Model Question Paper-1 with effect from 2021(CBCS Scheme)

USN | | | | | | | | | | |

Sixth Semester B.E. Degree Examination

Renewable Energy Power Plant

TIME: 03 Hours SET -2 **Max. Marks: 100**

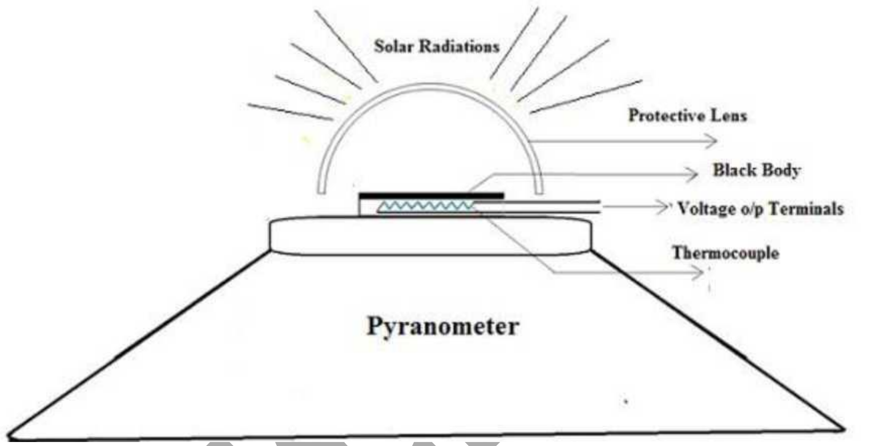
Note: 01. Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE**.

		Module –1 Download	**Bloom's Taxonomy Level**	**COs**	**Marks**
Q.01	a	Elaborate on India's Production and reserves of Commercial Energy Sources India's production and reserves of commercial energy sources are primarily dominated by fossil fuels, which play a crucial role in meeting the country's energy demands. Here's a detailed overview: 1. Coal : - Coal is a significant primary energy source in India, accounting for a substantial portion of the country's energy production. In the year 2000, India produced approximately 310 million tons (Mt) of coal, which contributed around 56.16% to the total energy production. - The production of coal has seen a remarkable increase over the past 50 years, with an eleven-fold rise from 1951 to 2004, reflecting an average annual growth rate of about 4.5%. - As of 2006, India had large reserves of coal, with proved reserves estimated at 95,866 Mt and total resources (including indicated and inferred reserves) reaching approximately 253,301 Mt. 2. Oil : - Oil is another critical energy source, with India producing about 103.44 Mt in 2000, contributing approximately 29.75% to the total energy production. - The domestic production of crude oil has varied over the years, with significant imports to meet the growing demand. The data shows a consistent increase in oil consumption,	L2	CO 1	10

		highlighting the reliance on both domestic production and imports. 3. Natural Gas : - Natural gas production in India has been steadily increasing, with production rising from just 0.516 billion cubic meters (bcm) in 1969 to 27.860 billion cubic meters in 2000. This growth reflects a shift towards cleaner energy sources, with natural gas contributing about 7.47% to the total energy production in 2000. - The production of natural gas is expected to peak around 2025, indicating a growing reliance on this resource as oil production declines. 4. Water Power : - Water power, or hydroelectric power, is a renewable energy source that contributed about 5.25% to India's total energy production in 2000, with an annual production of 74,362 GWh. - This energy is generated from flowing water, typically from rivers or dams, and relies on the natural water cycle. 5. Nuclear Power : - Nuclear power, while a smaller contributor, produced 16,621 GWh in 2000, accounting for about 1.37% of the total energy production. The capacity for nuclear energy has been gradually increasing as more units are commissioned. fossil fuels (coal, oil, and natural gas) meet approximately 93% of India's commercial energy requirements, with coal being the dominant source. The country's total energy production from commercial sources in 2000 was about 14,559 × 10^15 J, which represented only 3.5% of the total world production. This highlights both the reliance on fossil fuels and the potential for growth in renewable energy sources as India seeks to diversify its energy portfolio in response to the anticipated decline in fossil fuel reserves.			
	b	List advantages and disadvantages of renewable energy resources Renewable energy resources come with a variety of advantages and disadvantages. Here’s a detailed breakdown: Advantages: 1. Sustainability : Renewable energy sources, such as solar, wind, and hydro, are continuously replenished by	L2	CO 1	10

		nature. This means they can provide energy indefinitely as long as they are managed responsibly. 2. Environmental Benefits : Unlike fossil fuels, renewable energy sources are generally environmentally clean. They produce little to no greenhouse gas emissions during operation, helping to combat climate change. 3. Energy Independence : Utilizing renewable resources can reduce dependence on imported fuels, enhancing energy security for countries. 4. Job Creation : The renewable energy sector is labor-intensive, which can lead to job creation in manufacturing, installation, and maintenance. 5. Diverse Energy Supply : Renewable energy can be harnessed from various sources (solar, wind, hydro, geothermal, and biomass), providing a diversified energy portfolio. Disadvantages: 1. Intermittency : Many renewable energy sources, such as solar and wind, are not always available. Their output can be affected by weather conditions and time of day, leading to challenges in reliability. 2. High Initial Costs : The installation of renewable energy systems, like solar panels or wind turbines, often requires significant upfront investment, which can be a barrier for some users. 3. Space Requirements : Renewable energy installations, particularly solar farms and wind farms, require large areas of land, which can lead to land use conflicts. 4. Energy Storage Challenges : Efficiently storing energy generated from renewable sources for use during non-productive times (like at night for solar energy) remains a significant challenge, often adding to costs. 5. Resource Location : The availability of renewable resources can vary significantly by location. For example, solar energy is more abundant in sunny regions, while wind energy is more effective in areas with consistent wind patterns. while renewable energy resources offer a sustainable and environmentally friendly alternative to fossil fuels, they also present challenges that need to be addressed to maximize their potential.			
		OR			
Q.02	a	With schematic representation explain mechanism of absorption, scattering beam and diffused radiation received at Earth's surface	L2	CO2, CO 3, CO	10

