

# OR0551 - RENEWABLE ENERGY SOURCES

## UNIT -1

### PRINCIPLES OF SOLAR RADIATION

#### 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. 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

#### 5. 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

#### 6. Name the energy sources available.

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

- Primary energy sources
- Secondary fuels
- Supplementary sources

#### 7. 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.,

#### 8. 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.

#### 9. 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.

#### 10. 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.

**11. 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.

**12. What is meant by non –commercial energy?**

The energy derived from nature and used directly without passing through a commercial outlet is called anon-commercial sources. E.g., wood, animal dung cake, crop residue, etc.,

**13. 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, etc.

**14. 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.

**15. Differences between Renewable and Non-renewable Resources**

Renewable Resources	Non-renewable Resources
Renewable resources cannot be depleted over time	Non-renewable resources deplete over time
Renewable resources include sunlight, water, wind and also geothermal sources such as hot springs and fumaroles	Non-renewable energy includes fossil fuels such as coal and petroleum.
Most renewable resources have low carbon emissions and low carbon footprint	Non-renewable energy has a comparatively higher carbon footprint and carbon emissions.
The upfront cost of renewable energy is high. – For instance, Generating electricity using technologies running on renewable energy is costlier than generating it with fossil fuels	Non-renewable energy has a comparatively lower upfront cost.
Infrastructure for harvesting renewable energy is prohibitively expensive and not easily accessible in most countries.	Cost-effective and accessible infrastructure is available for non-renewable energy across most countries
Requires a large land/ offshore area, especially for wind farms and solar farms	Comparatively lower area requirements

**16. What is beam, diffuse and global radiation?**

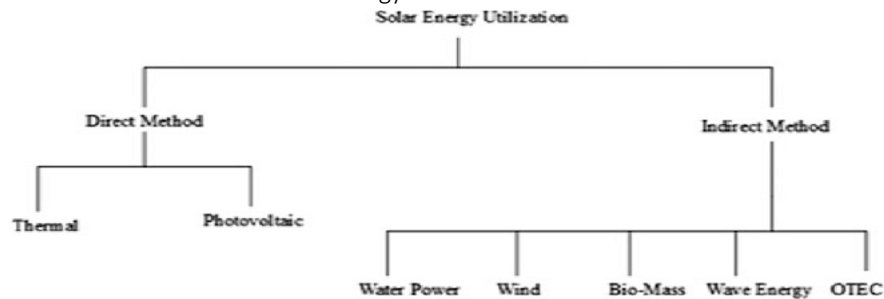
- Beam radiation is the solar radiation received from the Sun without having been scattered by the atmosphere.
- Diffuse radiation is that received from the Sun after its direction has been changed by scattering by the atmosphere.
- The sum of the diffuse and direct solar radiation is called global solar radiation.

**17. Name the energy sources available.**

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

- Primary energy sources
- Secondary fuels
- Supplementary sources

18. Give the classification of methods for solar energy utilization?



19. Define azimuth and zenith angle.

The solar azimuth and solar zenith express the position of the sun.

The **solar azimuth** is the angle of the direction of the sun measured clockwise north from the horizon.

The **solar zenith** is the angle measured from the local zenith and the line of sight of the sun.

20. Mention the instruments used for solar radiation and type of solar radiation measured using each instrument.

**pyrheliometers and pyranometers** that measure direct solar radiation and global solar radiation.

Pyranometer is a dome like structure that measures diffused sun energy while Pyrheliometer is an instrument that measures direct sun's energy

