UNIT – I: RENEWABLE ENERGY SYSTEMS

PART– A

1.	**Name the energy sources available.** The energy sources available can be divided into three categories. They are, • Primary Energy Sources • Secondary Energy Sources • Supplementary Energy Sources
2.	**What is meant by Primary and Secondary Energy source? Give example.** **Primary energy source :** Primary energy source can be defined as source which provides a net supply of energy. The energy that are either found or stored in nature. E.g. coal, oil, natural gas and biomass. **Secondary energy source :** The form of energy which is finally supplied to, a consumer for utilization is known as secondary or usable energy. E.g. Electrical energy, thermal energy (in the form of steam or hot water),chemical energy (in the form of hydrogen or fossil fuels),etc.,
3.	**What are the advantages of renewable energy source?** • Renewable energy sources are available in nature free of cost. • They produce no or little pollution. Thus by and large, they are environment friendly. • They are inexhaustible. • They have a low gestation period.
4.	**What is meant by renewable energy sources?** Renewable energy is energy that is collected from renewable resources, which are naturally replenished on a human timescales, such as sunlight, wind, rain, tides, waves and geothermal heat. Renewable energy often provides energy in four important areas: electricity generation, air and water heating/cooling, transportation and rural energy services.

5.	**What are the limitations of renewable energy source?** • The energy available in dilute form from the renewable energy sources. • Though available freely in nature, the cost of harnessing energy from a nonconventional source is generally high. • Availability is uncertain; the energy flow depends on various natural phenomena beyond human control. • Difficulty in transporting such forms of energy.
6.	**What is meant by commercial energy?** The energy sources that are available in the market for a definite price are known as commercial energy. The secondary usable energy forms such as electricity, petrol, diesel, gas etc., are essential for commercial activities and are categorized as commercial energy resources. The economy of the country depends on its ability to convert natural raw energy into commercial energy.
7.	**What is meant by non-commercial energy?** The energy derived from nature and used directly without passing through a commercial outlet is called a non-commercial sources. E.g., wood, animal dung cake, etc.,
8.	**What is meant by non-renewable energy source?** Non-renewable energy resource which are finite and do not get replenished after their consumption are called non-renewable. E.g., fossil fuels, uranium, coal, etc.
9.	**Are fossil fuels renewable? (NOV 2021)** Fossil fuels are a non-renewable source of energy. They are found everywhere, from the air we breathe to the water in the seas. Most of the energy used by us is obtained by the burning of fossil fuels. These fossil fuels are used up at a faster rate. They cannot be regrown at a scale compared to their consumption. With the increased demand for the production of various energies, fossil fuel energy is declining. It is difficult to replace them. That is why they are known as a non-renewable source of energy
10.	**What is meant by supplementary sources?** Supplementary sources are defined as those whose net energy yield is zero and those requiring highest investment in terms of energy insulation (thermal) is an example for this source.

11.	**What are the factors causing winds?** Winds are caused from two main factors : • Heating and cooling of the atmosphere which generates convection currents. Heating is caused by the absorption of solar energy on the earth's surface and in the atmosphere. • The rotation of the earth with respect to atmosphere, and its motion around the sun.

12.	**What are the features of wind energy?** The characteristics of wind energy are : • It is renewable source of energy • Like all forms of solar energy, wind power systems are non-polluting, so it has no adverse influence on the environment. • Wind energy systems avoid fuel provision and transport. • On a small scale, up to a few kilowatt system, is less costly.
13.	**What are the problems associated with wind energy?** The problems associated with wind energy are : • Wind energy available is dilute and fluctuating in nature. Because of the dilute form, conversion machines have to be necessarily large. • Wind energy need storage means because of its irregularity. • Wind energy systems are noisy in operation; a large unit can be heard many kilometers away. • Large areas are needed to install wind farms for electrical power generation.
14.	**Name the three categories of biomass resources.** Biomass resources fall into three categories : • The first category is to burn the biomass directly and get the energy. • The second category, the biomass is converted into ethanol and methanol to be used as liquid fuels in engines. • The third category is to ferment the biomass an aerobically to obtain a gaseous fuel called biogas.

15.	**Define heliostats.** In solar tower concentration system (tower power concept)the incoming solar radiation is focused to a central receiver or a boiler mounted on a tall tower using thousands of plane reflectors which are steerable about two axes are called heliostats.
16.	**Define energy yield ratio.** The energy yields ratio of an energy extraction process is defined as follows : Energy yield ratio = (Energy received from raw energy source) / (Energy spent to obtain raw energy source).
17.	**State the importance of non-conventional energy source.** • The demand of energy is increasing by leaps and bounds due to rapid industrialization and population growth, and hence the conventional sources of energy will not be sufficient to meet the growing dem and. • Conventional sources (except hydro) are non-renewable and are bound to finish up one day. • Conventional sources (fossil fuels, nuclear) also cause pollution; thereby their use degrades the environment. • Large hydro resources affect wildlife, cause deforestation and pose various social problems. • In addition to supplying energy, fossil fuels are also used extensively as feed stock materials for the manufacture of organic chemicals. As reserve deplete, the need for using fossil fuels exclusively for such purpose may become greater.
18.	**What is meant by energy conservation?** Energy conservation means reduction in energy consumption but without making any sacrifice in the quality or quantity of production. In other words, it means increasing the production from a given amount of energy input by reducing losses/wastage and maximizing the efficiency.

19.	**List the necessity of energy storage.** • The effective utilization of intermittent and variable energy source such as sunlight, wind, etc., often requires energy storage • Storing the energy and transporting it economically to a load centre. • The vehicle must carry its energy supply, the storage system must be readily transportable • Energy storage is also required for load leveling in an electric utility to reduce the overall cost of generating electrical power.
20.	**Define energy utility factor.** The relation between useful thermal energy and the available chemical energy in the fuel is expressed by means of the energy utility factor. Energy utility factor = Useful thermal energy/ Available energy in fuel
21.	**What are the needs of energy conservation?** • Energy conservation is necessary to reduce the wastage of energy. • It helps to keep the domestic charge payment constant even when the production cost of electricity increase.
	• It helps to maintain the profit in industries uniform even if the electricity charge increases.
22.	**What are the applications of solar energy?** • Heating and cooling residential building • Solar water heating • Solar distillation • Solar engines for water pumping • Food refrigeration.
23.	**What are the types of wind mills?** • Multi blade type • Sail blade type • Propeller type • Savonius type and • Darrieus type.

