

UNIT I-RENEWABLE ENERGY (RE) SOURCES

1. Name the energy sources available.

The energy sources available can be divided into three categories. They are

- ✓ Primary energy sources
- ✓ Secondary fuels
- ✓ Supplementary 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 is meant by renewable energy source?

Resource which are renewed by nature again and again and their supply is not affected by the rate of their consumption are called renewable. E.g., solar, wind, biomass, ocean, geothermal, hydro, etc.

4. What are the advantages of Renewable Energy source?

Non-conventional 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.
- ✓

5. What are the limitations of Renewable Energy source?

- ✓ The energy available in dilute form from these sources.
- ✓ Though available freely in nature, the cost of harnessing energy from
- ✓ a non-conventional 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 non-commercial sources. E.g., wood, animal dung cake, crop residue, 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., fossil fuels, uranium, etc.

9. 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.

10. How the energy resources are classified?

Based on usability of energy

- ✓ Primary resources
- ✓ Intermediate resources
- ✓ Secondary resources

Based on traditional use

- ✓ Conventional energy
- ✓ Non-conventional energy

Based on long term availability

- ✓ Non-renewable
- ✓ Renewable

Based on commercial application

- ✓ Commercial energy source
- ✓ Non-commercial energy source

Based on origin

- ✓ Fossil fuels Energy
- ✓ Nuclear Energy
- ✓ Hydro Energy
- ✓ Solar Energy
- ✓ Wind Energy
- ✓ Biomass Energy
- ✓ Geothermal Energy
- ✓ Tidal Energy
- ✓ Ocean thermal Energy
- ✓ Ocean wave Energy

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 kilowatts 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.
- ✓ Unlike water energy, wind energy need storage means because of its irregularity.
- ✓ Wind energy systems are noisy in operation; a large unit can be heard many kilometres away.
- ✓ Large areas are needed to install wind farms for electrical power generation.

14. Name the three categories of Biomass resources.

- ✓ Bio mass resources fall into three categories:
- ✓ Biomass in its traditional solid mass (wood and agricultural residue),and
- ✓ Biomass in non-traditional form (converted into liquid fuels).The first category is to burn the biomass directly and get the energy. In 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 anaerobically 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 demand.
- ✓ 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. State three incentives in Energy Conservation.

The three major incentives in energy conservation are:

- ✓ Decreasing the energy requirement
- ✓ Conserving the limited conventional assets of energy
- ✓ Saving the environment

20. List the general principles of Energy Conservation

The general principles of Energy Conservation are:

- ✓ Recycling of waste
- ✓ Modernization of technology
- ✓ Waste heat utilization
- ✓ Proper house keeping
- ✓ Judicial use of proper types of energy
- ✓ Judicial use of proper type of fuel
- ✓ Training of manpower
- ✓ Adopting daylight saving time
- ✓ Proper operation and maintenance Cogeneration

21. 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 levelling in an electric utility to reduce the overall cost of generating electrical power.

22. 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. $\text{Energy Utility Factor} = \frac{\text{Useful Thermal Energy}}{\text{Available Energy in Fuel}}$

PART B & PART C

1. What are the non-conventional energy sources in India? Explain.

Explain Briefly

- ✓ Solar energy
- ✓ Wind energy
- ✓ Hydro energy
- ✓ Tidal energy

- ✓ Geothermal energy
- ✓ Biomass energy
- ✓ Hydrogen

2. Write briefly on energy consumption pattern and growth rate of energy consumption in India. What do you conclude from this?

Indian energy scenario of conventional sources. Also explain its supply and demand

- ✓ **Coal**
- ✓ **Oil**
- ✓ **Natural gas**

3. **Write briefly on energy consumption of International energy scenario of renewable sources.**

- ✓ **Solar**
- ✓ Wind
- ✓ Geothermal Power
- ✓ Biomass

4. **Explain the Limitations of RE sources**

Despite of advantages when it comes to renewable energy, the positives outweigh the negatives. Some of the limitations of renewable energy sources are;

- ✓ Some type of renewable energy sources is location-based and commercially feasible
- ✓ These types of energies need storage capacities
- ✓ Some energy sources cause pollution.
- ✓ Renewable energies frequently need funding for making them reasonable
- ✓ Some types of energy sources require a huge space

5. **Give a short note on Sustainable Design developments of RE sources.**

Sustainable design seeks to reduce negative impacts on the environment and the health and comfort of human beings, thereby improving performance of energy systems. Sustainable design principles include the ability to:

- ✓ optimize site potential;
- ✓ minimize non-renewable energy consumption;
- ✓ use environmentally preferable products;
- ✓ protect and conserve water;
- ✓ enhance indoor environmental quality; and
- ✓ optimize operational and maintenance practices.

6. **What are the Green House Gas Emissions from Various Energy Sources and explain it.**

The other GHG that are emitted as a result of human activity are

- ✓ Methane (CH_4), which comes from landfills, coal mines, agriculture, and oil and natural gas operations
- ✓ Nitrous oxide (N_2O), which comes from using nitrogen fertilizers and certain industrial and waste management processes and burning fossil fuels

- ✓ High global warming potential (GWP) gases, which are human-made industrial gases
- ✓ Hydrofluorocarbons (HFCs)
- ✓ Perfluorocarbons (PFCs)
- ✓ Sulfur hexafluoride (SF₆)
- ✓ Nitrogen trifluoride (NF₃)

UNIT II-WIND ENERGY

1. List out the factor led to accelerated development of wind power.

- ✓ Availability of high strength fibre composites for constructing large low cost rotor blades
- ✓ Falling prices of power electronics
- ✓ Variable speed operation of electrical generators to capture maximum energy
- ✓ Improved plant operation, pushing the availability upto 95%.
- ✓ Economy of scale, as the turbines and plants are getting larger in size.
- ✓ Accumulated field experience improving the capacity factor
- ✓ Short energy payback period of about one year

