M.Sc. PHYSICS
FOURTH SEMESTER
CONDENSED MATTER PHYSICS
MSP-403 A

(Use separate answer scripts for Objective & Descriptive)

Duration : 3 hrs. **Full Marks : 70**

(PART-A : Objective)

Time : 20 min. **Marks : 20**

Choose the correct answer from the following: ***1X20=20***

1. Quantum-confinement in Q-dots means:
   a. Confining the movement of a nanoparticle in any direction.
   b. Confining the movement of an atom in any direction.
   c. Confining the movement of an electron in any direction.
   d. Confining the movement of a Q-dot in any direction.

2. With UV-visible spectroscopy one can determine:
   a. Conductivity of a material
   b. Band gap of any material
   c. Both a and b
   d. None of the above

3. The X-ray diffraction spectrometer is based on the principle of:
   a. Interference of parallel beams of X-rays scattered from adjacent crystallographic Plane.
   b. X-rays incident at a certain angle to a specific miller plane may produce constructive Interference.
   c. Both a and b.
   d. None of the above.

4. Surface plasmons arises due to:
   a. Coherent vibration of surface electron
   b. Coherent vibration of surface phonons
   c. Coherent vibration of surface photons
   d. Coherent vibration of surface ions

5. A typical TEM works by detecting:
   a. Secondary electron emitted by nanoparticles.
   b. Primary electron emitted by the nanoparticle.
   c. X-rays emitted by nanoparticles.
   d. Electrons transmitted through the nanoparticles.

6. Choose the correct combination:
   Statement (S): Most polymers can conduct electricity.
   Reason(R): Most polymers have their valance electrons bounded in sp3 hybridized covalent bond.
   a. Both S and R are correct and R is the correct explanation of S.
   b. Both S and R are incorrect.
   c. Both S and R are correct and R is not the correct explanation of S.
   d. S is false and R is correct.

7. Capping of nanoparticle is necessary to:
   a. Increase band gap
   b. Prevent agglomeration
   c. Increase conductivity
   d. Prevent quantum confinement

(PART-B : Descriptive)

Time : 2 hrs. 40 min. **Marks : 50**

[Answer question no.1 & any four (4) from the rest]

1. What are intrinsic and extrinsic semiconductors? Describe the theory of a P-N junction in forward and reverse biased condition. Explain the working principle of Avalanche photo diode and Schottky diode. 2+4+4=10

2. What is quantum confinement? What are different nano structured materials? Explain those materials in accordance to quantum confinement and how their band structure gives rise to different optical properties. 2+2+6=10

3. What are nano thin films? Explain thin films in terms of quantum confinement. How quantum confinement leads to deference in properties of thin films in comparison to their bulk counter parts? Mention few applications of nano thin film. 1+2+5+2=10

4. Describe working principle of a p-n junction laser, XRD, and UV-visible spectroscopy. What is top down and bottom up approaches of nano particle synthesis? 9+1=10

5. What is carrier statistic and carrier mobility in a semiconducting material? Deduce the expressions.
   Describe diagrammatically the relation of fermi distribution function with carrier concentration. 6+4=10

6. Explain the working of Tunneling diode with energy band diagram correlating it with the IV curve. 10

7. Explain the working principle of a transistor as amplifier. Explain the IV characteristics associated with its operation. 5+5=10

8. What are CVD and PVD? Explain their working principles and uses in thin film synthesis. 3+3+4=10

= = *** = =

8. The depletion region in p-n junction is formed due to:
   a. Un neutralized atoms across the junction.
   b. Diffusion of un neutralized atoms.
   c. Accumulation of electron and holes across the junction.
   d. All of the above.

9. A Zener diode is based on the principle of:
   a. Thermionic emission.
   b. Tunneling of charge carriers across the junction.
   c. Diffusion of charge carriers across the junction.
   d. Ejection of atomic electron due to high voltage.

10. In a solar cell, the diode junction is:
   a. Forward biased.
   b. Electron-hole generation due to light absorption.
   c. Without any biasing, rather due to electron hole recombination.
   d. None of the above.

11. Blue shift of optical emission in nanoparticles happens due to:
   a. Widening of band gap.
   b. Shrinking of band gap.
   c. Merging of conduction and valance band.
   d. Tunneling of electrons from conduction to valance band.

12. The fermi level of a P-N junction at equilibrium is:
   a. At higher energy in N than P.
   b. At lower energy in N than P.
   c. Merges inside conduction band in N and valance band in P respectively.
   d. At same energy level for both P and N.

13. In a tunnel diode in forward biasing mode tunneling of electrons happen:
   a. From valance band of n-type to conduction band of n-type.
   b. From valance band of p-type to conduction band of p-type.
   c. From conduction band of n-type to valance band of p-type.
   d. From valance band of n-type to conduction band of p-type.

14. A photo conductor is:
   a. A junction diode that detects incoming photons.
   b. A semiconductor with surface charge carriers that detects incoming photons.
   c. A semiconductor whose conductivity increases with light illumination.
   d. A conductor whose conductivity increases with light illumination.

15. Epitaxial growth technique is used to create:
   a. Staking of semiconducting thin layers.
   b. P-N junctions in a semiconducting monolith.
   c. Thin films.
   d. All of the above.

16. The best technique to determine the size of a nanoparticle:
   a. UV b. XRD
   c. TEM d. SEM

17. Which technique is the best for studying band gap of a material?
   a. UV b. XRD
   c. AFM d. SEM

18. In general the mobility of a hole is .....than electron.
   a. Larger b. Smaller
   c. Equal d. None of the above

19. Effective mass of hole in a semiconducting block is:
   a. Zero b. Nonzero
   c. Always same as electron d. Variable

20. According to FS theory, the conductivity of a thin film is:
   a. More than bulk b. Less than bulk
   c. Equal to the bulk d. None of the above

-- --- --