		The mechanism of absorption, scattering, beam, and diffuse radiation received at the Earth's surface can be explained through a schematic representation of solar radiation interactions with the atmosphere. Here's a detailed breakdown: 1. Solar Radiation : The sun emits energy in the form of electromagnetic waves, which travel through space and reach the Earth. This radiation is categorized into two main types: beam radiation and diffuse radiation . 2. Beam Radiation : This is the direct solar radiation that travels in a straight line from the sun to the Earth's surface without being altered. It is also referred to as direct radiation. The intensity of beam radiation is influenced by the angle of the sun, which varies throughout the day and across seasons. 3. Atmospheric Interaction : As solar radiation enters the Earth's atmosphere, it encounters various gases and particles. This interaction leads to two primary processes: - Absorption : Certain wavelengths of solar radiation are absorbed by atmospheric components such as ozone and water vapor. This absorption increases the internal energy of the atmosphere, contributing to warming. For example, ultraviolet (UV) radiation is largely absorbed by ozone, while infrared radiation is absorbed by water vapor and carbon dioxide. - Scattering : This process occurs when solar radiation interacts with atmospheric molecules and particulate matter. Scattering redistributes the radiation in all directions. There are two types of scattering: - Rayleigh Scattering : This occurs with smaller particles and is responsible for the blue color of the sky, as shorter wavelengths (blue light) are scattered more than longer wavelengths (red light). - Mie Scattering : This occurs with larger particles and affects all wavelengths more uniformly, contributing to the white appearance of clouds. 4. Diffuse Radiation : The scattered radiation that reaches the Earth's surface from all parts of the sky is known as diffuse radiation. It is the result of the scattering process and is not directed from the sun. The combination of beam radiation and diffuse radiation is referred to as total or global radiation . 5. Schematic Representation : Imagine a diagram where:		4	

		- The sun is depicted at one end, emitting rays of light. - As these rays enter the atmosphere, some are shown being absorbed by ozone and water vapor (indicated by arrows pointing towards the atmosphere). - Other rays are shown scattering in various directions (indicated by arrows spreading out). - Finally, the remaining rays that reach the Earth's surface are split into two categories: direct (beam) radiation and scattered (diffuse) radiation.			
	b	Explain with neat sketch working of pyranometer The mechanism of absorption, scattering, beam, and diffuse radiation received at the Earth's surface can be explained through a schematic representation of solar radiation interactions with the atmosphere. Here's a detailed breakdown:  1. Solar Radiation : The sun emits energy in the form of electromagnetic waves, which travel through space and reach the Earth. This radiation is categorized into two main types: beam radiation and diffuse radiation . 2. Beam Radiation : This is the direct solar radiation that travels in a straight line from the sun to the Earth's surface without being altered. It is also referred to as direct radiation. The intensity of beam radiation is influenced by the angle of the sun, which varies throughout the day and across seasons. 3. Atmospheric Interaction : As solar radiation enters the Earth's atmosphere, it encounters various gases and particles. This interaction leads to two primary processes: - Absorption : Certain wavelengths of solar radiation are absorbed by atmospheric components such as ozone and water vapor. This absorption increases the internal energy of	L2	CO 2, CO 3, CO4	10

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		Module -2 **Download**			
Q. 03	a	Define the following (i) Declination Angle (ii) Hour Angle (iii) Latitude (iv) Zenith Angle (v) Surface Azimuth Angle Sure! Here are the definitions for each of the terms you requested:	L2	CO 2, CO 3, CO 4	10

		(i) Declination Angle (δ) : The declination angle is the angle between a line extending from the center of the Sun to the center of the Earth and its projection on the Earth's equatorial plane. This angle varies throughout the year due to the tilt of the Earth's axis, ranging from +23.5° on June 22 to -23.5° on December 22. On the equinoxes, which occur around March 21 and September 22, the declination is zero. (ii) Hour Angle (ω) : The hour angle is the angle through which the Earth must rotate to bring the meridian of a specific point directly in line with the Sun's rays. It is measured in degrees and is equal to 15° per hour, indicating the time since solar noon. (iii) Latitude (φ) : Latitude is the geographic coordinate that specifies the north-south position of a point on the Earth's surface. It is measured in degrees, with the equator at 0° latitude, the North Pole at +90°, and the South Pole at -90°. (iv) Zenith Angle (θz) : The zenith angle is the complementary angle of the Sun's altitude angle. It is defined as the vertical angle between the Sun's rays and a line perpendicular to the horizontal plane at a specific point. Mathematically, it can be expressed as $\theta z = 90° - \alpha$, where α is the solar altitude angle. (v) Surface Azimuth Angle (γ) : The surface azimuth angle is the angle between the normal to the collector surface and the south direction. It is measured in degrees along the horizontal plane, indicating the orientation of the collector relative to true north.			
	b	Calculate the angle made by beam radiation with the normal to a flat- plate collector on May 1 at 09ooh (local apparent time). The collector is located in New Delhi ($28^0 35'$N, $77^0 12'$E).It is tilted at an angle of 36^0 with the horizontal and is pointing due south.	L3	CO 2, CO 3, CO 4	10
OR					
Q.04	a	With a neat sketch explain any two types of concentrating collectors Certainly! Concentrating collectors are designed to focus sunlight onto a small area, which allows them to achieve	L2	CO 2, CO 3, CO4	10

