Q1 - Attempt any FIVE (10 Marks)

1) Define a) Declination angle b) Hour angle

- **Declination angle: Angle between sun's rays and equatorial plane, varies from +23.5° to -23.5° throughout the year**
- **Hour angle: Angular displacement of sun from local meridian, measured in degrees (15° per hour)**

2) Write down the application of solar Energy

Electricity generation (solar PV systems),Water heating (solar water heaters),Space heating and cooling,Cooking (solar cookers),Street lighting (solar street lights),Agricultural applications (solar pumps)

3) Write down Demerits of Wind Power

> **Intermittent nature - depends on wind availability High initial cost and maintenance expenses Noise pollution from turbine operation Visual impact on landscape Bird mortality due to rotating blades Requires large land area for wind farms**

4) .Define a) Cut-in speed b) Cut-out speed

- **Cut-in speed: Minimum wind speed at which wind turbine starts generating power (typically 3-4 m/s)**
- **Cut-out speed: Maximum wind speed at which turbine shuts down for safety (typically 25 m/s)**

6) Types of Fuel Cells:

Proton Exchange Membrane ,Solid Oxide Fuel Cell ,Molten Carbonate Fuel Cell ,Alkaline Fuel Cell ,Phosphoric Acid Fuel Cell

Q2 - Attempt any FIVE (20 Marks)

1) Write down the applications of Fuel Cell

Transportation (fuel cell vehicles) Stationary power generation (backup power) Portable electronics (laptops, phones) Space applications (satellites, spacecraft) Marine applications (submarines, ships)

2) Write a short note on Resistance Polarization

> **Definition: Voltage loss due to internal resistance of fuel cell components, Causes: Ohmic resistance in electrodes, electrolyte, and interconnections ,Effect: Reduces cell voltage and power output, Mitigation: Use conductive materials, reduce electrode thickness, optimize cell design**

3) What are the advantages and disadvantages of Direct Drive Power Plant

Advantages:

Higher efficiency - no gearbox losses ,Reduced maintenance - fewer moving parts, Lower noise - no gearbox noise, Better reliability - fewer components to fail

Disadvantages:

Higher cost - larger generator required, Heavier weight - larger permanent magnets

,Complex power electronics - for variable speed operation, Higher nacelle weight - affects tower design

(5) Site Selection for Wind Power Plant:

Wind resource assessment - high average wind speed (>6 m/s), Land availability - sufficient area for turbine spacing, Grid connectivity - proximity to transmission lines, Environmental factors - avoid bird migration routes, Topography - flat or gently sloping terrain preferred, Accessibility - roads for construction and maintenance, Zoning regulations - compliance with local laws, Distance from residential areas - noise considerations

6) Hydrogen Handling:

Storage: High-pressure tanks (350-700 bar) or cryogenic liquid storage Transportation: Specialized tankers or pipelines Safety measures: Leak detection systems, ventilation, fire suppression Material compatibility: Use hydrogen-compatible materials Training: Personnel training for safe handling procedures Regulations: Compliance with safety standards and codes