24.	**What are the draw backs on bio gas?** • Biomass combustion produces air pollution • Large scale production of biomass and its harvesting accelerate soil erosion and nutrient. • Domestic use of biomass in rural areas creates air pollution.
25.	**What are the environmental concerns of geo thermal energy?** • Gases containing H_2S are oxidized to SO_2 and H_2SO_4 and drops down as acid rain. • Chemicals like sulphates, chlorides and carbonates of lead, boron and arsenic pollute soil and water. • Discharge of waste hot water infects rivers and affect drinking water, farming and fisheries. • Noise pollution caused by exhausts is a health hazard and is controlled by using silencers.
26.	**What are the adverse effects produced by geo thermal energy source?** • Ammonia is used as working fluid in closed cycle OTEC system. Its leakage may cause great damage to the ocean eco system. • An OTEC plant displaces 4 cumec water/ MW generation. Massive flow disturbs thermal balance, changes salinity gradient and turbidity. It creates adverse impact on marine environment. • Mining of warm and cold water near the surface develops convection of sinking cold water. It triggers thermal effects, i.e., variation in temperature by 4 °C forcing mortality among coral and fines. • Ammonia is used as working fluid in closed cycle OTEC system; its leakage may cause great damage to the ocean ecosystem.
27.	**Define energy efficiency.** **(NOV 2021)** It is a measure of how efficiently an appliance, building, organization or country uses energy. Being energy-efficient is the opposite of wasting energy. It simply means using less energy to perform an action. A example of an energy-efficient device is the simple lightbulb. Traditional 60W incandescent bulb wastes most of its energy in heat, but modern, energy-saving LED light bulbs use far less energy to create the same amount of light – with 90% of the energy being used for light

PART – B

1.	Explain in detail about various RE sources available.
2.	Explain the formation of coal, natural gas and petroleum.
3.	Explain present Indian and international energy scenario of conventional and RE sources.
4.	What are the conventional and non-conventional energy sources? Describe the fossil fuels as the conventional energy sources. (N/D 2021)
5.	Give brief review of various sources of renewable energy. Describe the energy scenario of India. (N/D 2021)
6.	Explain the working of Pyranometer and Pyrheliometer with the help of neat sketch. (N/D 2021)
7.	Describe the various renewable energy resource available in india and its potential to supplement the conventional energy sources. (N/D 2020)
8.	Discuss the present status of world energy scenario. Criticize the energy planning issues aiming to bridge the gap between the energy demand and supply situation in india. (N/D 2020)

UNIT-II WIND ENERGY

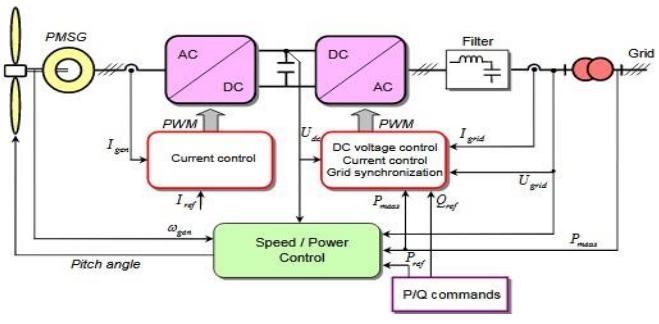
PART-A

1. What are the features necessary for the wind turbine site ?

The features necessary for the wind turbine site are,

- No tall obstructions for some distance in the upwind direction and also as low roughness as possible in the same direction.
- A wide and open view i.e., open plains, open shore line or offshore locations.
- Top of smooth well-rounded hill with gentle slopes on a flat plain.
- An island in a lake or the sea.
- A narrow mountain gap through which wind is channelized.
- Site reasonably close to power grid.
- Soil conditions must be such that building of foundations of the turbines and transport of road- construction materials loaded in heavy trucks is feasible.

2.	**Mention the factors which determine the power in wind. (Nov. 2020)** Power in the wind is given by the equation, $P = 0.5*\rho*A*V^3$ Where: P = Power in Watts; ρ= Air Density in Kg/m³ (about 1.225Kg/m³ at sea level, less higher up); A = Rotor Swept Area in m² = πr² (r= radius or blade length); V = Wind Speed in m/s (cubed) The factors which determine the power in the wind are the air density, rotor swept area, wind speed.
3.	**What are the merits and demerits of three blade rotor over two blade rotors ?** **Merits** • Compared to the two blade design, the three blade machine has smoother power output and balanced gyroscopic force.

	• The two blade rotor is also simpler to erect. **Demerits** • Adding a third blade increases the power output by about 5 %only, while the weight and cost of a rotor increases by 50 %,thus giving a diminished rate of return for additional 50 %weight and cost.
4.	**What are the types of generator drive for the operation of wind energy conversion system ?** The types of generator suitable for the wind generations are : • DC generator • Synchronous generator • Induction generator
5.	**Draw the schematic diagram of grid integrated PMSG based WECS.** **(NOV 2021)** 

6.	**Define power coefficient.** The fraction of the free flow wind power that can be extracted by a rotor is called the power-coefficient. Power coefficient = Power of wind turbine/Power available in the wind.
7.	**What are the features of vertical axis wind turbine ?** The features of vertical axis wind turbine : • It can accept wind from any direction, eliminating the need of yaw control. The gearbox, generator, etc., are located at the ground, thus eliminating the heavy nacelle at the top of the tower, thus simplifying the design and installation of the whole structure, including the tower. • It also reduces the overall cost.
8.	**List out the demerits of wind energy conversion system.** Wind energy available in dilute and fluctuating in nature.