2. What are the features prefer for the wind turbine site?

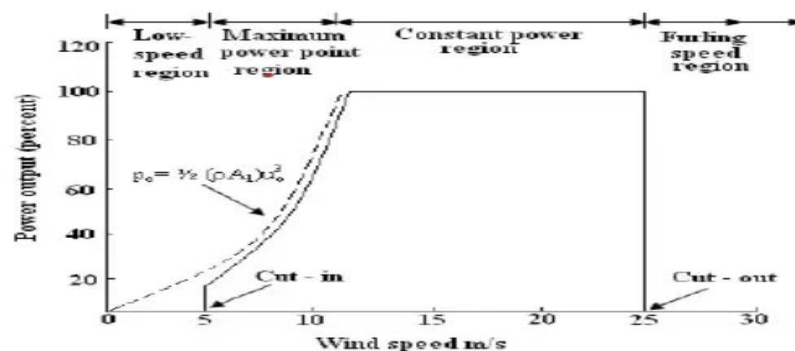
- ✓ No tall obstructions for some distance in the upwind direction and also a low roughness as possible in the same direction
- ✓ A wide and open view i.e., open plain, open shore line or offshore locations.
- ✓ Top of smooth well-rounded hill with gentle slopes on a flat plain
- ✓ An island in a lake or the sea
- ✓ A narrow mountain gap through which wind is channelled
- ✓ 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.
- ✓ Production results of existing wind turbines in the area to act as a guide to local wind conditions.

3. What are the merits and demerits of three blade rotor over two blade rotors?

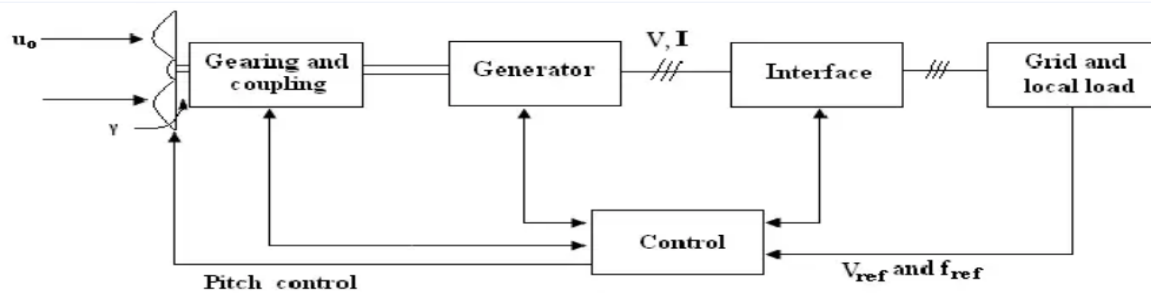
Compared to the two blade design, the three blade machine has smoother power output and balanced gyroscopic force.

- ✓ There is no need to teeter the rotor, allowing the use of a simple rigid hub. The blades may be cross-linked for greater rigidity.
- ✓ 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.
- ✓ The two blade rotor is also simpler to erect, since it can be assembled on the ground and lifted to the shaft without complicated manoeuvres during the lift.

4. Draw the power Vs wind speed characteristics.



5. Draw the block diagram of WECS.



6. What are the types of generator drive for the operation of WECS?

The types of generator are suitable for the wind generations are:

- DC generator
- Synchronous Generator
- Induction generator

7. Define gusts

.Rapid fluctuations in the wind velocity over a wide range of frequencies and amplitudes, due to turbulence caused by mechanical mixing of lower layers of atmosphere by surface roughness, are commonly known as gusts.

8. What are the features of VAWT?

The features of VAWT:

- ✓ 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.
- ✓ The inspection and maintenance also gets easier
- ✓ It also reduces the overall cost

9. 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

10. List out the merits of WECS

- ✓ It is a 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.
- ✓ On a large- scale costs can be competitive with conventional electricity and lower costs could be achieved by mass production.

11. List out the demerits of WECS

- ✓ Wind energy available in dilute and fluctuating in nature.
- ✓ Unlike water energy wind energy needs storage capacity because of its irregularity
- ✓ Wind energy systems are noisy in operation; a large unit can be heard many kilometres away.
- ✓ Large areas are needed, typically, propellers 1 to 3 m in diameter, deliver power in the 30 to 300W range.

12. 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.,

13. Classify the schemes available for electric generation.

The schemes available for electric generation is of three categories.

- ✓ Constant-speed constant frequency systems (CSCF)
- ✓ Variable speed constant frequency systems (VSCF)
- ✓ Variable speed variable frequency systems (VSVF)

14. 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.

15. What is cut in speed and cutout wind speeds for turbine?

CUT IN SPEED

Wind speed at which wind turbine starts delivering shaft power.

Cut in speed:

- ✓ While operating - 7m/s
- ✓ While stopping - 5m/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 windspeed.

Cut out speed:

- ✓ While operating - 20m/s
- ✓ While stopping - 17m/s
- ✓ Rated speed - 14m/s

16. Name the two natural phenomena in the atmosphere of different origins.

Winds are natural phenomena in the atmosphere and have two different origins.

Planetary Winds

are caused by daily rotation of earth around its polar axis and unequal temperatures between polar regions and equatorial region.

Local Winds

are caused by unequal heating and cooling of ground surfaces and ocean/lake surfaces during day and night.

17. 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 .

18. Mention the advantages of vertical axis wind turbine over horizontal axis

They 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.

19. What are the factors consider 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.

20. 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.

21. What are the types of rotors for HAWT?

The different types of rotor for HAWT are:

- ✓ Single blade rotor
- ✓ Two blade rotor
- ✓ Three blade rotor
- ✓ Sailing rotor
- ✓ Chalk multiblade rotor
- ✓ American multibladed rotor
- ✓ Dutch type rotor

22. What are the types of rotors for VAWT?

The different types of rotor for HAWT are:

- ✓ Cup type rotor
- ✓ Savonius rotor
- ✓ Darrieus rotor
- ✓ Musgrove rotor
- ✓ Evans rotor.