21. Explain What is 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.

## Part B

1. Discuss about the terrestrial and extraterrestrial solar radiation. Derive the equation for solar radiation falling on a tilted surface.
2. Which instruments are used for the measurement of the beam, diffuse and global radiation? Explain working of solar Pyranometer for measuring global radiation in detail.
3. What is the need for studying alternative sources of energy? What are the different types of New and Renewable Sources of energy? What are the advantages and limitations of the use of Renewable sources of Energy?
4. Describe the various nonconventional energy resources available in Indian and its potential to supplement the conventional energy sources
5. Calculate Sunrise and sunset solar (LAT)s well as (IST) time, and Day length at Pune (18.53°N, 73.85°E) on 15 th October. Estimate monthly- mean hourly Direct, Diffuse and Global Radiation at 10, 12 and 14 (LAT) hours at Pune in the month of October on Horizontal surface taking the constants A= 1136W/m<sup>2</sup>, B= 0.155 and C=0.113 for these calculations.
6. With the help of neat sketch, explain and give equations for declination angle, hour angle, zenith angle, solar azimuth angle and angle of incidence. Determine the monthly average value of daily global radiation on a horizontal surface at Nagpur (latitude 21°06' N, longitude 79°03' E) during the month of March. If constants a and b are given equal to 0.27 and 0.50 respectively and average sunshine hours per day is 9.2

## **UNIT II SOLAR ENERGY COLLECTION**

### **1. 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.

### **2. 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.

### **3. 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

### **4. 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.

#### **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.

**5. 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

**6. List the five 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

**7. 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)

**8. 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%

**9. 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.

**10. What is the need for solar crop drying?**

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

**11. 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.

**12. List the different modes of solar cooling**

Evaporative cooling

Absorption cooling and

Passive desiccant cooling

**13. What are the 4 units of absorption type solar cooler?**

Generator

Condenser

Evaporator

**14. What are the two types of flat plate collectors?**

Liquid heating collectors

Solar air heaters

**15. What Essential subsystems in a solar energy plant:**

Solar collector or concentrator: It receives solar rays and collects the energy. It may be of following types: a) Flat plate type without focusing b) Parabolic trough type with line focusing c) Paraboloid dish with central focusing d) Fresnel lens with centre focusing e) Heliostats with centre receiver focusing

**16. What are the components of solar energy?**

1. Collector 2. Storage

**17. What is concentration ratio?**

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

**18. List the various types of solar energy collectors.**

1. Stationary collectors (or) Non- concentrating Flat plate collectors

Compound parabolic collectors Evacuated tube collectors

2. Sun tracking concentrating collector Single axis tracking Two-axis tracking

**19. List any four applications of solar collectors.**

- Solar water heating
- Solar space heating systems
- Solar refrigeration
- Industrial process heat systems

20. List the four important solar systems.
- Low temperature cycles using flat plate collector or solar pond
  - Power tower or central receiver system
  - Distributed collector system
  - Concentrating collectors for medium and high temperature cycle
21. List the advantages of solar Energy.
1. Solar energy is free from pollution
  2. They collect solar energy optically and transfer it to a single receiver, thus minimizing thermal-energy transport requirements 2/2
  3. They typically achieve concentration ratios of 300 to 1500 and so are highly efficient both in collecting energy and converting it to electricity.
  4. The plant requires little maintenance or help after setup
  5. It is economical
22. List any four disadvantages of solar energy.
1. Available in day time only
  2. Need storage facilities
  3. It needs a backup power plant
  4. Keeping back up plants hot includes an energy cost which includes coal burning

### **PART B**

1. Describe the characteristics and types of flat plate solar collectors.
2. Discuss about the features of different types of concentrating type solar collectors and its applications.
3. With the help of neat sketch explain the concentration and working of central receiver collector and its advantages.
4. Explain the working of flat plate collector used in solar water heating system using thermosiphon method with the help of neat sketch.
5. Explain the working of cylindrical parabolic concentrator with help of neat sketch. What are the terms tracking and concentration ratio in this concentrator means?

### **UNIT III SOLAR ENERGY STORAGE AND APPLICATIONS**

#### **1. 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

## **2. What are the disadvantages of solar cell**

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.

## **3. What are the components of basic solar pumping system?**

The solar collector

The heat transfer system

Boiler or heat exchanger

Heat engine

Condenser

Pump

## **4. List the types of heat engines used in solar system**

Rankine engine

Reciprocating engine

Vapor engine

Stirling hot gas engine

Brayton cycle gas turbine

Rotary piston engine

## **5. Write the equation for overall efficiency of solar pump? $\eta_o = \eta_e \eta_c$**

Overall efficiency = Efficiency of the engine \* Efficiency of the collectors

## **6. List the working fluids used in solar pumps**

Foluene

Monochloro benzene

Frifuluroethanol



### **7. Define Solar distillation.**

Solar distillation is the use of solar energy to evaporate water and collect its condense it within the same closed system. Unlike other forms of water purification it can turn salt or brackish water into fresh drinking water.