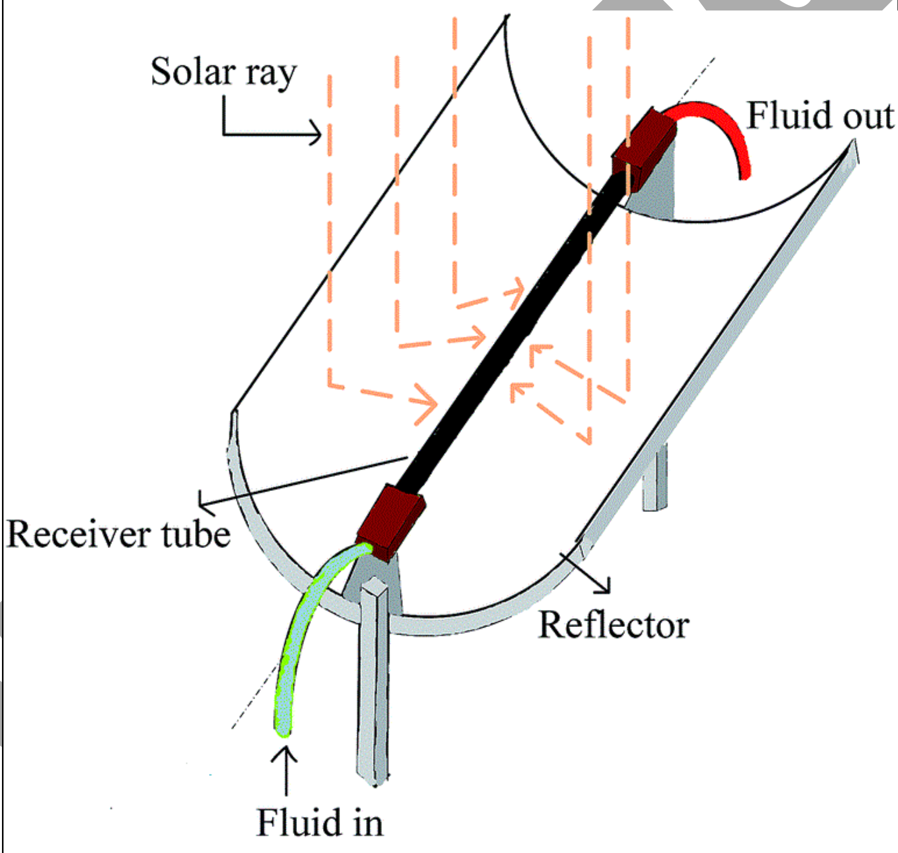
higher temperatures compared to non-concentrating types. Here are two common types of concentrating collectors along with a brief explanation and a neat sketch for each:

1. Parabolic Trough Collector

Description:

A parabolic trough collector consists of a long, curved mirror that focuses sunlight onto a receiver tube located at the focal line of the parabola. The receiver tube contains a heat transfer fluid, which is heated by the concentrated sunlight. This type of collector is commonly used in large-scale solar power plants.

- Structure: These have a parabolic-shaped reflector that focuses sunlight onto a receiver tube located along the focal line of the parabola.
- Application: Commonly used in solar thermal power plants for electricity generation.



2. Paraboloidal Collector (Dish Collector)

Description:

A paraboloidal collector, also known as a dish collector, has a dish-shaped reflector that focuses sunlight onto a receiver located at the focal point. This type of collector can achieve very high temperatures and is often used for applications like power generation or cooking.

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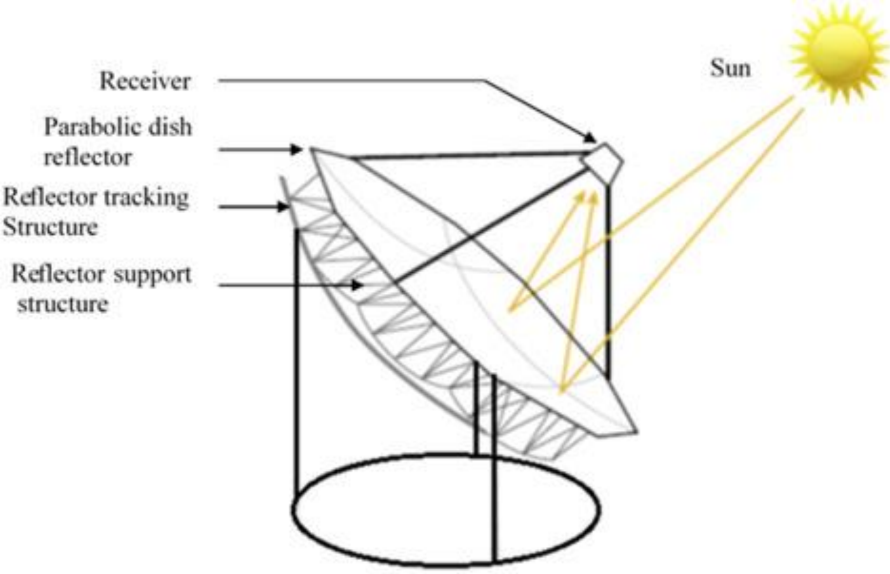
<tr><td></td><td></td><td>

Parabolic dish geometry concentrates light in a single focal point, i.e., all sun rays that are parallel to the axis of the parabola are directed towards the central receiver. This allows this type of collector to achieve the highest concentration ratios among all other type of solar collectors .
The process is economical and, for heating the pipe, thermal efficiency ranges from 60 to 80%. The overall efficiency from collector to grid, i.e. (Electrical Output Power)/(Total Impinging Solar Power) is about 15%, similar to PV (Photovoltaic Cells) but less than Stirling dish concentrators.

Summary of Advantages:
- High Efficiency: Both types can achieve higher temperatures, making them suitable for power generation and industrial heating.
- Modularity: They can be scaled up for larger applications or used in smaller setups.

These concentrating collectors are essential in harnessing solar energy efficiently, especially in applications requiring high temperatures</td><td></td><td></td><td></td></tr>
<tr><td></td><td>b</td><td>Describe Solar Pond for Solar Energy Collection and Storage

A solar pond is a type of thermal energy storage system designed to capture and store solar energy in a body of water. Unlike conventional solar collectors that use flat panels, solar ponds utilize the entire volume of water to absorb and store thermal energy. The water in a solar pond is stratified into layers with different temperatures, which allows it to store heat efficiently.</td><td>L2</td><td>CO2, CO 3, CO 4</td><td>10</td></tr>
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Solar Pond Working