23. What are the characteristics of good wind power site?

- ✓ A site should have a high annual wind speed
- ✓ There should not be any obstructions for a radius of 3Km
- ✓ An open plain or an open line may be a good location
- ✓ The top of a smooth.
- ✓

24. List the components of wind energy systems

- ✓ A rotor
- ✓ A gear box
- ✓ An enclosure
- ✓ A tail vane
- ✓

25. Explain the principles of wind energy conversion

There are two primary physical principles by which energy can be extracted from the wind; these are through the creation of either lift or drag force (or combination of two).

26. What are the features of lift and drag?

- ✓ Drag in the direction of air flow
- ✓ Lift perpendicular to the direction of air flow
- ✓ Generation of lift always causes certain amount of drag to be developed
- ✓ Lift devices are more efficient than drag device

27. List wind speed types.

- ✓ Start up wind speed
- ✓ Cut in wind speed
- ✓ Rated wind speed
- ✓ Furling wind speed
- ✓ Maximum design wind speed

28. What are basic designs of wind turbines?

- ✓ Vertical axis or egg beater style
- ✓ Horizontal axis (propeller style)

PART B & PART C

1. Explain in detail about the performance and efficiency of different types of wind mills.

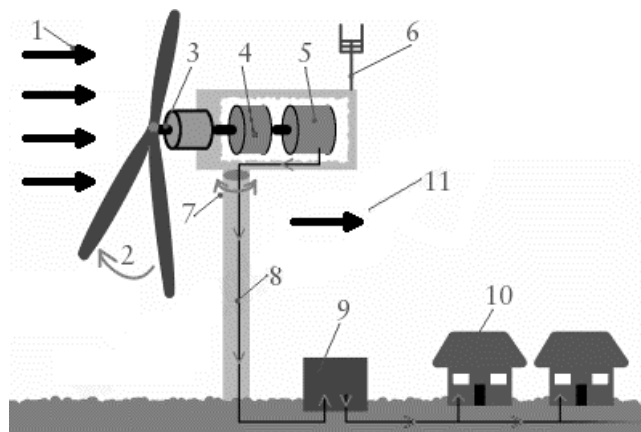
- **Utility-scale wind:** Wind turbines that range in size from 100 kilowatts to several megawatts, where the electricity is delivered to the power grid and distributed to the end user by electric utilities or power system operators.
- **Distributed or "small" wind:** Single small wind turbines below 100 kilowatts that are used to directly power a home, farm or small business and are not connected to the grid.
- **Offshore wind:** Wind turbines that are erected in large bodies of water, usually on the continental shelf. Offshore wind turbines are larger than land-based turbines and can generate more power.

Total power conversion coefficient and effective power output

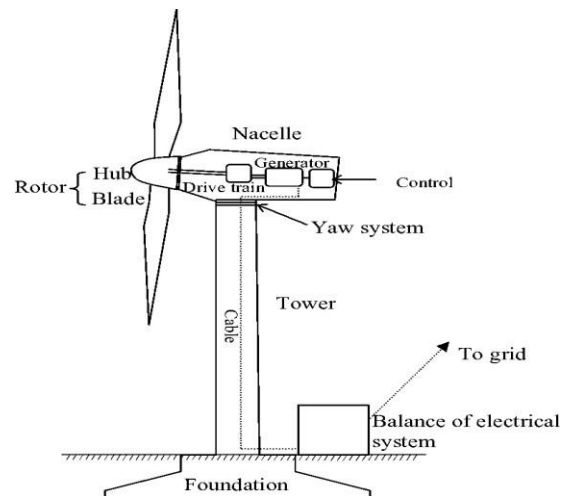
In the second stage, mechanical energy captured by wind blades is further converted into electrical energy via wind generators. In this stage, the converting efficiency is determined by several parameters

- ✓ Gearbox efficiency η_{gear} – The power losses in a gearbox can be classified as load-dependent and no-load power losses. The load-dependent losses consist of gear tooth friction and bearing losses and no-load losses consist of oil churning, windage, and shaft seal losses. The planetary gearboxes, which are widely used in wind turbines, have higher power transmission efficiencies over traditional gearboxes.
- ✓ Generator efficiency η_{gen} – It is related to all electrical and mechanical losses in a wind generator, such as copper, iron, load, windage, friction, and other miscellaneous losses.
- ✓ Electric efficiency η_{ele} – It encompasses all combined electric power losses in the converter, switches, controls, and cables.

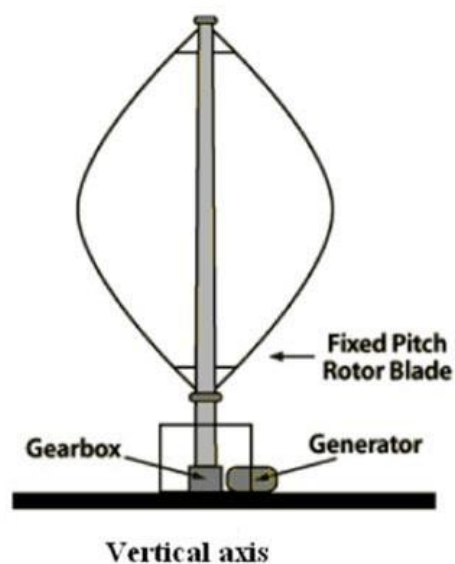
2. Describe with a neat sketch the working of a wind energy conversion system (WECS) with its main components



3. Explain the working of a horizontal axis wind turbine driven generator with a diagram. Show the mechanism for the automatic reorientation of the turbine axis along the wind direction



4. Explain the working of a vertical axis wind turbine driven generator with a diagram. Show the mechanism for the automatic reorientation of the turbine axis along the wind direction



5. Explain briefly about the various components of WECS.



UNIT III-SOLAR PV AND THERMAL SYSTEMS

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.

2. List the drawbacks of Solar Energy.

- ✓ The intermittent and variable manner in which it arrives at the earth's surface and
- ✓ The large area required to collect the energy at a useful rate.

3. Define solar constant.

Solar constant is defined as the amount of energy received in unit time on a unit area perpendicular to the sun's direction at the mean distance of the earth from the sun.