### **8. Define Active Distillation.**

Solar radiation is the input energy of the passive solar stills, but the efficiency of the system is low. Attempts have been made to increase the efficiency and productivity by preheating the saline water in solar stills. This method is called active solar distillation.

### **9. Define Latent heat storage.**

Latent heat storage uses the phase transitions of a material. Upon melting heat is transferred to the material, storing large amount of heat at constant temperature, the heat is released when the material is solidifies.

### **10. Difference between sensible heat and latent heat**

S.No	Sensible heat	Latent heat
1	When an object is heated its temperature rises as heat is added, the Increasing heat is called sensible heat	All pure substance in nature are able to change their state. Solid can become liquid and liquid can become gases.The heat causes the changes its called latent heat.
2	Change in temperature	No change in temperature

### **11. Define Stratified storage**

Layered or stratified charge storage is hot water storage tank, typically for solar thermal energy. The warmest storage layer is the top storage cylinder and below this there are colder storage layer through natural layer.

### **12. Define Solar Energy Storage.**

Solar thermal storage refers to the accumulation of energy collected by a given solar field for its later use.

### **13. Define Thermo chemical storage**

Thermal energy for the sun can be stored as chemical energy in a process is called solar thermo chemical energy storage (TCES).

#### **14. Define Solar Dryers and its Types.**

Solar dryer are device that use solar energy to dry substance especially food.

There are two general types of solar dryer

1. Direct
2. In direct

#### **15. Define Photovoltaic Cell.**

Photovoltaic cell is the basic unit of the system where the photovoltaic effect is utilised to produce electricity from light energy.

#### **16. Define Indirect Solar Dryer.**

This method does not expose the crop directly to the sunlight. The solar radiation is absorbed and converted into heat by another surface (like a black top) usually called the collector. Air that will be used for drying is passed over this surface and gets heated, which is then used to dry the food item inside the dryer.

#### **17. Give any five the application of Solar Energy.**

- A) Solar Heater
- B) Solar Distillation
- C) Solar Dryer
- D) Solar Cooler
- E) Solar Power Plant

#### **18. Give different types of passive solar water distillers.**

- A) Single-effect Stills
- B) Multi-effect Stills
- C) Basin-type Stills
- D) Wick Stills
- E) Multi-wick Stills
- F) Diffusion Stills

#### **19. Give the Advantages of Solar Distillation.**

- It is a relatively cheap and low-maintenance system.

- It can be used at the household level and scaled up through programmatic approaches.
- There are climate change adaptation and mitigation benefits.
- There are no energy costs.
- There are no moving parts.

**20. Give the advantages of indirect Solar dryers.**

The temperatures can be controlled. The sizes can vary from kilograms to metric tons, but it is expensive and more complex to construct when compared to direct solar dryers.

**21. Give the application of power plants.**

- Solar power plant is powering cities in most efficient manner.
- Solar panels could be used to generate electricity individually for each house especially in remote areas.

**PART -B**

1. Explain Solar ponds in detail.
2. Explain Solar dryers in detail.
3. Explain Solar distillation in detail.
4. Explain the types of solar energy storage in brief.
5. Explain the working principles of Solar power plant or solar cell.