1. Layered Structure: A solar pond typically consists of three distinct layers:

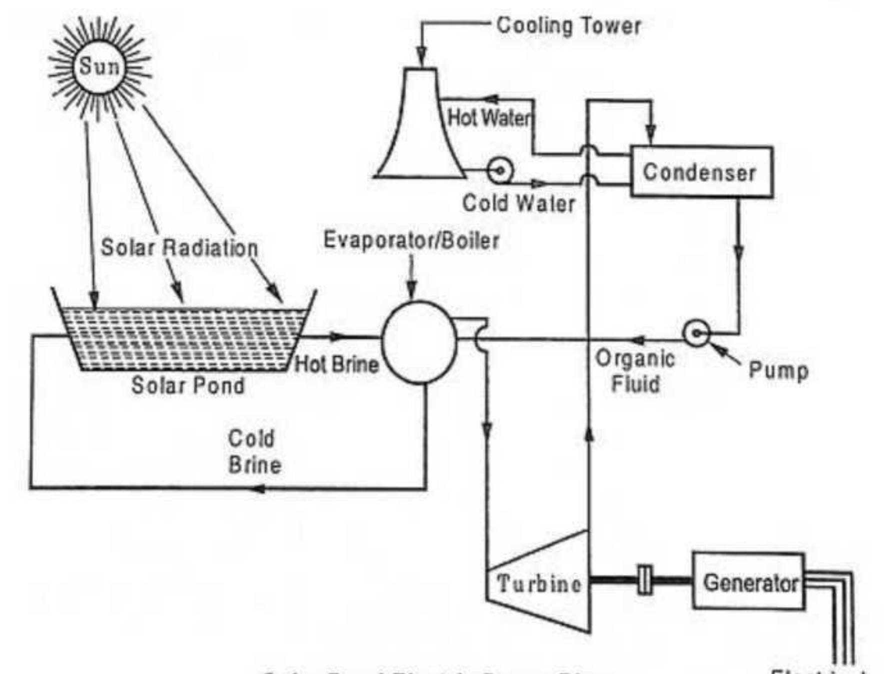
• Upper Convective Zone: The top layer is relatively shallow and exposed to the atmosphere. It absorbs solar radiation and allows heat to transfer to the layers below.

• Middle Non-Convective Zone: This layer is thicker and acts as an insulating barrier. It contains salts or other additives that help retain heat by preventing convection and heat loss to the surface.

• Lower Convective Zone: The bottom layer is where the highest temperatures are achieved. It stores the bulk of the thermal energy collected by the pond.

2. Heat Capture and Storage: Solar energy is absorbed by the pond's surface and transferred to the lower layers through conduction. The thermal gradient created by the layered structure allows the pond to store significant amounts of heat over extended periods.

3. Heat Extraction: Heat can be extracted from the solar pond through various methods, such as piping hot water to a heat exchanger or using the thermal energy for industrial processes or electricity generation. The extraction can occur at different depths depending on the temperature required.



Solar Pond Electric Power Plant.

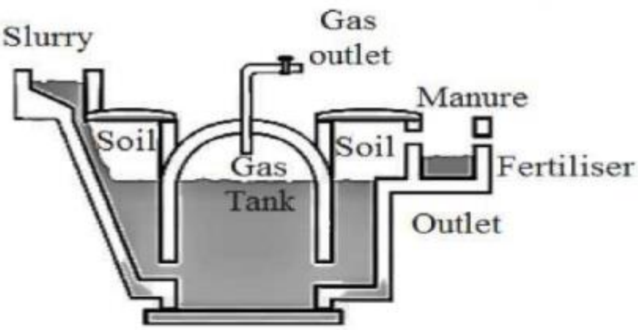
Advantages of Solar Ponds

1. High Thermal Storage Capacity: Solar ponds can store large amounts of thermal energy due to their volume and the thermal gradient created within them.

		2. Long-Term Storage: Unlike some other thermal storage systems, solar ponds can retain heat for extended periods, making them suitable for balancing energy supply and demand. 3. Simplicity and Low Cost: Solar ponds are relatively simple to construct and maintain compared to other advanced thermal storage technologies. 4. Versatility: They can be used for various applications, including heating, cooling, and even electricity generation in conjunction with thermoelectric generators. Applications 1. Heating: Solar ponds can provide heating for residential, commercial, and industrial applications. The stored thermal energy can be used directly for space heating or hot water supply. 2. Electricity Generation: In some cases, solar ponds are coupled with thermoelectric generators or organic Rankine cycle systems to produce electricity from the stored thermal energy. 3. Industrial Processes: The high-temperature heat from solar ponds can be utilized in industrial processes that require significant thermal input.			
Module -3 **Download**					
Q. 05	a	Describe the main consideration in selecting the site for wind generator When selecting a site for a wind generator, several key considerations must be taken into account to ensure optimal performance and efficiency. Here are the main factors: 1. Wind Resource Assessment : This is crucial for determining the potential energy that can be generated. The site should have a consistent and strong wind resource, which involves measuring wind speed and direction over time. Higher wind speeds significantly increase energy production, as the kinetic energy of the wind increases with the cube of the wind speed. 2. Topography : Local geographical features, such as hills, valleys, and bodies of water, can influence wind patterns and speeds. Understanding these local effects is essential, as they can either enhance or reduce the wind energy potential at a specific location. 3. Land Use : The site must have sufficient land available for the installation of wind turbines. This includes	L2	CO2, CO 3, CO 4	10

		considering the impact on local ecosystems, wildlife habitats, and existing land uses, such as agriculture or recreational activities. Wind farms require a significant amount of land, and careful planning is needed to minimize disruptions. 4. Environmental Impact : It's important to assess the potential environmental impacts of the wind farm, including effects on local wildlife, particularly birds and bats, which may collide with turbine blades. Community acceptance is also a factor, as local opposition can hinder project development. 5. Accessibility : The site should be accessible for construction and maintenance activities. This includes considering the logistics of transporting equipment and personnel to the site. 6. Regulatory and Permitting Requirements : Understanding local regulations and obtaining the necessary permits is essential for the development of wind projects. This may involve environmental assessments and community consultations. 7. Grid Connection : Proximity to existing power lines and grid infrastructure is important for the efficient transmission of generated electricity. The site should allow for easy integration into the local or regional power grid. By carefully considering these factors, developers can select optimal sites for wind generators that maximize energy production while minimizing environmental and social impacts			
	b	Wind at 1 standard atmospheric pressure and 15^0C has velocity of 15 m/s. Calculate : (i) The total power density in the wind stream (ii) The maximum power density (iii) Reasonable power density, assume efficiency = 35% (iv) Total power (v) Torque and axial thrust Given : Turbine Diameter = 120 m, and Turbine Operating speed = 40 rpm at maximum efficiency. Consider Propeller type wind turbine	L3	CO 2, CO 3, CO 4	10
		OR			
Q. 06	a	Explain the biomass sources for biogas generation Biogas generation primarily relies on various biomass	L2	CO2, CO3,	10

sources, which are organic materials that can be broken down through anaerobic digestion to produce biogas, mainly composed of methane and carbon dioxide. Here are some key biomass sources for biogas production:



1. Agricultural Residues : This includes leftover materials from crop production, such as corn stalks, wheat straw, and rice husks. These residues are often abundant and can be effectively utilized for biogas generation.