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 of 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 the 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 air 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?

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 application 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
Battery charging
Street lighting

14. What are the advantages & disadvantages of PV solar energy conversionsystem?

Advantages

Direct room temperature conversion of light to electricity through a simple solid state device. Absence of moving parts
Maintenance cost is low s they are easy to operated
not create pollution
Long effective life
Highly reliable

Disadvantages

High costing many applications energy storage is required because of no insolation at night.

15. What are the advantages & disadvantages of concentrating collectors over flat plate type collectors?

Advantages:

- ✓ Reflecting surfaces required less material and are structurally simpler than flat plate collectors. For a concentrator system the cost per unit area of solar collecting surface is therefore potentially less than that for flat plate collectors
- ✓ The absorber area of a concentrator system is smaller than that of a flat plate system for same solar energy collection and therefore the insulation intensity is greater.
- ✓ Little or no anti-freeze is required to protect the absorber in a concentrator system whereas the entire solar energy collection surface requires anti-freeze protection in a flat plate collector.

Disadvantages:

- ✓ Out of the beam and diffuse solar radiation components, only beam component is collected in case of focusing collectors because diffuse component can not be reflected and is thus lost.
- ✓ Additional requirements of maintenance particular to retain the quality of reflecting surface against dirt, weather, oxidation etc.,
- ✓ Non-uniform flux on the absorber whereas flux in flat plate collectors is uniform
- ✓ Additional optical losses such as reflectance loss and the intercept loss, so they introduce additional factors in energy balances

- ✓ High initial cost

16. 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)17.

17. What are the zones in solar pond?

- ✓ Surface convective zone or upper convective zone (0.3-0.5m)
- ✓ Non-convective zone (1-1.5m) salinity increases with depth.
- ✓ Storage zone or lower convective zone (1.5-2m) salinity =20%

18. 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

19. What are the limitations of solar cooker?

- ✓ According to sunshine menu should be prepared
- ✓ Short time cooking not possible
- ✓ Cooking at night or cloudy days is difficult
- ✓ Takes long time for cooking
- ✓ Chapatis are not cooked because of high temperature requirement and needs manipulation at the time of baking.

20. What are the reasons for solar pumping usage?

- ✓ Need for pumping occurs during the summer when solar radiation is greatest.
- ✓ During periods of low radiation when pumping reduce evaporation losses from crops also low.
- ✓

21. What is the need for solar crop drying?

High moisture crops are prone to fungus infection, attack by insects and rests. Solar dryers remove moisture with no ingress at just and the product can be preserved for a longer period at time.

22. State the use of solar kilns?

For large scale drying ie seasoning of timber, corn drying, tea processing, fish and fruit drying, solar kilns are in use.

23. List the different modes of solar cooling

- ✓ Evaporative cooling
- ✓ Absorption cooling and
- ✓ Passive desiccant cooling

24. What are the advantages of solar cells?

- ✓ 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
- ✓ Compares with other sources of energy solar cells produce electric power at very high cost
- ✓ Solar cell output is not constant and it varies with the time of day and weather
- ✓ They can be used to generate small amount of electric power.

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

- ✓ The solar collector
- ✓ The heat transfer system
- ✓ Boiler or heat exchanger
- ✓ Heat engine
- ✓ Condenser
- ✓ Pump

26. What are the two types of flat plate collectors?

- Liquid heating collectors
- Solar air heaters

27. What is Green house effect?

The energy we receive from sun in the form of light is a shortwave radiation (not visible to human eye). When this radiation strikes a solid or liquid it is absorbed and transformed into heat, the material becomes hot and conducts it to surrounding materials (air, water or liquids) or reradiates it to other materials of low temperature as long wave radiation.

28. What is concentration ratio?

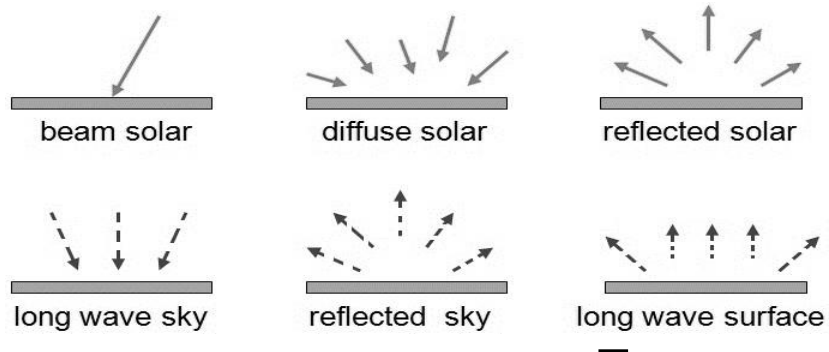
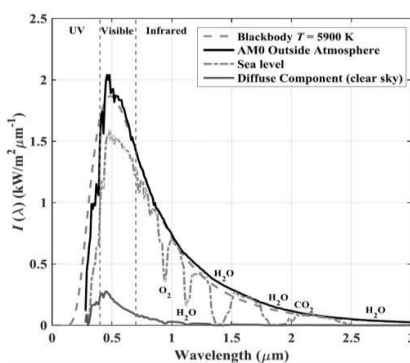
Concentration ratio is the ratio between the aperture area and receiver / absorber area of the collector.

