Ref. No.: Ex/PG/IEE/PC/T/122/2025

M.TECH. INSTRUMENTATION AND ELECTRONICS ENGINEERING
FIRST YEAR SECOND SEMESTER EXAM 2025
Subject :SENSOR MATERIALS AND CHARACTERIZATION

Time: Three hours Full -100

All questions are carrying 10 marks

Gr A any 2

1. What makes nanostructured materials suitable for sensing applications? Discuss at least five unique nanoscale effects with examples.
2. Explain quantum effects observed in nanomaterials and how they influence electrical and optical properties of sensors.
3. Describe the advantages of combining nanomaterials with polymers or graphene in hybrid sensors. Include at least one fabricated example.
4. Discuss the surface-to-volume ratio concept in nanomaterials and its role in increasing sensitivity.

Gr B any 2

5. Describe seven key sensor performance parameters (e.g., sensitivity, selectivity, hysteresis, repeatability, etc.) with brief definitions.
6. Discuss the importance of material selection in designing a biosensor for glucose detection.
7. Compare and contrast top-down and bottom-up synthesis approaches. Provide three techniques from each with detailed mechanisms.
8. Explain electrospinning and its application in forming core–shell fibers. Include schematic diagram.

Gr C any 2

9. Explain chemical vapor deposition (CVD) and its role in synthesizing carbon nanotubes and graphene. Include catalyst effects.
10. What are reverse micelles? Explain their structure and how they act as nanoreactors for uniform nanoparticles.
11. Compare and contrast thin film deposition techniques:
    a. Sputtering
    b. Thermal evaporation
    c. CVD
    d. Spin coating
12. What is altermagnetism? How does it differ from ferromagnetism and antiferromagnetism? Discuss its role in spintronics.
13. How does optical transparency, birefringence, and fluorescence vary among different polymers? Discuss with examples like PET, PMMA.

Gr D any 2

14. Discuss how TiO_2 crystal phases (anatase, rutile, brookite) affect its suitability for sensor and photocatalytic applications. Include crystal structure, bandgap, and optical response.
15. How do mesoporous architectures improve gas sensing performance? Discuss with examples of heterojunction-based designs.

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16. What is a heterostructure in sensor materials? Explain how n–n or p–n junctions enhance gas sensing response.
17. Describe the working mechanism of a CuO-based glucose sensor using non-enzymatic electrochemical detection.

Gr E any 2

18. Compare photodiodes, photoconductors, and photomultiplier tubes. Explain their working principles and differences in response.
19. Describe CCD sensor architecture and charge transfer process. Why are CCDs preferred in scientific image sensors?
20. Explain the basic principle of holography. Differentiate between amplitude and phase holograms using sketches
21. Explain Time–Temperature Superposition (TTS) and its role in DMA. How is it applied to predict long-term material behavior?
22. Describe the viscoelastic properties measured in DMA, and what storage modulus, loss modulus, and tan δ represent.