2. Animal Manure : Livestock waste, such as cow, pig, and poultry manure, is a significant source of biomass for biogas production. Manure not only provides a rich source of organic matter but also helps in managing waste and reducing environmental pollution.

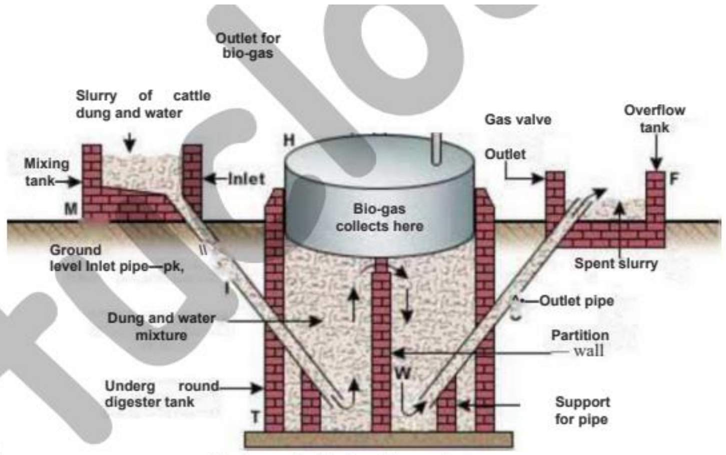
3. Food Waste : Organic waste from households, restaurants, and food processing industries can be collected and processed to produce biogas. This includes vegetable peels, fruit scraps, and leftover food, which are often disposed of in landfills.

4. Energy Crops : Certain crops are specifically grown for energy production. Examples include:
   - Short-Rotation Woody Crops : Trees like poplar and willow are harvested every few years and have high energy content.
   - Herbaceous Crops : Fast-growing grasses such as switchgrass and miscanthus can be used for solid biomass or converted into biofuels.

5. Organic Municipal Solid Waste : This includes biodegradable materials collected from urban areas, which can be processed in biogas plants to reduce landfill use and generate energy.

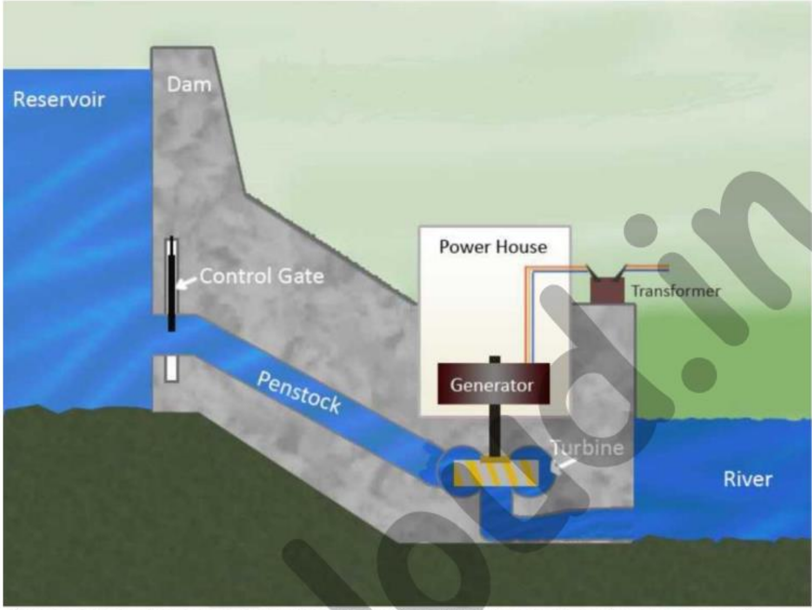
6. Food Processing By-products : Waste generated from

		food processing, such as pulp from fruit juice production or spent grains from breweries, can also serve as a feedstock for biogas production. The effective use of these biomass sources not only contributes to renewable energy generation but also aids in waste management and reduces greenhouse gas emissions. By utilizing organic waste materials, biogas production supports sustainable energy practices and enhances soil fertility through the use of digestate, the nutrient-rich by-product of the anaerobic digestion process.			

				CO4	
	b	Sketch and explain the working of a floating dome type biogas plant used in India A floating dome type biogas plant is an innovative design commonly used in India for the production of biogas through anaerobic digestion. Here’s a detailed explanation of its working and components:  Floating gas-holder type bio-gas plant. 1. Floating Gas Holder : A flexible dome that rises and falls with the volume of gas produced. 2. Inlet Pipe : Where the mixture of organic waste (like cattle dung and water) enters the digester. 3. Underground Digester Tank : The main chamber where anaerobic digestion occurs. 4. Gas Valve : Controls the release of biogas from the system. 5. Outlet for Biogas : Where the collected biogas exits the plant for utilization. 6. Mixing Tank : Ensures the feedstock is well mixed for optimal digestion. 7. Overflow Tank : Manages excess slurry and prevents overflow. Working of the Floating Dome Biogas Plant 1. Feedstock Preparation : Organic waste, such as cattle dung mixed with water, is collected and prepared. This mixture is essential for the anaerobic digestion process. 2. Anaerobic Digestion : The prepared feedstock is fed into the underground digester tank through the inlet pipe.	L2	CO2, CO 3, CO 4	10