	• Wind energy needs storage capacity because of its irregularity. • Wind energy systems are noisy in operation; a large unit can be heard many kilometers away. • Large areas are needed, typically, propellers 1 to 3 m in diameter, deliver power in the 30 to 300 W range.
9.	**What are the components of wind turbine generator units ?** A wind turbine unit consists of the following major assemblies : • A wind turbine with vertical axis or horizontal axis. • Gear chain. • An electrical generator(synchronous or asynchronous(induction))Associated civil works, electrical and mechanical auxiliaries, control panels etc.,

10.	**How the wind mills are classified? (Nov.2020)** There are different types of windmills, Which windmill to use is dependent on the requirement. • Post mill. • Smock mill. • Tower mill. • Fan mill.
11.	**Define wind turbine.** A wind turbine which converts wind power into rotary mechanical power. A wind turbine has aerofoil blades mounted on the rotor. The wind drives the rotor and produces rotary mechanical energy.
12.	**What is cut in speed and cut out wind speeds for turbine ?** **Cut in speed** Wind speed at which wind turbine starts delivering shaft power. Cut in speed : □ While operating - 7 m/s □ While stopping - 5 m/s **Cut out speed** At high velocities during storms, it is necessary to cut out the power conversion of wind turbine by furling the wind turbine blades. The speed at which power conversion is cut out is called cut out wind speed or furling wind speed. Cut out speed : □ While operating - 20 m/s □ While stopping - 17 m/s □ Rated speed - 14 m/s

13.	**Name the characteristics in which the speed of a wind turbine rotor depends.** The speed of a wind turbine rotor depends principally on, • Wind speed • Pitch of the turbine blades • Mechanical and electrical load i.e., shaft load, friction, breaking force etc., □ Orientation of yaw with reference to the wind.

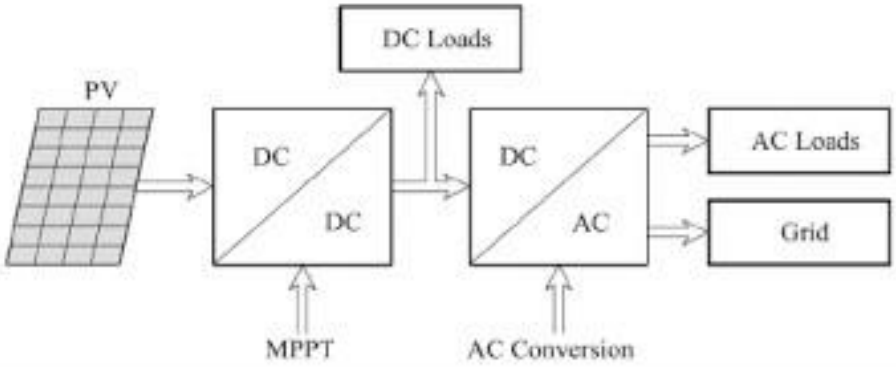
14.	**Mention the advantages of vertical axis wind turbine over horizontal axis.** Vertical axis wind turbine will react to wind from any direction and therefore do not need yawing equipment to turn the rotor into the wind. They can require less structural support because heavy components can be located at ground level. This configuration also eases installation and maintenance. Since the blades do not turn end over end, the rotor is not subjected to continue cyclic gravity loads.
15.	**What are the factors considered for the electrical generators and control method ?** The choice of an electrical generator and control method can be considered by following three methods : • The basis of operation i.e., either constant tip speed or constant tip speed ratio. • The wind power rating of the turbine. • The type of load demand e.g. battery connection.
16.	**What are the main environmental aspects due to wind turbines ?** The main environmental aspects are : • Indirect energy use and emissions • Bird life • Noise • Visual impact • Telecommunication interference Safety effects on ecosystem.
17.	**What are the types of rotors for horizontal axis wind turbine ?** The different types of rotor for horizontal axis wind turbine are : • Single blade rotor Two blade rotor Three blade rotor Sailing rotor • Chalk multi blade rotor American multi blade rotor. Dutch type rotor.

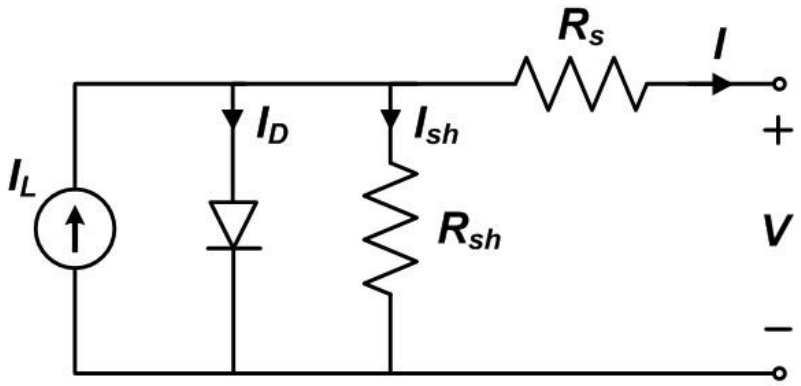
18.	**What are the types of rotors for vertical axis wind turbine ?** The different types of rotor for vertical axis wind turbine are : Cup type rotor Savonious rotor Darrieus rotor Musgrove rotor Evans rotor.

