

Name :

Roll No. :

Invigilator's Signature :

CS/M.TECH(BT)/SEM-3/MBT-315B/2011-12

2011

NANOTECHNOLOGY

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

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

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$
- i) In molecular manufacturing, the MIPS of compact parallel computing systems can be
 - a) 10
 - b) 10^2
 - c) 10^{15}
 - d) 0.5.
 - ii) Which cellular component is considered to be a nano (assembler) ?
 - a) Chromain
 - b) Ribosomes
 - c) DNA
 - d) mRNA.
 - iii) Kinesin, a protein that carries molecular cargo through a cell by microtubule motion is an example of a
 - a) nanoscale molecular motor
 - b) nanoscale neuroelectronic interface
 - c) carbon nanotube
 - d) nanoscale electronic nose.



- iv) One of the characteristics where solution phase chemistry and nanoscale mechano-synthetic chemistry differ is
- a) typical product size b) reaction volume
 - c) heat of reaction d) all of these.
- v) What purpose could nanotubes serve in biotechnology ?
- a) As a metallic conductor or semiconductor
 - b) For the creation of components of electronic equipment
 - c) For attachment of biomolecules, including enzymes, hormone receptors and antibodies
 - d) For the detection of a specific molecule in a sample, such as blood.
- vi) What is nanotechnology ?
- a) The individual manipulation of molecules and atoms to create materials with novel or improved properties
 - b) The creation of new terms to describe very small, almost unimaginable particles in physics
 - c) The term used to describe the size of cellular components
 - d) The transition of molecular biology into the physical sciences.
- vii) What is a potential use of nanoparticles in the field of biotechnology ?
- a) Delivery of pharmaceuticals or genetic material
 - b) Tumor destruction
 - c) Fluorescent labelling
 - d) All of these.



- viii) Visualization of *f*-CNT's inside cells is typically done by
- TEM, Confocal microscopy
 - FT-IR microscopy
 - both (a) and (b)
 - none of these.
- ix) Which of the following is a structure that can be created by nano-engineering of DNA ?
- Cubical structures
 - Nanoscale scaffolds and nanowires
 - Frameworks for mechanical device
 - All of these.
- x) A Coulomb blockade occurs in a nanoparticle or quantum dot
- at regions around low bias/zero voltage
 - at region of negative voltage
 - high bias voltage
 - when $kT \gg e^2/2C$
- xi) At a metal vacuum-vacuum interface, a surface plasmon resonance (SPR) band has a frequency value of
- $\omega_s = \omega_p / \text{sq. root } 2$
 - $\omega_s = \omega_p / 2$
 - $\omega_p = \omega_s / \text{sq. root } 2$
 - $\omega_p = \omega_s / 2$
- xii) Nanomotor is present in
- Bacterial flagellum
 - Mammalian heart
 - Fungal mycelial tip
 - none of these.
- xiii) Nanogold particles melt at..... temperature than M.P. of gold.
- below
 - same
 - higher
 - none of these.



GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.

$$3 \times 5 = 15$$

2. a) Write about the contribution of the any *three* of the following persons in the development of nanotechnology:
 - (i) Richard Feynman,
 - (ii) Eric Drexler,
 - (iii) Richard Smaller, Robert Curl & Harold Kroto,
 - (iv) Gerd Bining & Heinrich Rohrer.
- b) Write the applications of nanotechnology.
3. a) Write the names of different branches of science which helped to develop nanotechnology.
- b) Describe size dependent properties of nanomaterials.

$$2\frac{1}{2} + 2\frac{1}{2}$$

4. a) Who coined the term 'Nanotechnology' first ?
- b) Describe the different applications of Nanotechnology.
- c) Describe the difference between nanotechnology and nanoscience.
5. a) Why is organic functionalization important for biological applications of carbon nanotubes (CNT) ? Name 2 such applications.
- b) What are the two common types of CNT's ? How are they geometrically different ?
6. a) Use the sequence CGCGTTC to highlight how DNA sensing can be used in nanoscience. How can you use this example to establish quantitative sensitivity of nanoscale DNA finger-printing ?
- b) How has nanodot technology been used in the development of DNA sensors ?

$$2\frac{1}{2} + 2\frac{1}{2}$$



7. Draw a labelled diagram of a scanning near-field optical microscope (SNOM) with basic operational details. Name one important nanotech application in the biomedical field where SNOMs have been utilized. 3 + 1 + 1
8. Bacterial spore can be used in nano-vaccination . Discuss.

OR

Write on magnetic nano-particle in disease diagnosis and separation technology.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

9. a) Describe the different diagnostic and therapeutic applications of nanotechnology in medicine.
- b) Describe the role of Bottom-Up and Top-Down approaches in Nanotechnology with diagram.
- c) Describe the use of CNT as antibacterial nanocarpets with diagram.
- d) Describe the use of nanoparticle in cancer therapy with diagram. $2\frac{1}{2} + 2\frac{1}{2} + 5 + 5$



10. a) Give a graphical representation of Moore's law.
- b) Interpret how a violation of Moore's law would imply a 'slowing' of chip technology progress.
- c) What are the technological steps that have been taken to ensure that Moore's law will not be violated over the next decade in chip lithography ?
- d) Describe the method of operation of an EUV lithographic etching system. 4 + 3 + 4 + 4
11. a) What is sensor and how does it work ?
- b) Why do we need nanosensor ?
- c) Describe the recognition process and application of Nanosensor through a diagram only.
- d) Describe the mechanism of the following with diagram :
- (i) H_2S nanosensor
- (ii) SiNW based nanosensor in detection of protein and DNA.

2 + 2 + 3 + 8

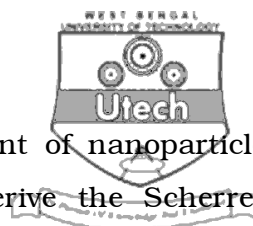


12. a) Use two examples to highlight the methods by which functionalized carbon nanotubes (f-CNTs) have been used for cellular uptake measurements.
- b) Tunnelling nanotubes have been implicated in cell to cell communication. What is the mechanism of action of the nanoscale, F-actin containing membrane tubes ? What are the experimental methods utilized for carrying out these measurements ?
- c) A drug delivery system is generally designed to improve the pharmacological and therapeutic profile of a drug molecule. Outline through two specific examples how carbon nanotubes have been successfully used in drug delivery applications. What are two technical reasons that have contributed to the delay in medical regulatory approval of nanomedicines ?

$$4 + (3 + 3) + (2\frac{1}{2} + 2\frac{1}{2})$$

13. a) Protein nanoparticles are more useful than liposome for drug delivery. Discuss.
- b) What types of proteins are used for production of nanoparticle and why and how ?
- c) Mention some novel applications of protein nanoparticles in drug delivery.

$$3 + (2 + 2 + 2) + 6$$



14. a) One of the methods for measurement of nanoparticle size has been X-ray diffraction. Derive the Scherrer equation applicable for such a nanoparticle diffraction measurement. Plot the X-ray diffraction pattern for a representative ZnS nanoparticle cluster.
- b) How is soft lithography fabrication typically achieved ? What properties make PDMS a suitable master mold material ? Draw labelled diagrams to represent two methods of soft lithography.
- c) Explain how carbon nanotubes (CNTs) have been implicated as a reason for indoor environmental pollution.

(4 + 2) + (1 + 2 + 3) + 3
