ENERGY SOURCES AND POWER PLANT ENGINEERING

1. Differentiate between renewable and non-renewable sources of energy.

Ans: Renewable Energy sources are inexhaustible and environmentally friendly, as they do not deplete natural resources and have minimal environmental impact

Ex: Solar, wind etc.

Non-renewable Energy sources are limited in nature and cause significant environmental harm due to emissions and resource depletion

Ex: coal, crude oils etc.

2. Define the following terms with respect to nuclear reactor : (a) Fission (b) Fusion

Ans: Fission: It is the process of splitting a heavy atomic nucleus into two lighter nuclei, accompanied by the release of energy. This is the principle used in most current nuclear reactors to produce energy

Fusion: It is the process in which two light atomic nuclei (typically isotopes of hydrogen) combine to form a heavier nucleus, releasing a significant amount of energy in the process

3. List out the solar energy storage methods.

Ans: Thermal energy storage methods like molten salts, sensible heat, and phase change materials are primarily used in concentrated solar power (CSP) systems, where heat is stored and converted into electricity as needed.

i) **Electrical energy storage** technologies such as batteries, pumped hydro, compressed air, and super-capacitors are more commonly used in residential and commercial photovoltaic solar systems.

ii) **Hydrogen storage** offers an exciting possibility for large-scale energy storage, enabling solar energy to be stored in a chemical form.

iii) **Gravitational and passive solar storage** methods provide alternative or supplementary solutions for energy storage with relatively low environmental impact

4. Suggest any three applications of fuel cells.

Ans: Fuel cells are versatile and offer a clean, efficient alternative for various energy needs, especially in transportation, backup power, and remote applications. They are increasingly being adopted as a sustainable solution in both industrial and consumer markets due to their efficiency and low environmental impact

5. State the necessity of renewable sources of energy.

Ans: The transition to renewable sources of energy is essential for addressing climate change, ensuring energy security, promoting economic development, and providing a sustainable, long-term solution to the world's growing energy needs. The shift toward renewables will help create a cleaner, more resilient, and equitable energy future for future generations

6. Purpose of Pyranometer.

Ans: A pyranometer is an instrument used to measure solar radiation, specifically the global solar radiation that is received from the sun, including both direct sunlight and diffuse sunlight scattered in the atmosphere. It is commonly used in meteorology, environmental monitoring, and solar energy research to assess the amount of solar energy that reaches a specific surface

7. Purpose of Pyrheliometer.

Ans: A Pyrheliometer is a specialized instrument used to measure direct solar radiation-that is, the radiation received directly from the sun, without any scattering or diffusion by the atmosphere. It is typically used in scientific and meteorological applications to measure the intensity of sunlight that reaches the Earth's surface

8. List out the different types of bio-gas plants.

Ans:
i) Fixed Dome Biogas Plant
ii) Floating Drum Biogas Plant
iii) Bag-type (Flexible Membrane) Biogas Plant
iv) Continuous Biogas Plant
v) Batch Biogas Plant
vi) Upflow Anaerobic Sludge Blanket (UASB) Biogas Plant
vii) Anaerobic Filter Biogas Plant
viii) Composting Biogas Plant
ix) Paddle Wheel Biogas Plant

9. List out the solar energy storage methods.

Ans:
i) **Batteries (Electrochemical Storage):** Batteries store solar energy in the form of chemical energy, which is converted back to electrical energy when needed

ii) **Pumped Hydro Storage:** Water is pumped to a higher elevation during periods of excess solar energy production, then released to flow back down through turbines to generate electricity when needed

iii) **Thermal Energy Storage:** Solar thermal storage captures and stores heat for later use, rather than converting it to electricity

iv) **Compressed Air Energy Storage (CAES):** Solar energy is used to compress air into underground storage caverns or tanks. When energy is needed, the compressed air is released and passed through a turbine to generate electricity

v) **Hydrogen Storage:** Solar electricity is used to power electrolysis, splitting water into hydrogen and oxygen. The hydrogen is stored and can later be used in fuel cells or burned to generate electricity

vi) **Flywheel Energy Storage:** Solar energy is used to spin a flywheel at high speeds, storing energy in the form of rotational motion. The stored energy can be retrieved by slowing the flywheel, converting kinetic energy back into electrical energy

vii) **Super capacitors (Ultra capacitors):** Super capacitors store energy electrostatically and can discharge energy very quickly, but they generally hold less energy than batteries

viii) **Gravity-Based Energy Storage:** Energy is stored by lifting a mass (such as a large weight) to a height using solar electricity. When energy is required, the mass is allowed to fall, and its potential energy is converted back into electricity via a generator

ix) **Molten Salt Storage:** Molten salts, typically a mixture of sodium nitrate and potassium nitrate, are heated by solar power and stored in insulated tanks. The heat can be released later to generate steam and produce electricity

10. What are the basic components of a windmill?

Ans: A windmill consists of several key components that work together to harness wind energy and convert it into mechanical energy or electricity. Here are the basic components of a windmill:

i) **Blades (Rotor Blades):** These are the large, aerodynamic blades that capture the wind's kinetic energy. As the wind blows, the blades spin, causing the rotor to rotate

ii) **Nacelle:** The nacelle is the housing that contains the main components of the windmill's machinery, including the generator and gearbox

iii) **Rotor:** The rotor consists of the blades and the hub (the central part that connects the blades to the shaft)

iv) **Hub:** The hub is the central component to which the blades are attached. It connects the rotor blades to the main shaft

v) **Main Shaft:** The main shaft is a large, heavy-duty component that connects the hub to the gearbox

vi) **Gearbox (or Transmission):** The gearbox converts the low-speed rotation of the rotor into higher-speed rotation suitable for driving the generator

vii) **Generator:** The generator converts the mechanical energy (rotational energy) from the rotor into electrical energy

viii) **Yaw System:** The yaw system allows the windmill to rotate on its vertical axis to face the wind direction

ix) **Tower:** The tower is the tall structure that supports the nacelle, rotor, and blades. It is typically made from steel or concrete

x) **Controller:** The controller is an electronic system that monitors the windmill's performance and safety. It ensures that the windmill operates within optimal parameters

xi) **Brakes:** Windmills are equipped with braking systems to stop or slow down the rotor during high wind speeds or maintenance periods

xii) **Electrical Systems:** This includes electrical components like transformers, inverters, and power cables

xiii) **Anemometer (Wind Speed Sensor):** A device that measures the wind speed