19.	**List the components of wind energy systems.** The components of wind energy systems are blades, rotor, pitch, brake, low speed shaft, gear box, generator, controller, anemometer, wind vane, nacelle, high speed shaft, yaw drive, yaw motor and tower.
20.	**What is the principle of wind energy conversion?** The wind has kinetic energy (movement energy) which is changed into mechanical energy by the blades on the turbine. The turbine then turns a generator which creates electrical energy (voltage). The turbine is usually connected by a gearbox to help control the speed it turns the generator.
21.	**Write the wind power equation. (NOV 2021)** The wind power equation is expressed as follows: $P = 0.5*\rho*A*V^3$ Where: P = Power in Watts; ρ= Air Density in Kg/m³ (about 1.225Kg/m³ at sea level, less higher up); A = Rotor Swept Area in m² = πr² (r= radius or blade length); V = Wind Speed in m/s (cubed)
22.	**What are the types of wind power plants ?** The types of wind power plants are, • Remote • Hybrid • Grid connected system.
23.	**What are the advantages of wind energy systems ?** • Inexhaustible fuel source • No pollution • Often an excellent supplement to other renewable sources • Reduces fossil fuel consumption • Wind power plant create many jobs • Increases local tax revenues • Least reliance on foreign oil

24.	**What are the disadvantages of wind energy systems ?** The disadvantages of wind energy systems are, • Large areas are needed. • Relatively expensive to maintain. • Large numbers of wind generators are required to produce useful amount of heat or electricity.
25.	**What are the safety systems in wind energy system ?** • The computer • Emergency stop • Revolution counters • Lightning arresters are the safety systems.
	PART-B
1.	Explain in detail about the construction and components of Wind energy conversion system (WECS).
2.	Explain various types of wind power plants.
3.	Explain the working and operation of doubly fed induction generator based WECS with neat block diagram.
4.	(i) Clearly explain the principle of WECS with neat block diagram. **(Nov. 2020)** (ii) Discuss the various considerations taken into account for site selection of a wind energy system. **(Nov. 2020) (NOV 2021)**
5.	**(i)** Explain the peak power tracking scheme in WECS. **(Nov. 2020)** **(ii)** Explain the working of grid tied WECS with neat diagram. **(Nov. 2020)**
6.	Wind at 1 standard atmospheric pressure and 15°C temperature has a velocity of 10 m/sec. The turbine has diameter of 120 m and its operating speed in 40 rpm at maximum efficiency, Calculate : i) The total power density in the wind stream ii) The maximum obtainable power density assuming η = 40% iii) The total power produced in kW iv) The torque and axial thrust. **(Nov. 2020)**
7.	Explain in detail about Type A and Type B wind power plants. **(NOV 2021)**

8.	Calculate the power converter from the wind, if Blade length, l=52m, wind speed, V=12m/sec, Air density, ρ=1.23kg/m3 and Power coefficient, Cρ=0.4. Calculate the length of blade that would be needed to produce the same power by a marine turbine as produced by the wind turbine in the above problem. Take density of water as 1000kg/m3.**(NOV 2021)**

UNIT III SOLAR PV AND THERMAL SYSTEMS	
PART – A	
1.	**What is meant by solar energy?** The energy received in the form of radiation, can be converted directly or indirectly into other forms of energy, such as heat and electricity, which can be utilized by man. The total amount of solar energy received on Earth is vastly more than the world's current and anticipated energy requirements.
2.	**Draw the block diagram of solar photo voltaic system. (Nov/Dec 2017, April/May 2018, NOV 2021)** 

3.	**Draw the equivalent circuit diagram of solar cell.** 

4.	**Define solar time.** Solar time (Local Apparent Time) is measured with reference to solar noon, which is the time when the sun is crossing the observer's meridian. Solar time = Standard time ± 4 (Lst – Lloc) +E Where Lst = Standard longitude Lloc = Longitude of the observer's location E = Equation of time diffused radiation is known as global radiation.
5.	**What is meant by solar collector ? Mention its types.** A solar collector is a device for collecting solar radiation and transfers the energy to a fluid passing in contact with it. There are two types of collectors : • Non- concentrating or flat plate type solar collector. • Concentrating (focusing) type solar collector.
6.	**Mention the ways by which solar energy can be utilized.** Solar energy can be utilized directly in two ways : • By collecting the radiant heat and using it in a thermal system. • By collecting and converting it directly to electrical energy using a photovoltaic system.

7.	**What are the indirect forms of solar energy ?** • Wind energy • Biomass energy • Tidal energy • Ocean wave energy • Ocean thermal energy • Fossil fuels and other organic chemicals Hydro energy.
8.	**What are the performance indices of a solar collector ?** The performance indices of a solar collector are, **Collector efficiency** is defined as the ratio of the energy actually absorbed and transferred to the heat transport fluid by the collector(useful energy) to the energy incident on the collector. **Concentration ratio** is defined as the ratio of the area of aperture of the system to the area of the receiver. The aperture of the system is the projected area of the

	collector facing (normal) the beam. Temperature range is the range of temperature to which the heat transport fluid is heated up by th e collector.
9.	**Name the basic design of solar cookers.** The four basic designs of the solar cookers are : • Box type solar cooker • Dish type solar cooker • Community solar cooker Advanced solar cooker.

10.	**List out the advantages and disadvantages of air flat plate collector.** **Advantages of flat plate air heating collector are,** • It is compact, simple in construction and requires little maintenance. • The need to transfer thermal energy from the working fluid to another fluid is eliminated as air is used directly as the working fluid. • Corrosion is completely eliminated. • Leakage of air from the duct is less severe. • Possibility of freezing of working fluid is also eliminated. • The pressure inside the collector does not become very high. **Disadvantages of flat plate air heating collector are,** • A large amount of fluid is to be handled due to low density. As a result, the electrical power required to blow the air through the system can be significant if the pressure drop is not kept within prescribed limits. • Heat transfer between the absorber plate and air is poor. • There is less storage of thermal energy due to low heat capacity.
11.	**What is meant by solar pond ?** A natural or artificial body of water for collecting and absorbing solar radiation energy and storing it as heat. Thus a solar pond combines solar energy collection and sensible heat storage.
12.	**What is meant by solar photo voltaic effect ?** The direct conversion of solar energy into electrical energy by means of the photovoltaic effect, that is, the conversion of light (or other electromagnetic radiation) into electricity. The photovoltaic effect is defined as the generation of an electromotive force as a result of the absorption of ionizing radiation.

13. List the applications of solar PV system.

- Water pumping sets for micro irrigation and drinking water supply
- Radio beacons for ship navigation at ports
- Community radio and television sets
- Cathodic protection of oil pipe lines
- Weather monitoring
- Railway signalling equipment .