		Inside the digester, microorganisms break down the organic material in the absence of oxygen, producing biogas (primarily methane and carbon dioxide) and digestate (the solid and liquid residuals). 3. Gas Collection : As biogas is produced, it collects in the floating gas holder. The design allows the dome to rise as the gas volume increases, providing a visual indication of gas production. 4. Gas Utilization : The biogas can be directed through the gas valve to various applications, such as powering generators for electricity, heating systems, or even as fuel for vehicles. 5. Digestate Management : The remaining digestate can be processed and used as a nutrient-rich fertilizer for agricultural purposes, enhancing soil fertility and reducing the need for synthetic fertilizers. Advantages of Floating Dome Biogas Plants - Gas Storage : The floating dome allows for effective gas storage and easy measurement of gas production. - Scalability : Suitable for small to medium-scale operations, making it ideal for rural settings. - Cost-Effectiveness : While the initial construction may be more complex, the long-term benefits include reduced energy costs and the ability to utilize local organic waste. Floating dome biogas plants are a sustainable solution for energy production in India, particularly in rural areas where organic waste is abundant. They not only provide renewable energy but also contribute to waste management and soil enrichment, promoting a circular economy.			
		Module -4 **Download**			
Q. 07	a	With a neat sketch explain general layout of Hydro-electric power plant The general layout of a hydroelectric power plant typically includes several key components that work together to convert the potential energy of stored water into electrical energy. Here's a detailed explanation along with a neat sketch to illustrate the layout: General Layout of a Hydro-Electric Power Plant	L2	CO2, CO 3, CO 4	10

Layout and Working of Hydroelectric Power Plant



The above image shows the typical layout of a hydroelectric power plant and its basic components.

1. Dam and Reservoir :
   - The dam is constructed across a river in hilly areas to create a reservoir. The height of the water level in the reservoir, known as the water head, is crucial as it determines the potential energy stored in the water. The dam holds back a large volume of water, creating a significant elevation difference.

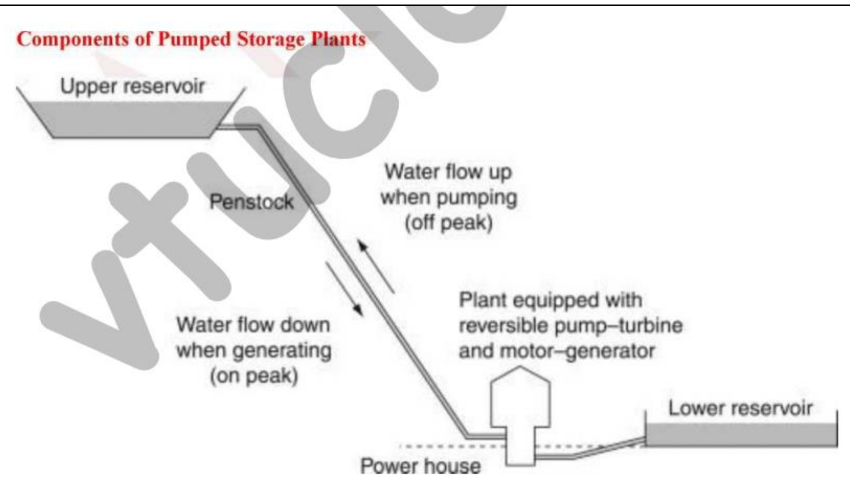
2. Control Gate :
   - This component regulates the flow of water from the reservoir to the penstock. By adjusting the control gate, operators can control the amount of water released, which in turn affects the energy output of the plant.

3. Penstock :
   - The penstock is a large steel pipe that carries water from the reservoir to the turbine. It is designed to withstand high pressure as water flows through it, and its diameter is crucial for maintaining the flow rate.

4. Turbine :
   - As water flows through the penstock, it strikes the blades of the turbine, causing it to spin. The turbine converts the kinetic energy of flowing water into mechanical energy.

5. Generator :
   - Connected to the turbine, the generator converts the mechanical energy from the turbine into electrical energy. This is achieved through electromagnetic induction, where the rotation of the turbine spins a rotor within a magnetic

		field. 6. Tail Race : - After passing through the turbine, the water exits into the tail race, which is a channel that carries the water back to the river or body of water from which it was originally sourced. 7. Powerhouse : - This is the structure that houses the turbine and generator. It is designed to protect these components from environmental factors while allowing for maintenance access. A hydroelectric power plant utilizes the potential energy of water stored in a reservoir, which is released through a control gate and flows down a penstock to turn a turbine. The turbine drives a generator that produces electricity, and the water is then returned to the river through the tail race. This layout is essential for harnessing renewable energy efficiently while considering environmental impacts and operational costs.			
	b	Explain with a neat sketch pumped storage plant Pumped storage plants are a type of hydroelectric power generation facility that can store and generate electricity to meet varying demand. They use two water reservoirs at different elevations to store and generate energy by moving water between them. How Pumped Storage Plants Work? 1. Pumping Mode: • Low-Demand Periods: During times of low electricity demand, excess power (often from renewable sources like wind or solar) is used to pump water from the lower reservoir to the upper reservoir. • Storage of Energy: This process effectively stores energy in the form of gravitational potential energy in the water stored at the higher elevation. 2. Generation Mode: • High-Demand Periods: During peak electricity demand, the stored water is released from the upper reservoir, flowing down through turbines to generate electricity. • Electricity Generation: The falling water turns the turbines, converting the potential energy back into electrical energy, which is then fed into the grid.	L2	CO 2, CO 3, CO4	10



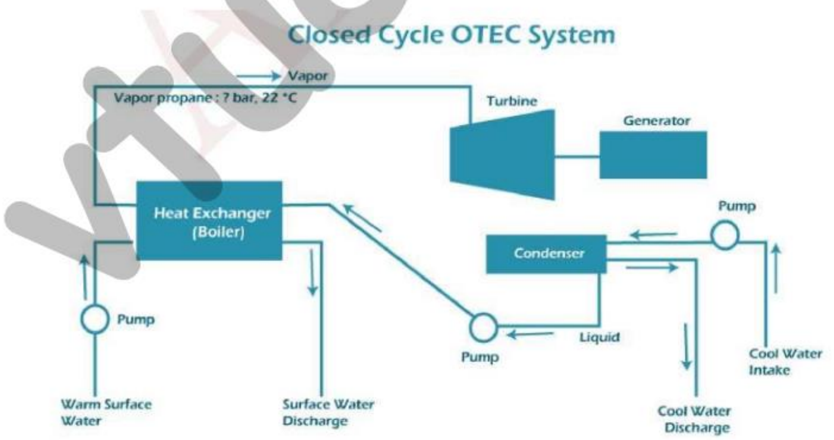
1. Upper and Lower Reservoirs:
- Upper Reservoir: Stores water during low-demand periods.
- Lower Reservoir: Receives water during the generation process and serves as the source for pumping water back up.
2. Pumping/Turbine Units:
- Reversible Pumps/Turbines: These units can function both as pumps (to move water to the upper reservoir) and as turbines (to generate electricity when water flows back down).
3. Penstocks:
- Conduits: Large pipes or tunnels that carry water from the upper reservoir to the turbines and from the turbines to the lower reservoir.
4. Powerhouse:
- Facility: Houses the reversible pump-turbine units and generators, controlling the operation of the plant.

