FUEL CELL TECHNOLOGY
(CHEN 4221)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) What is the primary function of a fuel cell?
(a) To generate heat (b) To generate electricity
(c) To generate mechanical energy (d) To generate chemical energy.

(ii) What is polarization in a fuel cell?
(a) The loss of voltage due to internal resistance
(b) The loss of current due to internal resistance
(c) The loss of power due to internal resistance
(d) The gain of voltage due to internal resistance.

(iii) Which of these should not be a properties of fuel cell electrodes?
(a) Good electrical conductors
(b) Highly resistant to corrosive environment
(c) Should perform charge seperation
(d) Take part in chemical reactions.

(iv) What is the primary advantage of high-temperature fuel cells?
(a) Higher efficiency (b) Lower cost
(c) Greater flexibility (d) All of the above.

(v) Which of the following is a type of high-temperature fuel cell?
(a) Molten electrolyte fuel cell (b) Solid electrolyte fuel cell
(c) Alkaline fuel cell (d) Polymeric membrane fuel cell.

(vi) Which of these fuel cells operates at high temperatures and pressures?
(a) High temperature solid oxide fuel cell (b) Alkaline fuel cell
(c) Molten carbon fuel cell (d) Phosphoric acid fuel cell

(vii) Which type of fuel cell is designed to operate at small scales and is used in portable electronics?
(a) Micro fuel cell (b) Regenerative fuel cell
(c) Biochemical fuel cell (d) Alkaline fuel cell.

(viii) What is the primary function of the heat management system in a fuel cell?
(a) To supply fuel to the cell
(b) To remove products from the cell
(c) To regulate the temperature of the cell
(d) To connect the cell to an external circuit.

(ix) Which type of fuel cell is commonly used in power plants for vehicles?
(a) Proton exchange membrane (PEM) fuel cell
(b) Solid oxide fuel cell (SOFC)
(c) Molten carbonate fuel cell (MCFC)
(d) Alkaline fuel cell (AFC).

(x) Which space agency has successfully used fuel cells in space missions?
(a) NASA (b) ESA
(c) Roscosmos (d) CNSA.

Fill in the blanks with the correct word

(xi) OCV of a fuel cell is_____ volt.

(xii) Fuel cells have a higher _____ density compared to batteries.

(xiii) The alkaline fuel cell uses _____ as the electrolyte.

(xiv) _____ fuel is used at the anode in microbial fuel cell.

(xv) The polarization curve is a graphical representation of the relationship between _____ and current density in a fuel cell system.

Group - B

2. (a) Explain the fundamentals and classification of fuel cells. Describe the differences between various types of fuel cells. *[(CO1)(Analyse/HOCQ)]*
(b) Derive the thermodynamic efficiency of a fuel cell and explain its significance. *[(CO1)(Remember/LOCQ)]*

6 + 6 = 12

3. (a) Describe the characteristics of oxygen electrodes and hydrogen electrodes in fuel cells. *[(CO1)(Analyse/HOCQ)]*
(b) Compare the batteries and fuel cells, highlighting their advantages and disadvantages. *[(CO1)(Remember/LOCQ)]*

6 + 6 = 12

Group - C

4. (a) Describe the working principle of Molten carbonate fuel cell. *[(CO2)(Analyse/HOCQ)]*
(b) Calculate the theoretical efficiency of a hydrogen-oxygen fuel cell operating at 25°C and 1 atm, assuming a cell voltage of 0.7 V. *[(CO2)(Remember/LOCQ)]*

6 + 6 = 12

5. (a) Explain the principles of operation of a direct methanol fuel cell, including the electrochemical reactions and the role of the catalyst. *[(CO2)(Analyse/HOCQ)]*

(b) Explain the concept of heat and mass transfer in fuel cells, highlighting the importance of thermal management and water management. *[(CO2)(Remember/LOCQ)]*

6 + 6 = 12

Group - D

6. (a) Define regenerative fuel cell. Describe the advantages and disadvantages of regenerative fuel cells with conventional fuel cells. *[(CO3)(Analyse/HOCQ)]*

(b) Discuss the working principle of microbial fuel cell with net schematic diagram. *[(CO3)(Remember/LOCQ)]*

(2 + 4) + 6 = 12

7. (a) A fuel cell has an energy conversion efficiency of 40%. Calculate the amount of heat generated by the fuel cell per unit of electrical energy produced, assuming an energy input of 100 kJ. *[(CO3)(Analyse/HOCQ)]*

(b) A microbial fuel cell operates at 0.5 V and 50 mA/cm^2. Calculate the power output of the fuel cell in watts and explain its significance in portable power applications. *[(CO3)(Remember/LOCQ)]*

6 + 6 = 12

Group - E

8. (a) Describe the application of fuel cell systems in large-scale power generation. *[(CO4)(Analyse/HOCQ)]*

(b) Explain the concept of fuel cell power plants for vehicles, including their design and operation. *[(CO4)(Remember/LOCQ)]*

6 + 6 = 12

9. (a) Explain the concept of fuel cell hybrid systems, including their design and operation. *[(CO4)(Apply/IOCQ)]*

(b) Describe the use of fuel cells in emergency power applications. *[(CO4)(Apply/IOCQ)]*

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	43.75	12.50	43.75