14. Why the efficiency of solar thermal power generation is lesser than other systems? (Nov 2020)

Solar thermal energy generation system is characterized by simple system, thermal conductivity direct usage to generate steam. Though its construction and maintenance cost is relatively low than other systems, its focus is relatively small and temperature rise is limited and heat loss during operation is relatively large.

Therefore efficiency of solar thermal generation is less than other systems.

15. Name the types of concentrating collectors.

The main types of concentrating collectors are :

- Parabolic trough collector
- Mirror strip reflector Fresnel lens collector
- Flat plate collector with adjustable mirrors Compound parabolic concentrator (CPC).

16. What are the merits of solar cooker ?

- No attention needed while cooking
- No fuse required
- Negligible maintenance cost
- No pollution
- Vitamins of food are not destroyed No overflowing.

17. Indicate the instruments for measuring solar radiation and sun shine. (NOV 2021)

There are two important types of instruments to measure solar radiation:

Pyrheliometer is used to measure direct beam radiation at normal incidence.

Pyranometer is used to measure total hemispherical radiation - beam plus diffuse - on a horizontal surface.

Photoelectric sunshine recorder: The device has two selenium photovoltaic cells, one of which is shaded, and the other is exposed to the available solar radi ation. When there is no beam radiation, the signal output from both cells is similar, while in bright sunshine, signal difference between the two cells is maximized. This technique can be used to monitor the bright sunshine hours.

18. Write the difference between beam radiation and diffuse radiation?

Beam radiation is the radiation which moves through the atmosphere in a straight line without being scattered, reflected or absorbed by particles in the air.

Diffuse Radiation is the solar radiation which is being scattered, reflected or absorbed by the particles while passing through the atmosphere but ultimately reaches the earth's surface.

19. What are the basic components of solar pumping system ?

- The solar collector
- The heat transfer system Boiler or heat exchanger Heat engine.

20. Differentiate flat plate collectors and concentrating collectors.

Flat plate collectors	**Concentrating type collectors**
Absorber area is large.	Absorber area is small.
Concentration ratio is 1.	Concentration ratio is high.
It uses both beam and diffuse radiation.	It uses mainly beam radiation.
Application limited to low temperature uses suitable for all places as it can work in clear and cloudy days.	High temperature application such as power generation suitable where there are more clear days in a year.
Simple in maintenance.	Difficult in maintenance.

21.	**What are the advantages of solar cells ?** Advantages of solar cells are,
	• They need little maintenance. • They have longer life. • They do not create pollution problem. • Their energy source is unlimited. • Easy to fabricate. • They can be made from raw materials which are easily available in larger quantities.
22.	**What is battery sizing?** (i)The battery type recommended for using in solar PV system is deep cycle battery. Deep cycle battery is specifically designed for to be discharged to low energy level and rapid recharged or cycle charged and discharged day after day for years. The battery should be large enough to store sufficient energy to operate the appliances at night and cloudy days. (ii) Sizing a stationary battery is important to ensure that the loads being supplied or the power system being supported are adequately catered by the battery for the period of time (i.e. autonomy) for which it is designed. Improper battery sizing can lead to poor autonomy times, permanent damage to battery cells from over-discharge, low load voltages, etc.
23.	**What are the two types of flat plate collectors ?** The two types of flat plate collectors are, □ Liquid heating collectors □ Solar air heaters.
24.	**What is concentration ratio ?** Concentration ratio is the ratio of solar radiation entering the collector to solar radiation received by the receiver. It represents the system's ability to concentrate solar energy.

25.	**List the advantages of solar energy.** • It is free from pollution. • The plant requires little maintenance or help after set up. • It is economical. • They collect solar energy optically and transfer it to a single receiver thus minimizing thermal energy transport requirement.
	Concentration ratio is 300 to 1500 and are highly efficient both in collecting energy and in converting energy.
	PART-B
1.	Describe in detail about the different methods of solar energy storage systems.
2.	Explain and derive expression for beam and diffuse radiation.
3.	Demonstrate the working of a pyrheliometer & Pyranometer.
4.	Describe extra terrestrial and terrestrial solar radiation.
5.	With the help of schematic diagram, explain the working of solar pond. (N/D 2021)
6.	With the help of block diagrams, explain the operations of stand-alone and grid interactive solar PV systems. (N/D 2021)
7.	With a schematic diagram explain the structure of medium temperature solar power plant. Explain the working of solar water pumping system. (N/D 2020)
8.	Explain the algorithm for maximum power point tracking. also discuss the necessary conditions while synchronizing the PV system with grid supply. (N/D 2020)

UNIT-4 BIOMASS ENERGY	
PART-A	
1.	**What is meant by biomass energy and biomass energy resource?** Organic matters derived from biological organisms are called biomass. The energy obtained from biomass is called biomass energy. The raw organic matter obtained from nature for extracting secondary energy is called biomass energy resource.
2.	**Classify the biomass resources.** Biomass resources are broadly classified into two categories : Biomass from cultivated fields, crop and forest.

	□ Biomass derived from waste e.g., municipal waste, animal excreta/dung, forest waste, agricultural waste, bioprocess waste, butcharry waste, fishery waste/processing waste etc.,
3.	**What do you mean by fossil fuels ?** Fossil fuels (coal, petroleum oil and natural gases) are produced from dead, buried biomass under pressure and in absence of air during several millions of years. However; they are considered separately as fossils and are not included in the category of biomass.
4.	**What are the categories of scope of biomass energy ?** The scope of biomass energy is of three categories. They are, • Rural application of biomass energy • Urban and industrial applications of biomass energy • Biomass as a primary source for large scale electrical power generation.
5.	**List the secondary energy forms of biomass.** The biomass can be converted to useful secondary energy forms such as, □ Heat □ Gaseous fuels □ Solid fuels □ Organic chemical □ Liquid fuels.
6.	**Point out the cultivated biomass.** The cultivated biomass (biomass from energy farms) includes : • Sugar cane crops, sweet sorghum crops, sugar beets. • Herbaceous crops which are non-woody plants which can be converted into biogas or biochemical fuels. • Cereals, potatoes and other carbohydrate fruit crops, etc. grown for producing in feeds to the fermentation plants. • Forests crops of fast growing energy intensive trees specially grown as source of energy. • Aquatic crops grown in fresh water, sea water, muddy water etc., and these crops include submerged plants, surface plants and include seaweeds, marine algae, water hyacinth, floating kelp etc. algae is considered to be a promising aquatic biomass.

