

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 is the disadvantage(s) of hydrogen?
(a) Inflammability (b) Leaking
(c) Explosive limit (d) All of the mentioned.
 - (ii) Which of the following is not an example of a fuel cell?
(a) Hydrogen-oxygen cell (b) Methyl-oxygen-alcohol cell
(c) Propane-oxygen cell (d) Hexanone-oxygen cell.
 - (iii) During cracking of Natural gas, what is produced?
(a) Carbon (b) Hydrogen
(c) Both C and H₂ (d) None of the mentioned.
 - (iv) Catalytic reforming produces what percentage of hydrogen?
(a) 30-55 (b) 45-70 (c) 75-95 (d) 100-150.
 - (v) In presence of which catalyst is H₂ from water gas and steam extracted?
(a) Magnesium oxide (b) Copper oxide
(c) Iron oxide (d) Nickel.
 - (vi) A fuel cell is used to convert chemical energy into _____.
(a) mechanical energy (b) solar energy
(c) electrical energy (d) potential energy.
 - (vii) The fuel cell is considered a battery in which ____ is continuously replaced.
(a) fuel only (b) oxidizer
(c) both fuel and oxidizer (d) none of the mentioned
 - (viii) Fuel cell performance is not limited by
(a) First law of Thermodynamics (b) Second law of Thermodynamics
(c) Third law of Thermodynamics (d) All three laws are applicable.

- (ix) 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.
- (x) Which of these gases or liquids are not used as source of hydrogen in fuel cells?
(a) C₂H₆ (b) C₂H₂ (c) C₆H₆ (d) C₂H₅OH.

Group - B

2. (a) Define fuel cell. Describe the classification of fuel cell. [(C01)(Remember/LOCQ)]
(b) Define the thermodynamic efficiency of a fuel cell and compare with the IC engine efficiency. [(C01)(Understand/LOCQ)]
(c) Define open circuit potential. [(C01)(Analyze/IOCQ)]
(1 + 4) + 5 + 2 = 12
3. (a) Describe the significance of Nernst equation in the fuel cell electrochemical reaction. [(C01)(Remember/LOCQ)]
(b) Define standard electrode potential. How the electromotive force is changes with the concentration of fuel. [(C01)(Analyze/IOCQ)]
(c) Describe the important limitations for the electrochemical reactions. [(C01)(Analyze/IOCQ)]
5 + 4 + 3 = 12

Group - C

4. (a) State the required properties for the polymer electrolyte membrane fuel cell. [(C02)(Remember/LOCQ)]
(b) Define active catalyst area with net schematic diagram. State the name of different type of supported electrocatalyst. [(C02)(Analyze/LOCQ)]
(c) Why support is required for the development of electrocatalyst? Describe one method for the electrocatalyst synthesis. [(C02)(Analyze/HOCQ)]
3 + 4 + 5 = 12
5. (a) Why heat management is required in fuel cell stack? State the different methods for the heat management. [(C02)(Understand/LOCQ)]
(b) Describe the working principle of SOFC. [(C02)(Understand/LOCQ)]
(c) Describe the working principle of molten carbonate fuel cell. [(C01)(Analyze/IOCQ)]
4 + 4 + 4 = 12

Group - D

6. (a) Draw the schematic diagram for the PEMFC stack with electrical fittings. [(C03)(Remember/LOCQ)]

- (b) Define Air de-polarized cells. Write a short note on zinc-air battery.
[[C02](Remember/IOCQ)]
- (c) Define biochemical fuel cell. Describe the potential application of Biochemical fuel cell.
[[C02](Analyze/IOCQ)]
4 + 4 + 4 = 12
7. (a) Describe the construction a battery with net schematic diagram.
[[C03](Remember/LOCQ)]
- (b) State the different methods for the production of Hydrogen.
[[C03](Understand/IOCQ)]
- (c) Describe the various option for the fuel cell stack cooling.
[[C03](Analyze/HOCQ)]
4 + 4 + 4 = 12

Group - E

8. (a) Describe the application of fuel cell in domestic and agriculture power supply.
[[C04](Remember/LOCQ)]
- (b) Describe the polarization curve with net schematic diagram.
[[C03](Understand/HOCQ)]
6 + 6 = 12
9. (a) Describe the US-DOE target for the fuel cell components.
[[C04](Remember/IOCQ)]
- (b) Describe the current and future trends in Fuel cell commercialization.
[[C02](Understand/HOCQ)]
6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	45.83	32.30	21.87

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

