

**Q1 [7M]**

- a) Draw, label, and explain the operational mechanism/working principle for the standard dye - sensitized electrochemical photovoltaic cells (DSSCs). [1.5]
- b) Write the electrochemical reactions happen inside the cell. [1.5]
- c) Mention at least 2 unwanted steps in operation. [1]
- d) Mention the most important characteristics for the anode. [2]
- e) Suggest two engineering designs for the standard DSSCs which can help to enhance the cell efficiency. Explain technically within 2-3 lines. Draw necessary graphs/images. Extra writing will not be considered. [1]

**Q2 [7M]**

Consider oxygen reduction reaction (ORR) over Pt/carbon black nanocatalyst for a Polymer Electrolyte Membrane (PEM) Fuel Cell. Explain (within 4-5 lines) the importance of nanostructure for the catalyst, by considering a case study. Draw necessary graphs/images and write the important equations. Only technical explanation will get marks. Extra writing will not be considered

**Q3 [8M]**

The electrical, mechanical, optical, magnetic properties are observed to be different between bulk and nanomaterials. Explain the causes with proper examples and equations. [4 x 2]

**Q4 [8M]**

Consider that you want to prepare nano materials right for the SOFC applications.

- a) Decide and mention what standard precursors (for cathode, anode, electrolyte etc.) you will use. [1]
- b) Discuss your basic important strategical considerations within 2-3 lines. [1]
- c) Mention and explain (step by step starting from the precursors) separate method (one only) for the preparation of each part. [2]
- d) What nano features you are expecting for each part material you have fabricated? Mention the properties precisely. [1]
- e) What characterization technique could you use to be sure of these features? Discuss within 2-3 lines. [1]
- f) What you will do if your materials are not as per the expectation? Explain your strategy point wise and logically. [2]