[This question paper contains 2 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7372 **L**

Unique Paper Code : 2513040024

Name of the Paper : Biosensors and Nanotechnology (DSE)

Name of the Course : **B.Sc. (H) Instrumentation**

Semester : VIII

Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. There are **seven** questions in all, out of which you have to attempt any **five** questions.
3. **All** questions carry equal marks.
4. Question **1** is compulsory.
5. Non-programmable scientific calculator is allowed.

1. (a) What are optical biosensors? Explain their working with the help of an example. (3)
   (b) Discuss the importance of terms Sensitivity, Specificity and detection limit while designing a biosensor. (3)
   (c) Calculate the SA/V ratio for a 10 nm nanoparticle (spherical) versus a 10 nm cube. (3)
   (d) Why do properties change at the nanoscale? (3)
   (e) Explain Physical adsorption immobilization technique used in biosensors. Also outline its advantages and disadvantages. (3)
   (f) What are conducting polymers? List two commonly used conducting polymers used in designing of biosensors. (3)

2. (a) How can gold nanoparticles enhance the signal in electrochemical glucose sensors? (6)
   (b) Explain the working principle of a biosensor with the help of a neat block diagram. Also describe the function of each of its components (6)
   (c) Explain how enzyme-based detection takes place in a glucose detection kit used in homes. (6)

3. (a) With the help of a suitable example, explain the reason/s for the change in magnetic properties of a nanomaterial in comparison to its bulk material. (6)
   (b) Explain the difference between label-based and label free based biosensor detection along with example. (6)
   (c) What is the underlying principle of a plasmonic biosensor? What causes the signal change in these sensors? (6)

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4. (a) Name different Nanomaterials used in detection of biomolecules along with their unique properties. Also discuss how different nanomaterials are revolutionizing the biosensor industry. (6)

   (b) Why do 1D nanowires exhibit different optical properties compared to 3D bulk materials? (6)

   (c) How does the increase in surface area affect the melting point and hardness of a metal nanomaterial? (6)

5. (a) What is meant by immobilization? Explain the techniques entrapment and cross linking used for immobilization. (6)

   (b) Differentiate between biological and electronic amplification in a biosensor. Explain how signal transduction is achieved in electrochemical biosensors. (6)

   (c) Explain the role of nano sensors used in drug delivery system and point-of-care diagnostics. (6)

6. (a) What is meant by Signal to Noise (SNR) ratio in biosensor design? What is its importance? Outline one chemical and one electrical method used to minimize noise. (6)

   (b) Compare DNA-based biosensors and immunosensors in terms of their biorecognition principles. Provide one application for each and explain why selectivity is vital in their design. (6)

   (c) Explain the process of Ball Milling method for synthesis of nanomaterials. List some of its advantages and disadvantages. (6)

7. (a) What are the primary dimensional classifications of nanostructures? Explain with suitable examples. (6)

   (b) What is the primary bottom-up methods used for the synthesis of quantum dots? (6)

   (c) A 5 MHz AT-cut quartz crystal biosensor is used to detect the binding of a specific antibody. The active electrode area of the crystal is 0.5 cm^2. After the antibody binds to the surface, a stable frequency shift (Δf) of -45Hz is recorded. Calculate the total mass change (Δm) obtained after binding. (Density of quartz=2.648 g/cm^3, Shear modulus of quartz: 2.947×10^{11} g cm^{-1} s^{-2}). (6)