7.	**List out the biomass energy resources from waste.** The waste to energy processes convert organic wastes to intermediate or secondary energy forms such as heat, biogas, alcohol, fuels, chemicals, etc. The waste is classified as urban (municipal) waste industrial organic waste, process waste

	agricultural farm waste rural animal waste forest waste fishery, poultry, butcharry waste Animal and human excreta
8.	**What is meant by biogas plant?** The plant which converts biomass to biogas (methane plus carbon dioxide) by the process of anaerobic digestion is generally called a biogas plant.
9.	**Mention the advantages and disadvantages of biomass energy.** **Advantages of biomass energy:** It is a renewable source. The energy storage is an in-built feature of it. It is an indigenous source requiring little or no foreign exchange. The forestry and agricultural industries that supply feed stocks also provide substantial economic development opportunities in rural areas. The pollutant emissions from combustion of biomass are usually lower than those from fossil fuels. **Disadvantages of biomass energy:** It is a dispersed and land intensive source. It is often of low energy density. It is also labour intensive and the cost of collecting large quantities for commercial application is significant. Most current commercial large quantities for commercial application are significant. Most current commercial applications of biomass energy, use material that has been collected for other reasons, such as timber and food processing residues and urban waste. Capacity is determined by availability of biomass and not suitable for varying loads. Not feasible to set up at all locations
10.	**Classify the biogas plant.** The biogas plant are classified into • Continuous and batch types • The dome and drum types.
11.	**What is meant by biomass gasification?** The word gasification (or thermal gasification) implies converting solid fuel into a gaseous fuel by thermo chemical method without leaving any solid carbonaceous residue.

12.	**List the factors affecting bio digestion or generation of gas. (Nov 2020)** The factors affecting bio digestion or generation of gas are: pH or the hydrogen-ion concentration Temperature Total sold content of the feed material Loading rate Seeding Uniform feeding Nutrients Type of feed stocks Toxicity due end product Pressure Acid accumulation inside the digester

13.	**Where the biogases are mainly utilized?** The biogas can be utilized effectively for Household cooking Lighting Operating small engines Utilizing power for pumping water Chaffing fodder Grinding flour.
14.	**List the feature of continuous plant.** It will produce gas continuously. It requires small digestion chambers. It needs lesser period for digestion. It has less problems compared to batch type and it is easier in operation.
15.	**List the features of batch plant.** • The gas production in it is intermittent, depending upon the clearing of the digester. It needs several digesters or chambers for continuous gas production, these are fed alternatively. • Batch plants are good for long fibrous materials. • This plant needs addition of fermented slurry to start the digestion process. This plant is expensive and has problems comparatively; the continuous plant will have less problems and will be easy for operation.

16. Write the advantages and disadvantages of floating drum plant.

Advantages:

- It has scum troubles because solids are constantly submerged.
- In it, the danger of mixing oxygen with the gas to form an explosive mixture is minimized.
- No problem of gas leakage.
- Constant gas pressure.

Disadvantages:

- It is costlier since cost is dependent on steel and cement.
- Heat is lost through the metal gas holder, hence it troubles in colder regions and periods
- Gas holder requires painting once or twice a year, depending on the humidity of the location.
- Flexible pipe joining the gas holder to the main gas pipe requires maintenance, as it is damaged by ultraviolet rays in the sun.

17. Mention some advantages and disadvantages of fixed dome type plant.(Nov 2021)

Advantages:

- It is cheaper as compared to floating drum type, as it uses only cement and no steel.
- It has no corrosion trouble.
- Heat insulation is better as construction is beneath the ground.
- Temperature will be constant.
- Cattle and human excreta and long fibrous stalks can be fed.
- No maintenance.

Disadvantages:

- This type of plant needs the service of skilled masons, who are rather scarce in rural areas.
- Gas production per cubic meter of the digester volume is also less.
- Scum formation is a problem as no stirring arrangement.
- It has variable gas pressure.

18.	**What are the techniques or methods of maintaining biogas production ?** The methods for maintaining biogas production are, □ Insulating the gas plant □ Composting □ Hot water circulation □ Use of chemicals □ Solar energy systems.
19.	**What is meant by cogeneration?** A procedure for generating electric power and useful heat in a single installation is known as cogeneration. Heat may be supplied in the form of steam, hot water or hot air. The net result is overall increase in the efficiency of fuel utilization.
20.	**Mention the types and explain the cogeneration principles.** Types of cogeneration principles are : **The Topping Cycle:** Primary heat is used to generate high pressure and temperature steam for electrical energy generation. The discharged low grade heat, which would otherwise be dispersed to the environment, is utilized in an industrial process or in other ways. **The Bottoming Cycle:** Primary heat at high temperature is used directly for industrial process requirements. The remaining low grade heat is then used for electrical power generation, e.g. high temperature cement kiln.

21.	**What are the three general types of cogeneration systems?** The three general types of cogeneration principles systems are : • Waste heat utilization, o Space heating and cooling o Warm water in agriculture o Warm water in aquaculture • Total/Integrated energy system for residential complex □ Total Energy System (TES) for industry.
22.	**What is meant by incineration ? (Nov 2021)** Organic matter can be burnt in presence of oxygen/air to produce heat and by products. This is the well known process called combustion. Complete combustion to ashes is called incineration.