**UNIT – 4**

**WIND ENERGY**

**MCQ IMPORTANT QUESTION**

**1. Wind energy is harnessed as \_\_\_\_\_ energy with the help of windmill or turbine.**

(A) Mechanical

(B) Solar

(C) Electrical

(D) Heat

ANS: A

**2. Winds having following speed are suitable to operate wind turbines.**

(A) 5 – 25m/s

(B) 10 – 35m/s

(C) 20 – 45m/s

(D) 30 – 55m/s

**ANS: A**

**3. The following factor(s) affects the distribution of wind energy**

(A) Mountain chains

(B) The hills, trees and buildings

(C) Frictional effect of the surface

(D) All of the above

**ANS: D**

**4. How many blades does a modern wind turbine have?**

(A) 3

(B) 2

(C) 4

(D) There is no standard number of blades

**ANS: A**

**5. Which of these is NOT a part of a modern wind turbine?**

(A) Gearbox

(B) Yaw Drive

(C) Compressor

(D) Nacelle

**ANS: C**

**6. What is the diameter of wind turbine blades?**

(A) 320 feet

(B) 220 feet

(C) 80 feet

(D) 500 feet

**ANS: B**

**7. What are used to turn wind energy into electrical energy?**

(A) Turbine

(B) Generators

(C) Yaw motor

(D) Blades

**ANS: A**

**8. The following is(are) the classification of winds**

(A) Global wind

(B) Local Wind

(C) Both (A) and (B)

(D) None of the above

ANS: C

9. What is not applicable for wind power?

(A) It releases no greenhouse gases or acid-forming emissions.

(B) It provides a constant, uninterrupted source of energy

(C) It has been used for hundreds of years

(D) It can be used to produce electricity

ANS: B

10. *Yaw control is the part of*

(A) solar concentration collector

(B) OTEC devices

(C) biomass energy generator

(D) wind energy conversion system

ANS: D

### **MCQ QUESTIONS**

1. *The aerobic digestion of sewage is utilized in the production of*

(a) metal articles

(b) biofuels

(c) biomass

(d) synthetic fuels

ANS: B

2. *Biomass is used in the production of*

(a) fibers

(b) chemicals

(c) transportation fuels

(d) biochemicals

ANS: C

3. *This forestry material is used as biomass*

(a) fish oil

(b) logging residues

(c) manure

(d) tallow

ANS: B

4. Dead organisms also come under the biomass.

a) True

b) False

ANS: A

5. The \_\_\_\_\_ is used as the agricultural fertilizer.

a) Bio ethanol

b) Bio ethane

c) Bio methanol

d) Digestate

ANS: D

6. The term biomass most often refers to \_\_\_\_\_

- a) Inorganic matter
- b) Organic matter
- c) Chemicals
- d) Ammonium compounds

ANS: B

7. Which of the following statements about traditional biomass cooking are true?

Please select all that apply.

- A) Improved cooking stoves eliminate the damaging effects of air pollution
- b) Charcoal production can be sustainably produced and cleanly burnt in stoves
- c) Adding a chimney is a cheap, versatile and effective solution to air pollution from stoves
- d) Reducing air pollution significantly requires insulating the combustion region and providing sufficient air.

ANS: B

8. Which of the following statements about biomass are true?

Please select all that apply.

- a) Water supply is not a concern for large scale biomass production.
- b) Food production can be in competition with biomass production.
- c) Electricity from biomass does not require energy storage.
- d) Biomass is a carbon-neutral fuel.

ANS: C

9. \_\_\_\_\_ digestion is the decomposition of organic matter in the absence of air by bacteria.

- A) Anerobic
- B) Anearobic

ANS: B

10. Which of the following biochemical conversion process is performed by microorganisms?

- A) Anaerobic digestion
- B) Fermentation
- C) Composting
- D) All of the above

ANS: D

**PART - A**  
**2 MARKS**

1. 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.

2. Define wind turbines.

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.

3. 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

4. Define Cut-in speed and Cut- out speed .

Cut- in speed: The lowest wind speed at which a wind turbine begins producing usable power is called cut-in speed. It is about 3m/s.

Cut-out speed: The highest wind speed at which a wind turbine stops producing power is called cut-out speed. It is about 30m/s.

5. Write the types of Wind Turbines.

A) Horizontal Axis Wind turbines

B) Vertical Axis Wind Turbines.

6. Write Betz Limit

No wind turbine could convert more than 59.3% of the kinetic energy of the wind into mechanical energy turning a rotor. This is known as the Betz Limit, and is the theoretical maximum coefficient of power for any wind turbine.

7. Define Anaerobic digestion.

Anaerobic digestion is the biological process by which organic matter is broken down to produce biogas in the absence of Oxygen. Microorganisms such as Acidogenic bacteria and acetogens convert the biodegradable matter to biogas.

