

Instructions: Answer all the questions. Answers must be specific and concise. More than required number of answer for the questions will lead to zero marks. Questions are self-explanatory; hence, no queries are responded to during the exam. Each of the questions carries 3 marks. Total marks 30.

1. (a) Calculate the strength of acetylcholinesterase inhibition by dichlorovos organophosphate pesticide if 0.4V and 0.3V are voltage signals without and with Dichlorvos detected in flow-injection calorimetric biosensors.

(b) Name the reactant used to produce gel from metal alkoxide sols in sol-gel technology.

(c) Which physicochemical factor in solid is closely related to the formation of piezoelectric effect? Show the equation involved in the bulk piezoelectric material with units.

2. (a) Draw the general configuration of the ISFET device, indicating its parts with proper labels.

(b) Which of the following is not a terminal of a FET device: (i) Gate, (ii) Drain, (iii) Source, (iv) Membrane element, (v) Body.

3. (a) Expand SELEX and (b) state four basic steps involved in the SELEX process (Only one word is allowed to write against each of these steps; zero mark will be awarded for non-compliance). (c) How ssDNA aptamers are different from antibody in terms of shelf-life and cost?

4. State three mechanisms bacteria utilize to transfer electrons to the environment.

5. Identify three different over potentials involved in fuelcells through a suitable graph indicating clearly the axes labels.

6. (a) Biofuel cell is a thermodynamically.....system. Fill the gap with a right word.

(b) Identify the correct statement: (i) Higher the anode potential, lower would be the metabolic energy gain for the bacteria in the microbial fuel cell. (ii) Upon scaling down the size of a biofuel cell, its ohmic resistance decreases. (iii) High power density is a major challenge to the practical utility of biofuel cells. (iv) The polarization curve used to characterize biofuel cells is a plot of current density versus time of its operation.

(c) Write 2 critical factors that attribute biofuelcell as green energy technology.

7. (A) Draw the Kretschmann configuration commonly used in SPR sensors, indicate its parts with proper labels.

(B) Calculate the refractive index change caused by the binding of COVID-19 on its specific antibody at the SPR sensor surface if the characteristic refractive index increment value is $0.3 \text{ cm}^3 \text{ g}^{-1}$ and the change in concentrations of the virus particles on the sensitive layer is 0.1 g/cm^3 .

8. What are BAW and SAW piezoelectric sensors? Identify a major difference between them.

9. (a) Define exciton in quantum dots. (b) State the difference between small and large quantum dots of the same materials in terms of fluorescence lifetime and give the reason. (c) What are the major advantages of quantum dots over traditional organic fluorophores?

10. (a) Show the reaction schematic on the ferrocene mediated glucose biosensor using glucose oxidase as biorecognition molecule. (b) When can we term a redox enzyme a "Molecular transducer"?

END

Handwritten notes and calculations at the bottom right of the page, including:

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- $\frac{1}{3}$
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