29. List any four disadvantages of solar energy

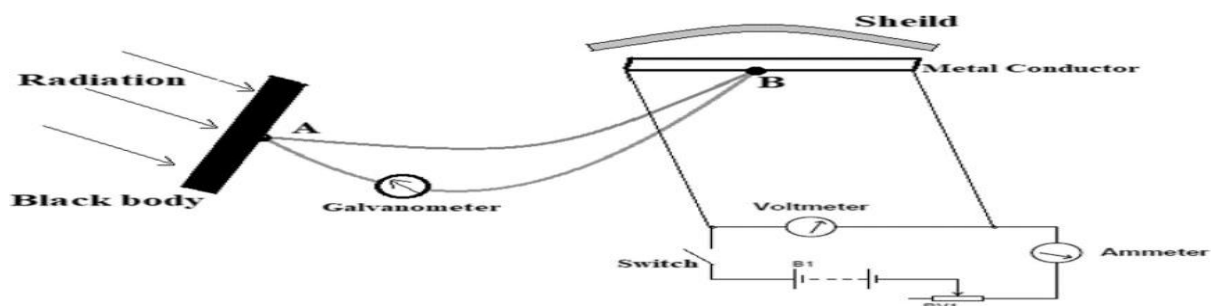
- ✓ It is available only by day and not when the sky is cloudy, thereby reducing the chances of it being totally reliable and requiring storage facilities
- ✓ It needs back up power plant to be kept hot and not to replace solar power stations they stop producing energy
- ✓ Keeping back up plants hot includes an energy cost which includes coal burning
- ✓ Places located at high altitudes or those that are often cloudy are not targets for solar power use.

PART B & PART C

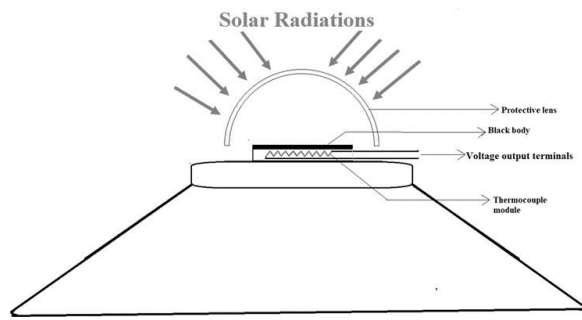
1. Draw illustrative diagram showing all the important components of solar heating and solar cooling unit. Explain the working principles of these devices.



2. Explain about 1.) Pyrheliometer 2) Pyranometer



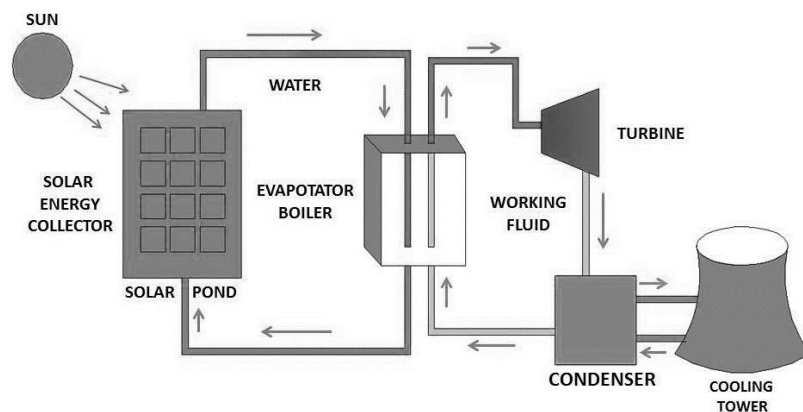
Pyranometer



explain its working and operation detailly.

3. Draw schematic diagram of solar thermal power plant used for power production and explain the operation of this system in detail.

- Solar pond
- Solar energy collectors
- Working fluid
- Evaporator Boiler
- Turbine and Generator
- Condenser and Cooling tower



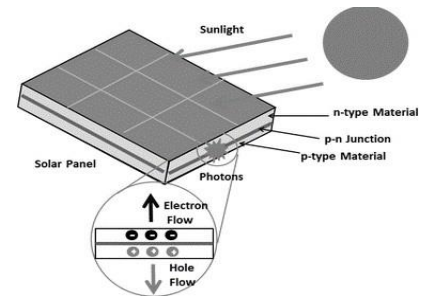
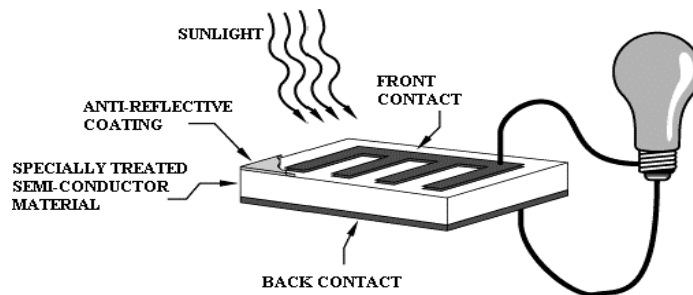
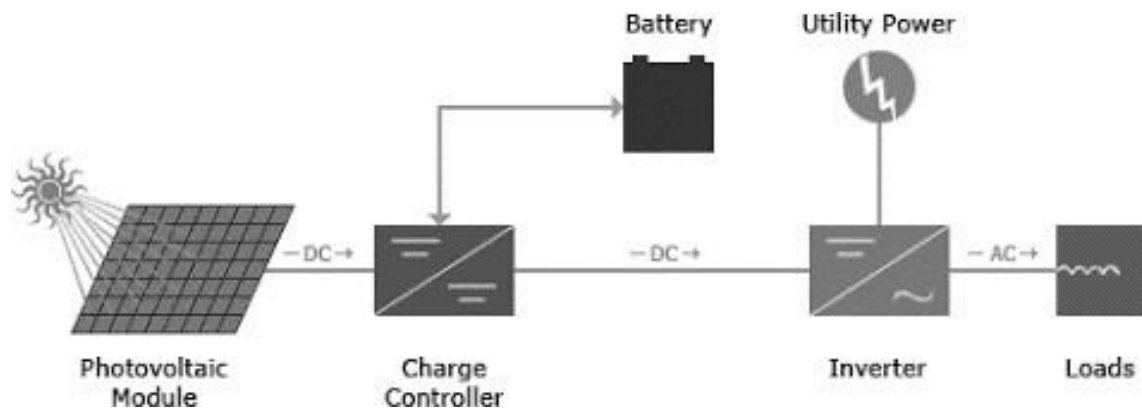
4. Write briefly about characteristics and principles of any three different types of solar collectors. Draw diagrams illustrating the constructional features of these collectors.