Advantages of Pumped Storage Plants

1. Energy Storage:
- Grid Stability: Provides a reliable way to store excess energy from intermittent renewable sources, helping to stabilize the grid.
- Peak Shaving: Reduces the need for expensive and less efficient peaking power plants by supplying energy during peak demand periods.
2. Flexibility and Reliability:
- Quick Response: Can quickly switch between pumping and generating modes, making it highly responsive to changing electricity demands.
- Load Balancing: Helps balance supply and demand on the grid, ensuring a stable electricity supply.
3. Efficiency:

		• High Efficiency: Typically has an overall efficiency of 70-80%, making it one of the most efficient large-scale energy storage options. Disadvantages of Pumped Storage Plants 1. High Initial Costs: • Construction Costs: Building the reservoirs, penstocks, and powerhouses involves significant capital investment. • Site Requirements: Suitable sites with the necessary elevation differences and water availability are limited. 2. Environmental Impact: • Ecological Disruption: Construction and operation can affect local ecosystems, water quality, and wildlife habitats. • Land Use: Requires substantial land for reservoirs and infrastructure, potentially leading to displacement and land-use changes. 3. Dependency on Water Availability: • Water Resource Management: Efficient operation depends on the availability of water, which can be affected by seasonal and climatic variations.			
		OR			
Q. 08	a	Explain principle of generation of tides The principle of generation of tides is primarily driven by the gravitational forces exerted by the Moon and the Sun on the Earth's oceans. This gravitational pull causes the water in the oceans to bulge out in the direction of the Moon, creating a high tide. As the Earth rotates, different areas of the planet move into and out of these bulges, resulting in the cyclical rise and fall of sea levels known as tides. There are two main types of tides: 1. Spring Tides : These occur when the Earth, the Moon, and the Sun are aligned, which happens during the full moon and new moon phases. The combined gravitational forces lead to higher high tides and lower low tides. 2. Neap Tides : These occur when the Moon is at a right angle to the Earth-Sun line, typically during the first and third quarters of the moon. The gravitational pull of the Sun partially offsets that of the Moon, resulting in lower high tides and higher low tides. The regular and predictable nature of tidal patterns is a significant advantage for harnessing tidal energy, as it allows for accurate forecasting of energy production. Tidal energy systems, such as tidal stream generators and tidal	L2	CO 2, CO 3, CO4	10

		barrages, exploit these predictable movements to convert the kinetic and potential energy of tides into electricity.			
	b	List advantages and disadvantages of wave energy Advantages of Wave Energy: 1. Abundant Resource: Oceans cover over 70% of the Earth's surface, providing vast areas for wave energy exploitation. 2. Consistency: Wave energy is more consistent and predictable than wind energy, as waves can be accurately forecast several days in advance. 3. Environmental Benefits: Wave energy systems have a smaller visual impact compared to other renewable energy sources and can coexist with marine activities like fishing and shipping. 4. Pollution-Free: Wave energy generates little to no pollution, making it a clean energy source. 5. Modular Design: Wave energy devices are modular and can be easily sited, allowing for additional devices to be added as needed. 6. Coastal Protection: Wave energy systems can dissipate wave energy, helping to protect shorelines from coastal erosion. 7. No Barriers to Marine Life: These systems present no barriers or difficulties for migrating fish and aquatic animals. Disadvantages of Wave Energy: 1. Technological Maturity: Many wave energy technologies are still in the experimental or early commercial stages, requiring further development. 2. Maintenance Challenges: The harsh marine environment can lead to damage or destruction of wave energy devices, resulting in higher maintenance costs. 3. Location Dependency: Wave energy conversion devices require suitable sites where waves are consistently strong, limiting their deployment. 4. Intermittent Power Generation: Power generation can be intermittent, as waves come in intervals and do not generate power during calm periods. 5. Visual Impact: There can be a visual impact from wave energy conversion devices on the shoreline and offshore. 6. High Distribution Costs: Sending generated power from offshore devices to land can incur high costs due to long underwater cables.	L2	CO2, CO 3, CO 4	10

		7. Navigational Hazards: Offshore wave energy devices can pose a threat to navigation, as they may not be easily detectable by radar.			
		Module -5 **[Download]**			
Q. 09	a	Explain with a sketch, the closed Rankine Cycle OTEC System The Closed Rankine Cycle Ocean Thermal Energy Conversion (OTEC) system is an innovative technology that harnesses the temperature difference between warm surface seawater and cold deep seawater to generate electricity. Here's a detailed explanation along with a sketch description: Closed Rankine Cycle OTEC System  Principle of Operation: 1. Warm Surface Seawater: The process begins with warm seawater, typically around 25°C to 30°C, which is pumped into an evaporator. 2. Evaporator: In the evaporator, this warm seawater heats a working fluid with a low boiling point, such as ammonia. The heat causes the ammonia to vaporize into gas. 3. Turbine: The high-pressure ammonia gas expands and drives a turbine connected to a generator, converting thermal energy into mechanical energy, which is then transformed into electrical energy. 4. Condenser: The gas then enters a condenser, where it is cooled by cold deep seawater (drawn from depths of around 1000 meters, where the temperature is approximately 4°C to 5°C). The cold seawater absorbs heat from the ammonia gas, causing it to condense back into a liquid.	L2	CO 2, CO 3, CO4	10