23.	**What are the advantages of bio-diesel as engine fuel?** • Biodegradable produces 80 % less CO_2 and 100 % less SO_2 emissions Renewable • Higher octane number • It can be used as neat fuel or mixed in any ratio with petro diesel It has a higher flash point making it safe to transport.
24.	**Write any two benefits of cogeneration. (Nov 2020)** Increased efficiency of energy conversion and use. • Lower emission to the environment in particular of CO_2, the main greenhouse gas. • Biomass fuels and some waste materials such as refinery gases, agricultural wastes are used. They serve as fuels for cogeneration schemes increases the cost effectiveness and reduces the need for waste disposal.
25.	**What are the types of cogeneration system?** There are three types of cogeneration systems. They are • Steam turbine cogeneration system • Gas turbine cogeneration system • Reciprocating engine cogeneration system.

	PART-B
1.	Write short notes on: a) Energy from industrial and municipal waste b) Applications of bioenergy.
2.	What is the principle involved in the production of biogas and what is the chemical composition of the gas? What are the various applications of this gas? Draw a sketch to illustrate the constructional features of a typical biogas plant and describe its operation.
3.	Draw schematic diagram of biogas power plant and explain its operation. State and justify the potential of this in satisfying energy demand of our country.
5.	With the help of neat sketch, explain the working of floating drum type biogas plant. (N/D 2021)

6.	What is geothermal energy? Explain the working principle of a geothermal power plant with the help of a neat sketch. (N/D 2021)
7.	Explain briefly the components of a biogas plant. Explain with neat diagram the working of a cogeneration plant. (N/D 2020)
8.	Explain with neat diagram the working of a geothermal power plant. With neat layout explain the working of hydroelectric power plant. (N/D 2020)

UNIT- V OTHER ENERGY SOURCES	
PART-A	
1.	**What is meant by tidal current energy?** Tidal currents are the flow of water during changing tidal level. The tidal currents flow in horizontal direction and have kinetic energy. This energy is called tidal current energy.
2.	**What is meant by tidal current?** The tidal rise and fall of water is accompanied by periodic horizontal to and fro motion of water called tidal currents.
3.	**Define tidal range.** The tidal range is the difference between consecutive high and low tide water levels. It is denoted by R, unit is meter. R = (High tide level) – (Low tide level) m
4.	**Define the following terms a) Spring tides b) Neap tides.** **a) Spring tides:** The tidal range is maximum on full moon and new moon and such tides are called spring tides. **b) Neap tides:** The tidal range is minimum on first quarter and third quarter moon and such tides are called the neap tides.
5.	**List out the limitations of tidal energy.** The main limitations of tidal energy are, □ Economic recovery of energy from tides is feasible only at those sites where energy is concentrated in the form of tidal range of about 5 m or more and the geography provides a favourable site for economic construction of a tidal plant. Thus it is site specific.

	• Due to mismatch of lunar driven period of 12 hours 25 min and human (solar) period of 24 hours, the optimum tidal power generation is not in phase with demand. • Changing tidal range in two-week periods produces changing power. • The turbines are required to operate at variable head. • Requirement of large water volume flow at low head necessitates parallel operation of many turbines. • Tidal plant disrupts marine life at the location and can cause potential harm to ecology.
6.	**List out the advantages of small hydro schemes.** • Small hydro plants can be tailored to the needs of the end use market within the limits of water resources available. • It serves to enhance economic development and living standards, especially in remote areas with limited or no electricity at all. • It has a short gestation period. • There is no need of long transmission lines because the output is consumed near the source. • High performing electrical equipment can be easily found in the market.
7.	**List out the disadvantages of small hydro schemes.** • Hydro systems, unlike solar components for example, do require some maintenance. • The quality of output of small power stations is not as good as that of bigger ones as these power plants are generally designed on the basis of short term raw data. Thus, the ground conditions of operation are much different from those considered for the design. • Spilling of water over spillways can result in super saturation of water with gases from the air. The gas bubbles absorbed into fish tissues, may cause damage and ultimately kill the fish. • In the absence of adequate hydrological and geological data, there are always uncertainties about their potential as a resource.

8.	**Mention the components of micro hydro scheme.** The main components of micro hydro scheme are, (i) Diversion weir (ii) Water conductor system with regulating gates and spillways (iii) Desilting tank with
	spillway, (iv) Headrace channel, (v) Forebay tank with desilting basin and spillway, (vi) Penstock (vii) Power house and (viii) Tail race channel.
9.	**Define the following terms a) Forebay b) Penstock c) Tailrace.** **a) Forebay** - A Forebay is a temporary storage of water (pond age), to be finally utilized for energy generation. The storage size ranges from 2 minutes to 6 hours depending on the economic justifiability. **b) Penstock -** A penstock is water conduit joining a forebay and a turbine. Penstock can be made of steel pipes, hume pipes and PVC pipes depending on the design pressure. **c) Tailrace -** Tailrace is a simple water channel to transport discharge from the turbine back to the river with maximum flow of 1 m/s.
10.	**What are the kinds of geothermal resources ?** There are five kinds of geothermal resources. They are : • Hydrothermal convective systems. o Vapour dominated or dry steam fields. o Liquid dominated system or wet steam fields and o Hot water fields. • Geo pressure resources • Petro-thermal or Hot Dry Rocks(HDR) • Magma resources Valcanoes.
11.	**What is meant by OTEC?** The temperature gradient can be utilized in a heat engine to generate power is called as Ocean Thermal Energy Conversion(OTEC).This energy has very low efficiency and has very high capital cost, because the temperature difference is small even in tropics

12.	**List the peculiarities of ocean thermal energy conversion system. (Nov 2020)** Ocean thermal energy conversion system (OTEC) is a process that can produce electricity by using the temperature difference between deep cold sea water and warm tropical surface waters. OTEC plants pumps large quantities of deep cold sea water and surface water to run a power cycle and produce electricity.