Solar collectors are classified as

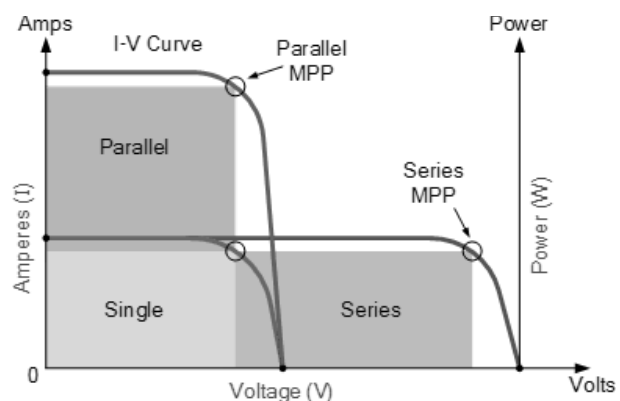
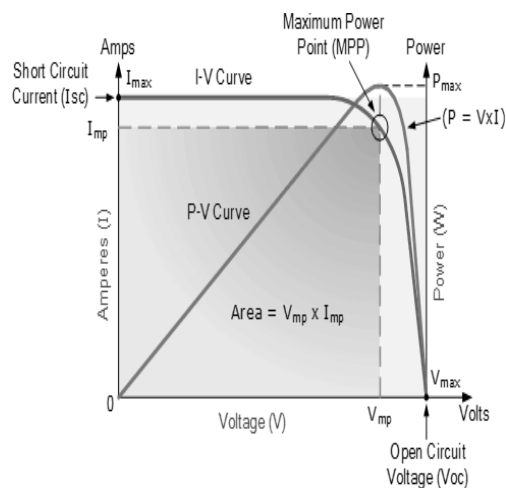
1. Non concentrating type
 - i) Flat-Plate Collectors
 - ii) Evacuated-Tube Collector
2. Concentrating type
 - i) Parabolic trough collector.
 - ii) Power tower receiver.
 - iii) Parabolic dish collector.
 - iv) Fresnel lens collector.

- Describe the photovoltaic principles of solar power generation. Compare the different types of solar cells with respect to power output and efficiency.

Explain Photovoltaic Effect & its operation



- Write briefly about characteristics and principles of solar PV.



UNIT-IV-BIOMASS ENERGY

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, forest and harvested periodically.
- ✓ Biomass derived from waste e.g., municipal waste, animal excreta/dung, forest waste, agricultural waste, bioprocess waste, butchery 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, but charry 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 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.

10. Mention 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.

11. What is meant by biomass gasification?

The word gasification (or thermal gasification) implies converting solid fuel into a gaseous fuel by thermochemical method without leaving any solid carbonaceous residue.

12. Classify the biogas plant.

The biogas plant are classified into

- ✓ Continuous and batch types
- ✓ The dome and drum types

13. List the factors affecting bio digestion or generation of gas.

The factors affecting bio digestion or generation of gas are:

- ✓ pH or the hydrogen-ion concentration
- ✓ Temperature
- ✓ Total solid 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

14. Why the biogases are mainly utilized?

Biogases are mainly utilized.

- ✓ The biogas can be utilized effectively for
- ✓ Household cooking,
- ✓ Lighting,
- ✓ Operating small engines,
- ✓ Utilizing power for pumping water,
- ✓ Chaffing fodder and
- ✓ Grinding flour.

15. 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.

16. 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 dementated 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.

17. Write the advantages of floating drum plant.

- ✓ 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

18. Write the disadvantages of floating drum plant.

- ✓ It has higher cost, as 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. It may be twisted also, with the rotation of the drum for mixing or scum removal.

19. Mention some advantages of fixed dome type plant

- ✓ It has low cost compare 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.

20. Mention some disadvantages of fixed dome type plant

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

21. 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

22. 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.

23. Mention the types and explain the cogeneration principles

.Types of cogeneration principles are:

The Topping Cycle:

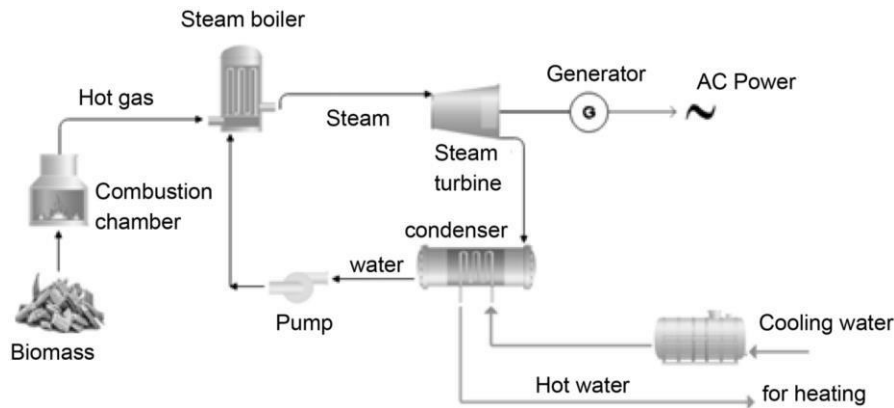
primary heat is used to generate high pressure and temperature steam for electrical energy generation. The discharged low grade heat, which would otherwise be dispersed to the environment, is utilized inane industrial process or in other ways.

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.

PART B & PART C

1. Describe in detail the construction and working of various types of bio-gas plants. State the merits and demerits of the biogas power plant.



