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) Hydrogen gas is the
(a) lightest gas
(b) heaviest gas
(c) heavier that methane
(d) heavier than naphtha

(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) Which is the best method for petroleum hydrogenation?
(a) Thermal decomposition
(b) Steam reforming
(c) Partial oxidation
(d) Catalytic reforming

(iv) Catalytic reforming produces what percentage of hydrogen?
(a) 30-55
(b) 45-70
(c) 75-95
(d) 100-150

(v) Select the incorrect statement from the following options.
(a) Fuel cells have high efficiency
(b) The emission levels of fuel cells are far below the permissible limits
(c) Fuel cells are modular
(d) The noise levels of fuel cells are high

(vi) A fuel cell is used to convert chemical energy into what energy?
(a) Mechanical energy
(b) Solar energy
(c) Electrical energy
(d) Potential energy

(vii) 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

(viii) 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

(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) What is the process of blue hydrogen production?
(a) Steam reforming
(b) Coal gasification
(c) Electrolysis
(d) Biomass gasification

Fill in the blanks with the correct word

(xi) _____ membrane is used for the electrolyte in PEMFC.

(xii) current durability target for the fuel cell operation is _____.

(xiii) OCV of a fuel cell is_____ volt.

(xiv) Green hydrogen is produced via_____.

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

Group - B

2. (a) Describe the classification of fuel cell with their various properties. *[(CO1) (Remember/LOCQ)]*

(b) Deduced the expression for the thermodynamic efficiency of a fuel cell and compare with the IC engine. *[(CO1) (Understand/IOCQ)]*

6 + 6 = 12

3. (a) Describe the significance of Nernst equation in the electrochemical reaction.
[(CO1) (Remember/LOCQ)]

(b) Describe the important limitations for the electrochemical reactions at the anode and cathode.
[(CO1) (Analyze/HOCQ)]

6 + 6 = 12

Group – C

4. (a) Define the advantages and disadvantages of the low temperature fuel cells.
[(CO4) (Remember/LOCQ)]

(b) Describe the polarization curve of fuel cell with net schematic diagram.
[(CO2) (Remember/HOCQ)]

5 + 7 = 12

5. (a) Describe the working principle of DMFC. *[(CO3, 4) (Remember/HOCQ)]*

(b) Describe the working principle of SOFC with net schematic diagram.
[(CO3, 4) (Understand/IOCQ)]

6 + 6 = 12

Group – D

6. (a) Describe the working principle of regenerative fuel cell with net schematic diagram. *[(CO3) (Remember/LOCQ)]*

(b) Describe the various methods for the purification of hydrogen produced by steam reforming and its effect on the fuel cell.
[(CO3) (Analyze/IOCQ)]

6 + 6 = 12

7. (a) Draw the schematic diagram for the PEMFC stack with electrical fittings.
[(CO3) (Remember/LOCQ)]

(b) Define Air de-polarized cells. Write a short note on zinc-air battery.
[(CO2) (Remember/IOCQ)]

(c) Define biochemical fuel cell. Describe the potential application of Biochemical fuel cell. *[(CO2) (Analyze/IOCQ)]*

4 + 6 + 2 = 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. *[(CO4) (Remember/IOCQ)]*

(b) Write a short note on the application of fuel cell in space system.
[(CO4) (Remember/HOCQ)]

6 + 6 = 12

9. (a) State the various limitation in the operation of fuel cell stack in the transportation sectors. *[(CO4) (Remember/LOCQ)]*

(b) State the various safety precautions for the large-scale power generation using fuel cell stack. *[(CO4) (Understand/IOCQ)]*

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	34.38	39.58	26.04

Course Outcome (CO):

After the completion of the course students will be able to
Course Outcomes:
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.*