		5. Pump: The liquid ammonia is then pumped back to the evaporator, increasing its pressure and preparing it to absorb heat again, thus completing the cycle. Advantages of Closed Rankine Cycle OTEC: - Efficiency: This system can achieve higher efficiencies compared to open-cycle systems due to the closed nature of the working fluid. - Environmental Benefits: It generates clean energy without the direct release of seawater vapor, minimizing environmental impact. - Desalination Potential: The system can be integrated with desalination processes, providing fresh water as a byproduct. Challenges: - High Initial Costs: The construction and deployment of closed-cycle OTEC plants require significant capital investment. - Technical Complexity: The technology involves advanced materials and engineering to withstand harsh marine environments. This closed Rankine cycle OTEC system represents a promising approach to harnessing renewable energy from our oceans while addressing some of the challenges associated with energy generation.			
	b	List and explain the problems associated with OTEC The Ocean Thermal Energy Conversion (OTEC) technology faces several significant problems and challenges that can hinder its implementation and operation. Here are some of the most notable issues: 1. High Initial Costs : The construction and maintenance of OTEC plants require substantial capital investment. The costs associated with advanced materials, engineering, and marine infrastructure are high, making it difficult for OTEC to compete with other energy sources in the initial stages. 2. Technical Challenges : OTEC technology involves complex engineering and the use of materials that can withstand the harsh marine environment. Issues such as corrosion, biofouling (the accumulation of marine organisms on structures), and structural integrity are major concerns that require innovative solutions. 3. Low Efficiency : The thermal efficiency of OTEC systems is relatively low, typically around 3% to 4%, due to the small	L2	CO2, CO 3, CO 4	10

		temperature differential between warm surface water and cold deep water. This limits the amount of energy that can be generated compared to other energy generation methods. 4. Environmental Impact : OTEC can have significant ecological impacts, including disruption of marine habitats, changes in local water temperatures, and the potential release of cold, nutrient-rich water that could affect local ecosystems and biodiversity. 5. Geographic Limitations : OTEC is most viable in tropical regions where there is a significant temperature gradient between surface and deep ocean water. This geographic limitation restricts the widespread implementation of OTEC technology. 6. Energy Transmission : Transmitting electricity from offshore OTEC plants to the mainland requires undersea cables, which can be costly and complex to install and maintain. 7. Maintenance and Durability : OTEC systems operate in a marine environment that subjects them to corrosion, biofouling, and other wear and tear, necessitating regular maintenance and the use of robust materials to ensure long-term operation. These challenges highlight the need to address both technical and economic issues for OTEC to become a viable and sustainable option in the future energy landscape.			
OR					
Q. 10	a	List various sources of Geothermal Energy. What are the problems associated with Geothermal Energy Conversion. Geothermal energy can be extracted from various sources, which are primarily classified as follows: 1. Hydrothermal Resources : These are the most commonly exploited and consist of hot water and steam found in permeable rock formations. They are divided into high-temperature and low-temperature resources. 2. Geopressured Resources : Found at great depths and under high pressure, these are often associated with natural gas deposits, which can be co-produced with geothermal energy. 3. Hot Dry Rock (HDR) Resources : Also known as	L2	CO2, CO 3, CO 4	10

		Enhanced Geothermal Systems (EGS), these are found in dry rock formations with high heat content but low natural permeability. They require artificial stimulation, such as hydraulic fracturing, to create a reservoir of hot water or steam. 4. Magma Resources : These involve accessing the Earth's magma directly. They are highly experimental and not commercially viable due to extreme conditions and technical challenges. Regarding the problems associated with geothermal energy conversion, the following issues are highlighted: 1. High Initial Costs : Developing geothermal power plants involves significant investment for exploration, drilling, and construction, which can be a barrier to entry. 2. Site Specificity : Geothermal resources are geographically specific, meaning not all locations have accessible and economically viable geothermal resources, limiting their applicability. 3. Environmental and Structural Risks : The extraction of geothermal energy can lead to land subsidence, induced seismicity (earthquakes), and the release of trace gases from geothermal reservoirs, requiring careful management. 4. Resource Depletion : If not managed properly, geothermal resources can become depleted or experience a decline in productivity over time, necessitating sustainable management practices. 5. Geographical Limitations : Effective geothermal energy production is often limited to regions with high geothermal activity, such as volcanic areas or tectonic plate boundaries, which may not be accessible or feasible in many regions. These factors are crucial to consider when evaluating the potential and viability of geothermal energy as a renewable energy source.			
	b	With a neat sketch Vapour dominated Geothermal thermal power plant A vapor-dominated geothermal power plant is a type of facility that harnesses steam directly from geothermal reservoirs to generate electricity. Here's a detailed explanation of how it works:	L2	CO 2, CO 3, CO4	10

		1. Steam Extraction : The process begins with the extraction of high-pressure steam from a geothermal reservoir located deep underground. This steam is typically found in areas with significant volcanic activity, where the Earth's heat is concentrated. 2. Steam Turbine : The extracted steam is directed to a steam turbine. As the steam enters the turbine, it expands and causes the turbine blades to spin. This mechanical motion is crucial as it converts the thermal energy of the steam into mechanical energy. 3. Electricity Generation : The spinning turbine is connected to a generator. As the turbine rotates, it drives the generator, which converts the mechanical energy into electrical energy. This electricity can then be fed into the power grid for distribution. 4. Condensation : After passing through the turbine, the steam exits and enters a condenser, where it is cooled and condensed back into water. This cooling process typically involves a heat exchanger, where the steam loses its heat to a cooling medium, often water or air. 5. Reinjection : The condensed water, now in liquid form, is reinjected back into the geothermal reservoir. This step is crucial for maintaining the pressure and sustainability of the geothermal resource, ensuring that the system can continue to operate efficiently over time. 6. Closed-loop System : The entire process operates in a closed-loop system, meaning that the water is continuously cycled between the surface and the geothermal reservoir. This minimizes environmental impact and maximizes resource utilization. Advantages : - Constant Energy Supply : Vapor-dominated plants can provide a stable and continuous supply of energy, unlike solar or wind power, which can be intermittent. - Low Emissions : They produce minimal greenhouse gas emissions compared to fossil fuel-based power plants, contributing to a cleaner environment. Example : One of the most notable examples of a vapor-dominated geothermal power plant is "The Geysers" in California, which is one of the largest geothermal complexes			

		in the world, with a capacity of approximately 1.5 GW.			

Bloom’s Taxonomy Level: Indicate as L1, L2, L3, L4, etc. It is also desirable to indicate the COs and POs to be attained by every bit of questions.