

NANOTECHNOLOGY
(CHEN 3233)

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

- (i) The gold alkanethiol bond
(i) is for immobilization of a long chain molecule on a solid substrate
(ii) a classic example of self assembly
(iii) primarily contains covalent bonds
Based on the above statements, which is most true?
(a) both (i) and (iii) are correct (b) both (ii) and (iii) are correct
(c) (iii) is correct (d) both (i) and (ii) are correct.
- (ii) Molecular wire are made of
(a) DNA
(b) long chain proteins
(c) deposited metal nano wires using nano templates
(d) long chain hydrocarbons.
- (iii) Apoferritin found in RBC is used in nanobiosynthesis
(a) for biomineralization (b) as a template
(c) as a linker chain (d) none of (a), (b) & (c).
- (iv) Excitons are created due to
(a) Combination of hole and electron
(b) absorption of energy lower than the energy gap
(c) inner shell electrons moving to the outer shell
(d) none of above.
- (v) Raman effect is scattering of
(a) Atoms (b) Molecules (c) Protons (d) Photons.
- (vi) The predominant material used in soft lithography is poly dimethyl siloxane because
(a) optically transparent (b) porous to O₂ and CO₂
(c) peels off easily (d) all of (a), (b) & (c).

- (vii) Principal of UV –VIS Spectroscopy is based on _____.
(a) Beer-Lambert law (b) Bragg's Law
(c) Both (a) and (b) (d) None of (a), (b) & (c)
- (viii) What is the standard form of AFM?
(a) Automatic Force Microscope (b) Atomic Force Microscope
(c) Atomic Force Micrometre (d) Atomic Florence Microscope.
- (ix) The finer resolution in lithography can be obtained using
(a) Blue light (b) UV Light (c) Red Light (d) X-rays.
- (x) Silicon oxide is patterned on a substrate using
(a) Physical lithography (b) Photolithography
(c) Chemical lithography (d) Mechanical lithography.

Group- B

2. (a) How is the nanoparticle shape determined from a thermodynamic point of view? Explain with the correct equation. [(CO3)(Understand/LOCQ)]
(b) Hardness of nanocrystalline copper increases as its grain size is reduced. Explain with reference to the crystalline structure. [(CO3)(Apply/IOCQ)]
(c) What is surface curvature? How is Gibbs free energy affected by surface curvature? [(CO3)(Apply/IOCQ)]
4 + 4 + 4 = 12
3. (a) From the expression of total equilibrium vacancy concentration for a nanoparticle, derive the expression for vacancy concentration in a concave and a convex surface. Which is greater? [(CO1)(Apply/IOCQ)]
(b) What do you mean by density of states? Draw the graph relating density of states with energy for a bulk material, 0D, 1D and 2D nanoparticle. Explain why you see a difference [(CO1)(Analyze/IOCQ)]
6 + 6 = 12

Group - C

4. (a) Describe the Langmuir-Blodgett process for the nanomaterial synthesis. [(CO2)(Understand/IOCQ)]
(b) Explain the mechanical process for the synthesis of nanomaterials. [(CO2)(Understand/HOCQ)]
6 + 6 = 12
5. (a) Explain Chemical Vapor Deposition of Carbon Nanotubes. [(CO2)(Remember/LOCQ)]
(b) What is S-layers? What properties of S-layers make them suitable for nanolithography? Describe the process of lithography using S-layers. [(CO2)(Analyze/IOCQ)]
6 + 6 = 12

Group - D

6. (a) Define TEM. Describe the working principle of TEM analysis for nanoparticle. [[CO3](Remember/LOCQ)]
 (b) Write the difference between optical microscope and confocal microscope with net schematic diagram. [[CO2](Remember/IOCQ)]
(1 + 5) + 6 = 12
7. (a) Write a note on UV-Vis NIR spectroscopy. [[CO3](Remember/LOCQ)]
 (b) Define Bragg's law. State and explain Debye-Scherrer equation. What is its significance in the analysis of nanoparticles? [[CO3](Understand/HOCQ)]
4 + (2 + 3 + 3) = 12

Group - E

8. (a) Explain the steps involved in Ion and X-ray Lithography. [[CO4](Remember/LOCQ)]
 (b) Define soft lithography and its important applications. [[CO3](Understand/HOCQ)]
8 + 4 = 12
9. (a) Explain photolithography with net schematic diagram. [[CO4](Remember/IOCQ)]
 (b) Describe the synthesis of aerogel and core shell nanoparticles. [[CO2](Understand/HOCQ)]
4 + 8 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	29.17	43.75	27.08

Course Outcome (CO):

After the completion of the course students will be able to

1. Able to understand fundamentals of electrochemistry, thermodynamics, fluid mechanics, and heat and mass transfer, appropriate for the design or review of components of fuel cells and fuel cell systems.
2. Analyze the fuel cell technology and compare different types of fuel cell systems.
3. Calculate the various losses in fuel cells and analyse the fuel cell power plant sub systems.
4. Defend the significance of fuel cell technology in the new global energy scenario.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