2. Write short notes on: a) Energy from industrial and municipal waste b) Applications of Bio-Energy.

Agricultural Residues

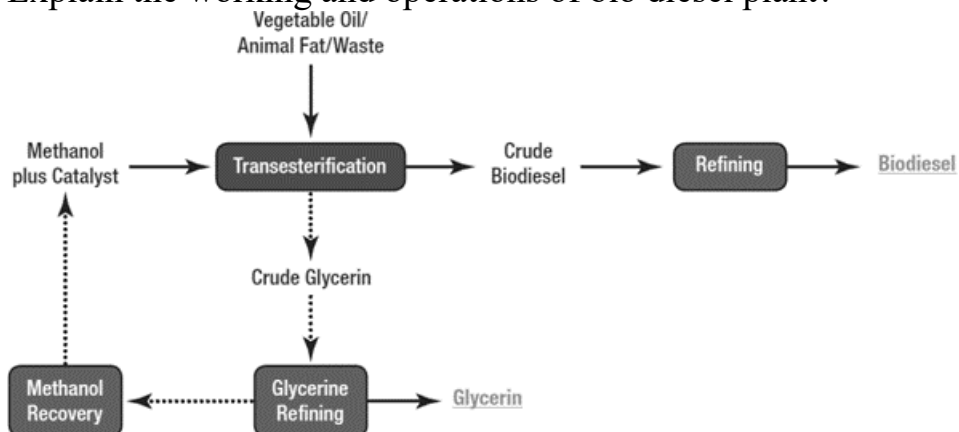
- Food Processing
- Municipal Solid
- Animal Waste
- Dedicated Biomass Energy Energy
- Herbaceous Energy Crops
- Woody Energy Crops
- Lipids are water insoluble oils and fats

3. Explain various conversion process of energy from bio mass.

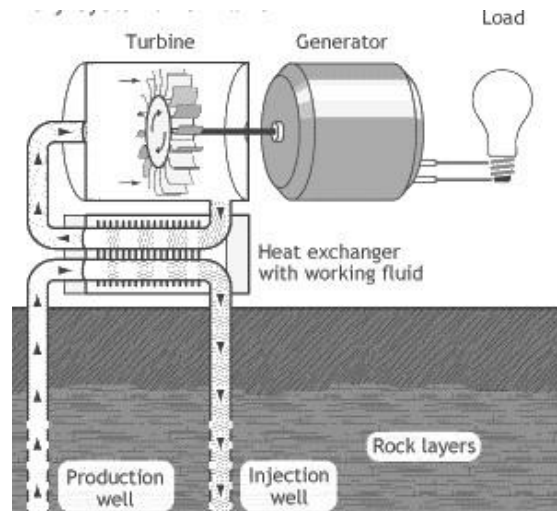
. The conversion technologies to utilize biomass can be classified into three basic categories

- ✓ Direct combustion processes.
- ✓ Thermochemical processes.
- ✓ Biochemical processes.

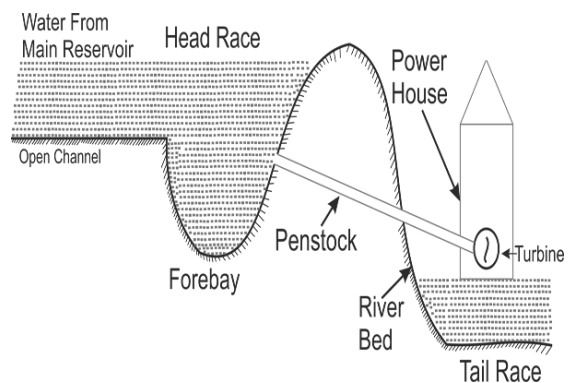
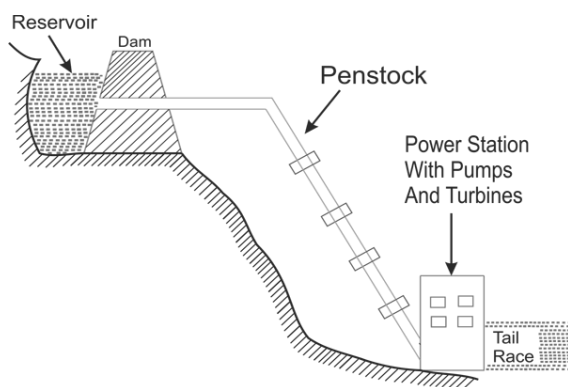
4. Explain the working and operations of bio diesel plant?



5. Draw and explain about schematic diagram of geothermal power plant.



6. Explain the working and operations of bio diesel plant



UNIT V-OTHER ENERGY SOURCES

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 Andro 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 metre. $R = (\text{High tide level}) - (\text{low tide level}) \text{ m}$

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 5m 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) powerhouse and (viii) tailrace channel.

9. Define the following terms a) Forebay b) Penstock c) Tailrace

a) Forebay

A Forebay is a temporary storage of water (pondage), 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, concrete 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.

- ✓ Vapour dominated or dry steam fields
- Liquid dominated system or wet steam fields and
- Hot water fields Geopressed resources Petro-thermal or hot dry rocks (HDR) Magma resources Volcanoes.
- ✓ Geo pressured resources
- ✓ Petro-thermal or hot dry rocks (HDR)
- ✓ Magma resources
- ✓ Volcanoes

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 form has very low efficiency and has very high capital cost, because the temperature difference is small even in tropics.

12. How the fuel cells are classified?

The classifications of fuel cells are:

- ✓ Based on the type of electrolyte
- ✓ Based on the types of the fuel and oxidant
- ✓ Based on operating temperature
- ✓ Based on application
- ✓ Based on the chemical nature of electrolyte

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 plant 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. Main components of Stirling engine

There are five main components of Stirling engine. They are:

- (a) Heater
- (b) Regenerator
- (c) Coolers
- (d) Displacer
- (e) Power piston

16. Mention some uses of Stirling engine.

- ✓ Uses of Stirling engine are:

- ✓ Automobile engine
- ✓ Low air pollution levels that are possible
- ✓ 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 engines.

17. 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

18. What are the important components of a tidal power plant

- ✓ Barrage
- ✓ Sluice gates
- ✓ Power house with turbines each coupled to a generator along with auxiliary equipment

19. What are the advantages of tidal plant?

- ✓ 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

20. What are the disadvantages of tidal plant?

- ✓ 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

21. What are the advantages of wave energy generation?

- ✓ 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

22. What are the disadvantages of wave energy generation?

- ✓ 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

23. 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

24. What are the types of OTEC plants?

- ✓ Open
- ✓ Closed and
- ✓ Thermoelectric

25. What is Biofouling?

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.

