

FUEL CELL TECHNOLOGY
(CHEN 4221)

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

Group - A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Which of the following use hydrogen as fuel?
(a) Fossil fuels (b) Anerobic digestion
(c) Fuel cells (d) Cooking.
- (ii) By which method the Hydrogen can be produced from hydrocarbon?
(a) Thermal decomposition (b) Partial oxidation
(c) Steam reforming (d) All of the mentioned.
- (iii) How is Hydrogen gas produced from fossil fuels?
(a) Partial oxidation of methane (b) Electrolysis
(c) Evaporation (d) Biomass gasification.
- (iv) The reaction occurring at the cathode of hydrogen-oxygen fuel cell is
(a) $2\text{H}_2 + 4\text{OH}^- \rightarrow 4\text{H}_2\text{O} + 4\text{e}^-$ (b) $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O} (\text{l})$
(c) $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$ (d) $\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightarrow 4\text{OH}^-$.
- (v) Chemical energy is converted to _____ energy by a fuel cell.
(a) solar (b) electrical (c) potential (d) mechanical
- (vi) The standard emf is _____ for hydrogen-oxygen fuel cells.
(a) 3.96 V (b) 1.23 V (c) 0.58 V (d) 2.54 V
- (vii) Which is the best method for petroleum hydrogenation?
(a) Thermal decomposition (b) Steam reforming
(c) Partial oxidation (d) Catalytic reforming.
- (viii) Which of the following is continuously replaced in a fuel cell?
(a) Oxidiser (b) Fuel
(c) Both fuel and oxidiser (d) None of the above.
- (ix) What does hydrogen fuel cell emit?
(a) Water (b) Steam (c) Greenhouse gas (d) Methane.

- (x) 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.

Group - B

2. (a) What is Electrochemical Cell? Name the different types of Fuel cells based on their operating temperatures range. [(CO1)(Remember/LOCQ)]
(b) Find the thermodynamic efficiency of a fuel cell and compare with Carnot efficiency. [(CO1)(Understand/IOCQ)]
(c) State the difference between the open circuit potential and closed-circuit potential of a single cell fuel cell. [(CO1)(Analyze/IOCQ)]
(1 + 4) + 5 + 2 = 12
3. (a) Describe the significance of Nernst equation in the electrochemical work. [(CO1)(Remember/LOCQ)]
(b) Define standard electrode potential. How the electromotive force is changes with the concentration of fuel. [(CO1)(Analyse/IOCQ)]
(c) Describe the working principle of PEM fuel cell. [(CO1)(Analyze/HOCQ)]
5 + 4 + 3 = 12

Group - C

4. (a) State the various properties for the bipolar plate in PEM fuel cell. [(CO2)(Remember/LOCQ)]
(b) State the various properties of electrocatalyst support material. State the name of different type of supported electrocatalyst. [(CO2)(Analyze/LOCQ)]
(c) Why support is required for the development of electrocatalyst? State the role of triple phase boundary layer in the electrocatalyst. [(CO2)(Analyze/HOCQ)]
3 + 4 + 5 = 12
5. (a) Describe the various losses (activation, Ohmic, and mass transport) in the polarization curve with net schematic diagram. [(CO2)(Understand/LOCQ)]
(b) Describe the working principle of DMFC and SOFC. [(CO2)(Understand/LOCQ)]
(c) Define MEA and its role in the fuel cell. [(CO1)(Analyze/IOCQ)]
4 + (3 + 3) + 2 = 12

Group - D

6. (a) Describe the working principle of regenerative fuel cell with net schematic diagram. [(CO3)(Remember/LOCQ)]
(b) State the difference between de-polarised cell and biochemical cell. [(CO3)(Remember/LOCQ)]
(c) Define micro fuel cell and its application. [(CO3)(Analyze/IOCQ)]
4 + 4 + 4 = 12

7. (a) Describe the pros and cons on alternative fuels. [(CO3)(Remember/LOCQ)]
(b) Describe the steam reforming process for the production of Hydrogen. [(CO3)(Understand/IOCQ)]
(c) Describe the various option for the fuel cell stack cooling. [(CO3)(Analyze/HOCQ)]
4 + 4 + 4 = 12

Group - E

8. (a) Describe the application of fuel cell in domestic and agriculture power supply. [(CO4)(Remember/LOCQ)]
(b) Describe the power curve with net schematic diagram. [(CO3)(Understand/HOCQ)]
6 + 6 = 12
9. (a) Describe the US-DOE target for the fuel cell components. [(CO4)(Remember/IOCQ)]
(b) Describe the fuel cell application in transportation sector. [(CO2)(Understand/HOCQ)]
6 + 6 = 12
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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	46.88	28.13	25

Course Outcome (CO):

After the completion of the course students will be able to

1. Able to understand fundamentals of electrochemistry, thermodynamics, fluid mechanics, and heat and mass transfer, appropriate for the design or review of components of fuel cells and fuel cell systems.
2. Analyze the fuel cell technology and compare different types of fuel cell systems.
3. Calculate the various losses in fuel cells and analyse the fuel cell power plant sub systems.
4. Defend the significance of fuel cell technology in the new global energy scenario.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

