in the context of Schrodinger equation. Mention the various postulates of quantum mechanics.
- b) A free particle of mass m moving in one dimension (say along positive x -axis) with momentum p and energy E can be described in quantum mechanics by the monochromatic plane wave $\psi(x,t) = Ae^{i(px-Et)}$, where A is some constant. Obtain the time dependent Schrodinger equation satisfied by this free particle. (2x5)
- IV. a) What are Excitons? Explain the different types of Excitons.
- b) Explain the differences in approaches used by Einstein and Debye theory to explain the specific heat of the solids. (2x5)

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UNIT - II

- V. a) Explain the two Hohenberg-Kohn Theorems used in Density Functional Theory.
b) Discuss gas-phase synthesis method of nanomaterials. Mention its advantages. (2x5)
- VI. a) Explain how filling polymers with different types of nanomaterials can improve the mechanical properties.
b) What are quantum dots? Why they are important and what applications are they used in? (2x5)
- VII. a) Compare the behavior of nanostructure of bottom up approach with respect to top down approach.
b) Explain why different bands in solids have different widths in energy. How do you expect the widths of the bands to vary as a function of energy, from low energy bands to high energy bands?
c) Explain the meaning of the terms (i) Fermi surface and (ii) Brillouin zone. (5,3,2)

x-x-x