	• OTEC is a firm power (24/7) system • It is a clean energy sources • It is environmentally sustainable • It is capable of providing massive levels of energy. These are the peculiarities of OTEC Systems.
13.	**Mention some advantages of fuel cells.** • It is quiet in operation . • Less pollutant. • Conversion efficiency is more due to direct single stage energy conversion. Fuel cell plant can be installed near the point of use, thus transmission and distribution losses are avoided. • Fuel cell plants are compact and require less space. • No charging is required.
14.	**What is meant by stirling engine?** A stirling engine is a mechanical device which operates on a closed regenerative thermodynamic cycle, with cycle compression and expansion of the working fluid at different temperature levels and where the flow is controlled by volume changes, so that there is a net conversion of heat to work or vice versa.

15.	**Mention some uses of Stirling engine.** Uses of stirling engine are : Automobile engine o Low air pollution levels that are possible o Low noise levels because there are no explosions as in internal combustion engines and o Ability to use a variety of fuels such as natural or synthetic gaseous or liquid hydrocarbons, stored in solar energy, or even possibly powdered coal Stationary engine.
16.	**What are the types of tidal power plants?** • Single basin single effect plant • Single basin double effect plant • Double basin with linked basin operation Double basin with paired basin operation.

17.	**What are the advantages and disadvantages of tidal plant?** **Advantages:** • Tidal power is predictable. • It is free from pollution. • It is inexhaustible and is a renewable source of energy. • Does not require valuable land as they are located on sea sources. • Tidal power with thermal plant can meet the load demand. • After the capital power is paid off , the cost of power generated is very low. • Tidal power is firm not changes seasonally. **Disadvantages:** • Tidal power plant output varies with the variation in tidal range. • Tidal power supply is intermittent. • Capital cost of plant is not economical compared to conventional sources of energy • Slitting of basins is a problem with tidal power plants

18.	**What are the advantages and disadvantages of wave energy generation?** **Advantages:** • It is a free and renewable energy source. • Wave power devices use less land than solar and wind. • Devices are pollution free. Remove energy from the waves; leave the water in a placid state. • The degree of power concentration effected by waves is large. **Disadvantages:** • Wave energy equipment must be capable of withstanding very reverse peak stress and storms. • Wave energy equipment's are complicated. • Capital investment, cost of maintenance repair and replacement growth of biological organisms are other problems. • Energy is available on the ocean. The extraction equipment must be operated in a marine environment.

19.	**Define lamberts law of absorption.** Each water layer of identical thickness absorbs an equal fraction of light that passes through it. The intensity of heat decreases with the increase in water depth.
20.	**What is Bio fouling?** The raw ocean water which is pumped in for evaporator and condenser contains microorganisms which stick on the water side of both the heat exchangers. This biological impurity of sea water that deposits and grows on the evaporator and condenser metal surfaces creating thermal resistance for heat transfer is known as bio fouling.
21.	**What are the types of geo thermal resources?** □ Hydrothermal □ Vapour dominated resource □ Hot dry rock resource □ Geo pressured resource □ Magma resource.
22.	**Mention various types of fuel cells with their electrochemical reactions.** **(Nov 2020)**

Fuel cell	Charge carrier through electrolyte	Anode reaction	Cathode reaction
Direct carbon (DCFC – SOFC-based)	O_{2-}	$C + O^{2-} \rightarrow CO_2 + 2e^-$	$½O_2 + 2e^- \rightarrow O_{2-}$
Polymer electrolyte (PEFC or PEM)	H^+	$H_2 \rightarrow 2H^+ + 2e^-$	$½O_2 + 2H^+ + 2e^- \rightarrow H_2O$
Phosphoric acid (PAFC)	H^+	$H_2 \rightarrow 2H^+ + 2e^-$	$½O_2 + 2H^+ + 2e^- \rightarrow H_2O$
Alkaline (AFC)	OH^-	$H_2 + 2OH^- \rightarrow 2H_2O + 2e^-$	$½O_2 + H_2O + 2e^- \rightarrow 2OH^-$
Molten carbonate (MCFC)	CO_{32-}	$H_2 + CO_3^{2-} \rightarrow H_2O + CO_2 + 2e^-$ $CO + CO_3^{2-} \rightarrow 2CO_2 + 2e^-$	$½O_2 + CO_2 + 2e^- \rightarrow CO_3^{2-}$
Solid oxide (SOFC)	O_{2-}	$H_2 + O^{2-} \rightarrow H_2O + 2e^-$ $CO + O^{2-} \rightarrow CO_2 + 2e^-$ $CH_4 + 4O^{2-} \rightarrow 2H_2O + CO_2 + 8e^-$	$½O_2 + 2e^- \rightarrow O_{2-}$

23. What is PEM fuel cell? (NOV 2021)

Polymer Electrolyte Membrane (PEM) Fuel Cell are also known as proton exchange membrane fuel cells (or PEMFCs). The temperature of these cells can operate from

temperature range of 50 ºC to 100 ºC. The electrolyte used in PEMFCs is a polymer which has the ability to conduct protons.A typical PEM fuel cell consists of bipolar plates, a catalyst, electrodes, and the polymer membrane.

24. Define fuel cell.

It is an electrochemical device that converts chemical energy of fuel in to electricity without involving a combustion cycle

25. What is hybrid energy systems?(Nov 2021)

A hybrid energy system or hybrid power, usually consists of two or more renewable energy sources used together to provide increased system efficiency as well as greater balance in energy supply.

PART-B

1. Describe the construction and working principle of geothermal power plants in detail. Enumerate the advantages and disadvantages of geothermal plant.

2.	Discuss the theory and working principle of ocean thermal energy conversion systems. (N/D 2021)
3.	What is tidal energy? Explain the working of a tidal power plant with a neat sketch. (N/D 2021)
4.	Discuss the various methods of production of hydrogen for use as an energy carrier. What are the various methods of hydrogen storage? (N/D 2021)
5.	Explain the principle of operation of open cycle OTEC system. (N/D 2020)
6.	Explain the working of tidal power plant with neat layout and specify the site requirements. (N/D 2020)
7.	What is wave energy? Explain the wave energy components with neat diagram. List out its merits and demerits.