Seventh Semester B.Tech. Degree Examination, November 2017
(2013 Scheme)
13.706.7 : NANOTECHNOLOGY (E)
Elective – III

Time : 3 Hours
Max. Marks : 100

PART – A

All question are compulsory.

1. How M-H curve of super paramagnetic material differ from ferromagnetic material?

2. Explain quantum mechanical tunnelling.

3. Calculate the diameter of next layer tubule to fit the zig zag tubule of n = 10 and also write its \((n, m)\) indices. \((a_{c-c} \text{ nearest carbon-carbon distance} = 3.44 \text{ Å})\)

4. Explain self-assembly process with an example.

5. Explain the formation of Kikuchi patterns in electron diffraction.

6. Discuss the different types of electron guns used in electron microscopy with examples.

7. Wavelength of electrons depends on the acceleration voltage. Explain.

8. Explain the use of Raman spectroscopy for carbon nanotube characterisation.

9. Discuss the various surface roughness measurements using atomic force microscopy.

10. Write notes on resonant tunnelling diodes.  

(10×2=20 Marks)

P.T.O.
PART – B

Answer one complete question from each Module.

Module – I

11. a) What is quantum size effect? Explain effective mass approximation model of quantum size effect in detail.
   b) Write short notes on superhydrophobic surfaces. How contact angle is measured?
   c) Explain different fabrication methods for one dimensional nanostructures.
   d) Differentiate between, electrochemical and electrophoretic deposition techniques for nanomaterial preparation. \( (4 \times 5 = 20 \text{ Marks}) \)

   OR

12. a) What is surface Plasmon resonance? Why gold nanoparticles with particles size less than 20 nm appear as red?
   b) Discuss size dependent variation of absorption of light in nanoparticles with the help of band structure.
   c) Explain the phenomenon related to size dependent colour shown by semiconducting and metal nanoparticles.
   d) What is Ostwald ripening? What is the driving force behind it? Give your answer on macroscopic and microscopic viewpoint. \( (4 \times 5 = 20 \text{ Marks}) \)

Module – II

13. a) Explain the chirality of carbon nanotubes. How would the diameter of nanotubes depended on the \((n \, m)\) indices?
   b) Write about single and multiwalled carbon nanotubes and arc-discharge process to prepare carbon nanotubes.
   c) What are core shell structures? Discuss about the principal core shell systems.
   d) List different equilibrium shapes possible for a nanometric crystal and discuss its stability based on quasimelting and magic number. \( (4 \times 5 = 20 \text{ Marks}) \)

   OR

14. a) Explain how the individual nanostructure minimizes surface energy at isotropic and an-isotropic conditions?
   b) How does DLVO theory explain the stability of nanoparticle dispersion in an electrostatically stabilized medium?
   c) Write about the covalent functionalization of the carbon nanotubes and also explain the need of functionalization of nanotubes.
   d) Explain different applications of carbon nanotubes. \( (4 \times 5 = 20 \text{ Marks}) \)
Module – III

15. a) Discuss different contrast mechanisms in transmission electron microscope.
    b) Explain different applications of electron diffraction.
    c) Magnetic Force Microscopy (MFM) is used to study the magnetic behaviour of nanomagnetic material explain the principle of MFM.
    d) With the help of neat sketch explain the working principle of scanning electron microscopy. (4×5=20 Marks)

OR

    b) Explain different sample preparation technique used in TEM.
    c) Discuss in detail the electron matter interaction.
    d) Explain principle behind scanning tunnelling microscopy. What is the relation between tunnelling current (I) and tip sample distance (d) ? (4×5=20 Marks)

Module – IV

17. a) Write a short note on photolithography and discuss the difference between negative and positive photoresist with examples.
    b) Explain isotropic and anisotropic etching process in nanofabrication.
    c) Write notes on quantum cascade lasers.
    d) Explain different steps involved a typical photolithographic process. (4×5=20 Marks)

OR

18. a) Describe the working principle of MEMS microaccelerometers.
    b) Draw the equivalent circuit diagram of a single electron transistor and discuss the I-V characteristics with respect to gate voltage and bias voltage.
    c) Explain the Critical Dimension (CD) measurements in nanometrology using atomic force microscope.
    d) Discuss different methods used for the oxidation of silicon. (4×5=20 Marks)