

HYDROGEN AND FUEL CELL TECHNOLOGY
(REEN 5241)

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) Steam reforming with CCUS will result in
(a) Grey Hydrogen (b) Green Hydrogen
(c) Blue Hydrogen (d) Brown Hydrogen.
- (ii) The temperature in the reformer furnace in steam reforming is
(a) 900°C (b) 700°C (c) 500°C (d) 815°C
- (iii) What is the cathode material used in electrolytic Hydrogen production?
(a) Iron (b) Nickel (c) Copper (d) Aluminium.
- (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) 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
- (vi) 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.
- (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) Catalytic reforming produces what percentage of hydrogen?
(a) 30-55 (b) 45-70
(c) 75-95 (d) 100-150.

- (ix) A fuel cell is used to convert chemical energy into _____
(a) mechanical energy (b) solar energy
(c) electrical energy (d) potential energy.
- (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) What are the differences between Grey, Blue and Green Hydrogen? [(CO1)(Analyze/IOCQ)]
(b) Why is water-gas shift reaction done in two stages for hydrogen production? [(CO1)(Analyze/IOCQ)]
(c) How can you avoid the problem of hydrogen storage in case of transportation of hydrogen to long distances? [(CO1)(Analyze/IOCQ)]
4 + 5 + 3 = 12
3. (a) Explain, in brief, the electrolytic production of hydrogen. [(CO1)(Understand/LOCQ)]
(b) On what factors does the product composition of the partial oxidation process depend? [(CO1)(Analyze/IOCQ)]
(c) Write a note on coal gasification. [(CO1)(Understand/IOCQ)]
6 + 2 + 4 = 12

Group - C

4. (a) What are the difficulties in the hydrogen storage using metal borohydrides? [(CO2)(Remember/LOCQ)]
(b) Describe the current DOE target for the hydrogen storage. [(CO2)(Analyze/LOCQ)]
(c) Define the impact of the utilization of hydrogen on the environmental aspect. [(CO2,3)(Analyze/IOCQ)]
4 + 4 + 4 = 12
5. (a) Define Metal–Organic Framework (MOF). [(CO1)(Understand/LOCQ)]
(b) How the MOF is used for the hydrogen storage? [(CO1)(Understand/LOCQ)]
(c) Describe the use of hydrogen in for the various application to reduce the global warming. [(CO1,CO2)(Analyze/IOCQ)]
2 + 4 + 6 = 12

Group - D

6. (a) Define the advantages and disadvantages of the proton exchange membrane fuel cell. [(CO4)(Remember/LOCQ)]

- (b) Define the polarization curve of fuel cell and describe all the parameters with respect different losses. [(CO2)(Remember/LOCQ)]
6 + 6 = 12
7. (a) Describe the working principle of alkaline fuel cells. [(CO3, 4)(Remember/LOCQ)]
(b) State the advantages and disadvantages of SOFC. [(CO3,4)(Understand/LOCQ)]
(c) Write the different names for the non-hydrogen fuel cells. [(CO2,4)(Analyze/IOCQ)]
5 + 5 + 2 = 12

Group - E

8. (a) Describe the application of fuel cell in the stationary and portable sector. [(CO4,7)(Remember/LOCQ)]
(b) Describe the application of fuel cell in the transport sector. [(CO4,7)(Understand/LOCQ)]
6 + 6 = 12
9. (a) Describe the backfire and pre-ignition of hydrogen. [(CO1,7)(Remember/LOCQ)]
(b) Define fuel carburetion method. [(CO1,6,7)(Understand/LOCQ)]
(c) Describe the emission curve for the hydrogen engine. [(CO1,7)(Analyse/IOCQ)]
5 + 3 + 4 = 12

| Cognition Level | LOCQ | IOCQ | HOCQ |
|-------------------------|-------|-------|------|
| Percentage distribution | 64.58 | 34.42 | 0 |

Course Outcome (CO):

After the completion of the course students will be able to

1. The objective of the course is to provide comprehensive and logical knowledge of hydrogen production, storage, and utilization. In addition,
2. Ability to demonstrate knowledge of renewable energy technology.
3. Able to understand the role of nanotechnology in energy conversion.
4. Provide an understanding of various fuel cell technologies.
5. To build knowledge to design nano-systems, component or process as per need and specification.
6. To acquire knowledge layered Integration and performance for micro fuel cell systems.
7. To 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

