

HYDROGEN AND FUEL CELL TECHNOLOGY (REEN 5241)

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 energy density of Hydrogen is
 - (a) 35 MJ/kg
 - (b) 50 MJ/kg
 - (c) 120 MJ/kg
 - (d) 80 MJ/kg
- (ii) The production cost of blue Hydrogen is
 - (a) 1 \$/kg
 - (b) 2-3 \$/kg
 - (c) 4-7 \$/kg
 - (d) 10 \$/kg
- (iii) The temperature of the steam reforming reactor is
 - (a) 900°C
 - (b) 400°C
 - (c) 815°C
 - (d) 350°C
- (iv) 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.
- (v) Select the incorrect statement from the following option.
 - (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) 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
- (vii) In presence of which catalyst is H₂ from water gas and steam extracted?
 - (a) Magnesium oxide
 - (b) Copper oxide
 - (c) Iron oxide
 - (d) Nickel

- (viii) Which of these fuel cells operates at high temperatures and pressures?
 (a) Solid oxide fuel cell (b) Alkaline fuel cell
 (c) Molten carbon fuel cell (d) Phosphoric acid fuel cell
- (ix) Catalytic reforming produces what percentage of hydrogen?
 (a) 30-55 (b) 45-70
 (c) 75-95 (d) 100-150.
- (x) A fuel cell is used to convert chemical energy into _____
 (a) Mechanical energy (b) Solar energy
 (c) Electrical energy (d) Potential energy.

Fill in the blanks with the correct word

- (xi) _____ is used as the binder matrix in the catalyst for the preparation of MEA.
- (xii) Full name of MEA in fuel cell is _____.
- (xiii) Bipolar plate is used for the distribution of _____.
- (xiv) Excess steam is used in steam reforming to prevent _____ deposition.
- (xv) Steam reforming with CCUS produces _____ hydrogen.

Group - B

2. (a) What are two major solutions to the problem of Hydrogen storage and transport? [[CO1](Analyse/IOCQ)]
 (b) Differentiate between grey, blue and green hydrogen. [[CO1](Analyse/IOCQ)]
- 6 + 6 = 12**
3. (a) Why is the water gas shift reaction carried out in two stages – a high temperature stage followed by a low temperature stage? [[CO1](Analyse/IOCQ)]
 (b) What problems would occur if interstage cooling is not done between the HT shift and LT shift reactors in the steam reforming process? [[CO1](Evaluate/HOCQ)]
 (c) What is the function of the diaphragm in the electrolyzer to produce Hydrogen? [[CO1,2](Analyse/IOCQ)]
- 4 + 4 + 4 = 12**

Group - C

4. (a) Define Metal–Organic Framework (MOF). [[CO1](Understand/LOCQ)]
 (b) Write a short note on the compressed hydrogen storage method. [[CO1](Understand/IOCQ)]
 (c) Describe various methods for the hydrogen utilization in IC engines, domestic cooking gas, and fuel cell. [[CO1,CO2](Analyse/IOCQ)]
- 2 + 4 + 6 = 12**
5. (a) Describe the different methods for the liquid hydrogen storage technology. [[CO2] (Remember/LOCQ)]

- (b) Describe the hydrogen storage methods using metal hydrides. [[CO1] (Understand/LOCQ)]
6 + 6 = 12

Group - D

6. (a) Define the advantages and disadvantages of the PEM fuel cell. [[CO4] (Remember/LOCQ)]
(b) Describe the Activation loss, ohmic's loss, and mass transport loss wising schematic diagram. [[CO2,CO4](Remember/IOCQ)]
6 + 6 = 12
7. (a) Describe the working principle of alkaline fuel cells. [[CO4](Analyse/IOCQ)]
(b) State the advantages and disadvantages of SOFC and DMFC. [[CO4](Understand/LOCQ)]
6 + 6 = 12

Group - E

8. (a) Describe the applications of the fuel cells in domestic power supply. Describe the drawbacks of fuel cell in the application of domestic power supply. [[CO4](Analyse/IOCQ)]
(b) Describe the application of fuel cell in the transport sector. [[CO4](Remember/LOCQ)]
(3 + 3) + 6 = 12
9. (a) Define the safety consideration and risk management for the handling of H₂ gas. [[CO4](Analyse/IOCQ)]
(b) Describe the emission control strategies in hydrogen fuelled automobile engines. [[CO4](Understand/LOCQ)]
6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	39.58	56.25	4.17

Course Outcome (CO):

After the completion of the course students will be able to

1. Provide comprehensive and logical knowledge of hydrogen production, storage, and utilization.
2. Demonstrate knowledge of renewable energy technology.
3. Provide an understanding of various fuel cell technologies and its components.
4. Acquire knowledge about the different types of fuel cell and their application.

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

