

FUEL CELL TECHNOLOGY
(CHE3221)

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) The operating temperature of PEFC is
 - (a) 600 – 1000°C
 - (b) 200 – 400°C
 - (c) 100 - 250°C
 - (d) 40 - 80°C
- (ii) Hydrogen can be produced from hydrocarbon by which method?
 - (a) Thermal decomposition
 - (b) Partial oxidation
 - (c) Steam reforming
 - (d) All of the mentioned
- (iii) External reformer for hydrocarbons is not needed in
 - (a) PEFC
 - (b) MCFC
 - (c) PAFC
 - (d) AFC
- (iv) Thermochemical cycles for hydrogen production mainly use:
 - (a) Solar or nuclear heat
 - (b) Wind energy
 - (c) Biomass only
 - (d) Electrical discharge
- (v) Which method is best for small plants for H₂ production?
 - (a) Electrolysis
 - (b) Thermal decomposition
 - (c) Partial oxidation
 - (d) None of the mentioned
- (vi) Domestic power" applications of fuel cells generally refer to:
 - (a) Powering entire cities from one cell
 - (b) Residential heating and electricity (CHP)
 - (c) Powering only kitchen appliances
 - (d) Portable outdoor camping lights
- (vii) The thermal efficiency of an ideal H₂/O₂ fuel cell operating reversibly at standard condition is
 - (a) 63%
 - (b) 73%
 - (c) 83%
 - (d) 93%

- (viii) Stoichiometric coefficient in fuel cells refers to:
 (a) Temperature variation (b) Reaction proportion of reactants
 (c) Pressure loss (d) Voltage drop
- (ix) Power plant for vehicles" refers to fuel cells used in:
 (a) Bicycles and skateboards (b) Fuel Cell Electric Vehicles (FCEVs)
 (c) Only trains (d) Engine cooling systems
- (x) Utilization percentage in fuel cells indicates:
 (a) Total power generated (b) Efficiency of heat transfer
 (c) Fraction of reactant consumed (d) Voltage loss in the system

Fill in the blanks with the correct word

- (xi) In AFC, the charge carrier is _____ .
- (xii) The voltage drop caused by resistance to electron and ion flow is known as _____ loss.
- (xiii) When fuel cells are connected in series, the total _____ increases.
- (xiv) The limitation due to inadequate supply of reactants is called _____ transport loss.
- (xv) The environmental impact of fuel cells is evaluated using _____ cycle analysis.

Group - B

2. (a) Define electrochemical cell. With a schematic diagram, give a brief account of a Galvanic cell. Give electrode reactions. [[CO1](Evaluate/HOCQ)]
 (b) Write short note on Alkaline Fuel Cell. [[CO1](Apply/IOCQ)]
 (c) What hydrogen mass flow rate is required to generate 0.8 A current in a PEFC fuel cell? [[CO1](Apply/IOCQ)]
5 + 3 + 4 = 12
3. (a) Mention the irreversible losses in an actual fuel cell. Discuss briefly any one of such losses. [[CO1](Understand/LOCQ)]
 (b) With a neat diagram, explain the ideal and actual cell voltage/current characteristics. [[CO1](Remember/LOCQ)]
 (c) Write down Nernst equation. [[CO1](Apply/IOCQ)]
7 + 3 + 2 = 12

Group - C

4. (a) Explain the need for water management in fuel cells. [[CO2](Remember/LOCQ)]
 (b) Discuss heat and water management in a fuel cell stack with design considerations. [[CO2](Apply/HOCQ)]
6 + 6 = 12
5. (a) Explain activation, ohmic and mass transport losses with the help of polarization curve. [[CO2](Analyze/HOCQ)]

- (b) Define polarization in fuel cells.

[[C02](Remember/LOCQ)]

7 + 5 = 12

Group - D

6. (a) Explain the working principle of thermochemical cycles for hydrogen production.
[[C03](Understand/LOCQ)]
(b) Discuss the advantages of thermochemical cycles over conventional electrolysis methods.
[[C03](Analyze/HOCQ)]
5 + 7 = 12
7. (a) Discuss their role in energy storage and transition to hydrogen-based systems.
[[C03](Analyze/HOCQ)]
(b) Define the concept of hydrogen economy and list its key drivers.
[[C03](Remember/LOCQ)]
7 + 5 = 12

Group - E

8. (a) Describe the economical limitation of fuel cell for its global application as per the DOE. Show the statistic of fuel cell price per kW changes from 2010.
[[C04](Remember/IOCQ)]
(b) State the various limitation in the operation of fuel cell stack in the transportation sectors.
[[C04](Remember/LOCQ)]
6 + 6 = 12
9. (a) Describe the concept of Life Cycle Analysis (LCA) of fuel cells.
[[C06](Remember/IOCQ)]
(b) Discuss the benefits of combined heat and power (CHP) systems based on fuel cells for household applications.
[[C06](Understand/IOCQ)]
6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	38.54	28.12	33.34