26. Define small hydro plant

A power station having 5000KW output and having a low head upto 15m. But there is no restriction on head.

27. Define micro & mini hydro plant

Stations upto 1000KW output – micro hydro plant Stations upto 5000KW output- mini hydroplane.

28. List the classifications of small hydro power stations based on capacity, load and scheme.

- ✓ Depending on capacity
- ✓ Depending on load
- ✓ Based on scheme
- ✓

29. What are the major components of small hydropower projects?

- ✓ Diversion weir and intake
- ✓ Desilting tank
- ✓ Water conductor system
- ✓ Forebay
- ✓ Penstock
- ✓ Spillway
- ✓ Power house
- ✓ Tail race

30. What are the three parts of earth?

- ✓ Crust
- ✓ Matle and
- ✓ Core

31. What are the two parts of the crust?

- ✓ Solid crust
- ✓ Ocean crust

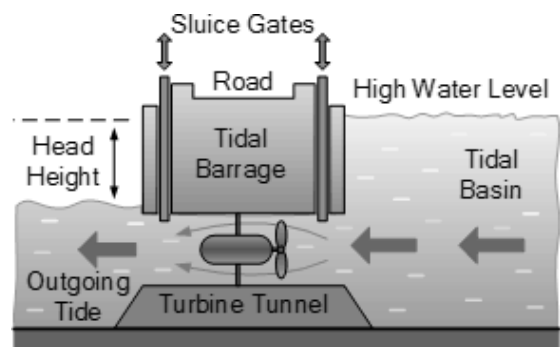
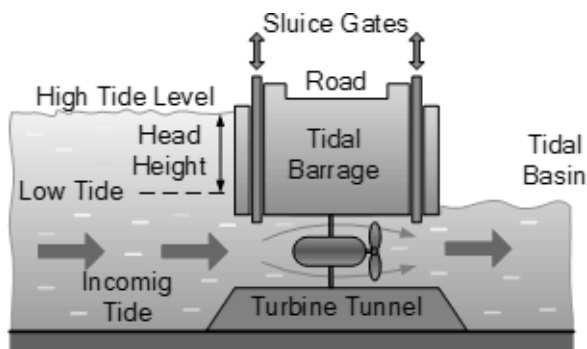
PART B & PART C

1. Explain the working of a tidal power plant and the two way operating cycle for its units.

Flood Generation: The tidal power is generated as the water enters a tidal reservoir on the incoming Flood tide.

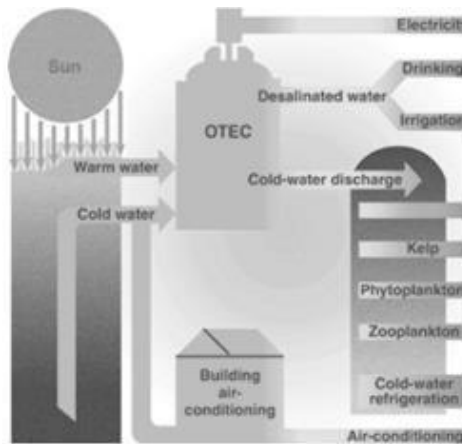
Ebb Generation: The tidal power is generated as the water leaves a tidal reservoir on the Ebb flowtide.

Two-way Generation: The tidal power is generated as the water flows in both directions in and out of the reservoir during both the Flood and the Ebb tides.

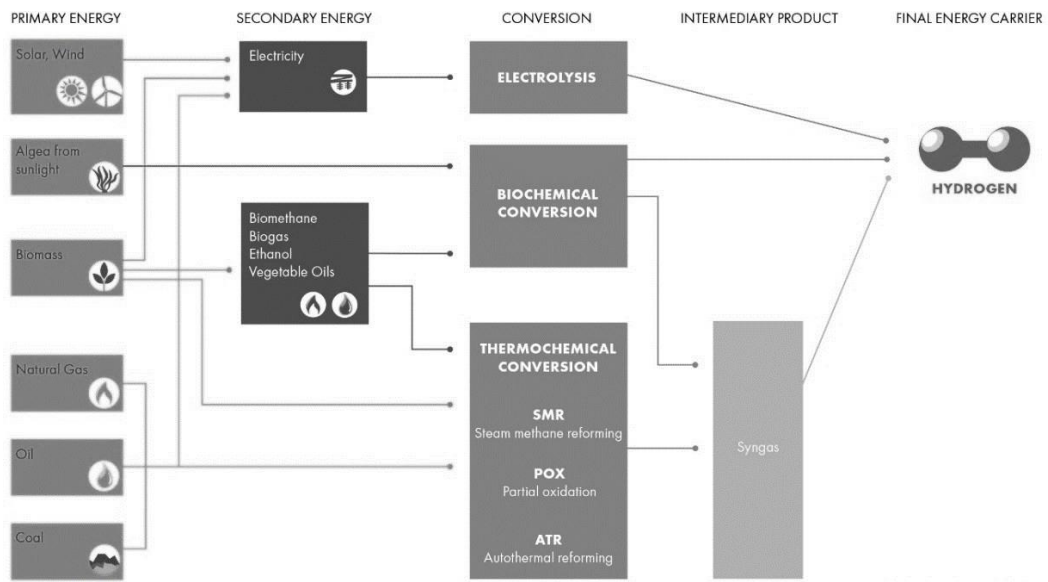


2. Explain the working of ocean thermal power plant and its types.

- ✓ **Closed Cycle**
- ✓ **and open cycle**



3. what are the Methods of producing hydrogen and explain it briefly.



4. explain the Types of fuel cells one by one?

The Polymer Electrolyte Membrane (PEM) Fuel Cell

- ✓ Phosphoric Acid Fuel Cell
- ✓ Solid Acid Fuel Cell
- ✓ Alkaline Fuel Cell
- ✓ Solid Oxide Fuel Cell
- ✓ Molten Carbonate Fuel Cell

5. Give a short note on 1.Lithium – Ion Battery, 2.Lead Acid Battery