8. How winds are formed? State various applications of Wind Energy.

Wind energy, or wind power, is created **using a wind turbine, a device that channels the power of the wind to generate electricity**. The wind blows the blades of the turbine, which are attached to a rotor. The rotor then spins a generator to create electricity.

Applications:

Wind energy in India is generally utilized in **wind pumps, wind battery charges, wind electricity generators** etc.

9. Explain the Pitch Angle?

The angle of inclination from the horizontal or vertical, or with respect to some reference plane; the angle relating or corresponding to the pitch.

10. Define Betz Limit.

The Betz limit is **a theoretical upper limit on the power production from a turbine whose blades sweep a given area** [1].

The limit is expressed as a maximum rotor power coefficient of  $C_P = 16 / 27$  . Wind turbines aspire to achieve this power coefficient, but in practice fall short for several reasons [2]

11. **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

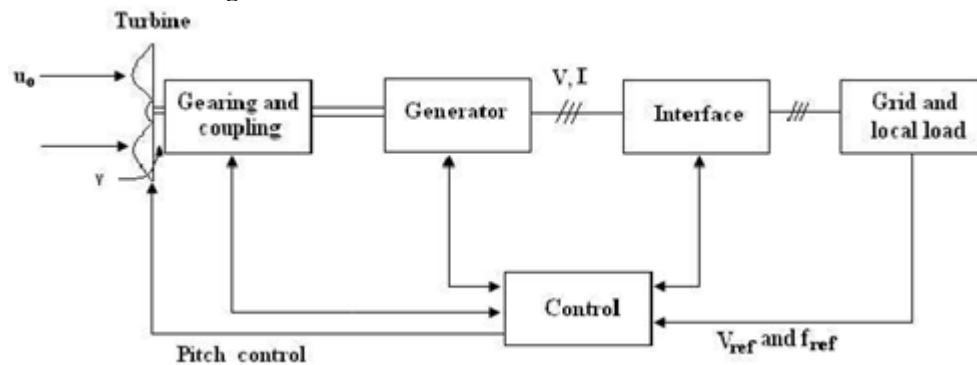
12. **What are the features prefer for the wind turbine site?**

- 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 channeled
- 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.

13. **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.

14. **Draw the block diagram of WECS**



15. **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

16. **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.

17. **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

18. **List out the merits of WECS**

- It is a renewable source of energy



- Like all forms of solar energy, wind power systems are nonpolluting, so it has no adverse influence on the environment.
- Wind energy systems avoid fuel provision and transport.
- On a small scale upto a few kilowatt system is less costly. On a large- scale costs can be competitive with conventional electricity and lower costs can be competitive with conventional
- electricity and lower costs could be achieved by mass production.

**19. 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 kilometers away.
- Large areas are needed, typically, propellers 1 to 3 m in diameter, deliver power in the 30to 300W range.

**20. 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.,

**21. Classify the schemes available for electric generation.**

The schemes are 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)

**22. 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.

**23. 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 threemethods:

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.

**24. 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.

**25. 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

**26. What is meant by biomass energy and biomass energy resource?**

Organic matters derived from biological organisms are called Biomass. The energy obtainedfrom biomass is called biomass energy.The raw organic matter obtained from nature for extracting secondary energy is called biomass energy resource.

**27. 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, butcherry waste, fishery waste/processing waste etc.,

**28. 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.

**29. 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.

**30. 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

**31. 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 sea weeds, marine algae, water hyacinth, floating kelp etc. algae is considered to be a promising aquatic biomass.

**32. 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, butcherry waste

Animal and human excreta

**33. 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.

**34. 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.

**35. 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.

**36. Classify the biogas plant.**

The biogas plant are classified into

Continuous and batch types

The dome and drum types

**37. List the factors affecting biodigestion or generation of gas.**

The factors affecting biodigestion 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

**38. 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

**PART B:**

1. Describe Briefly about the HAWT and give the advantages and disadvantages.
2. Describe Briefly about the VAWT and give the advantages and disadvantages.
3. Compare horizontal and vertical wind turbine.
4. Explain the parts of wind turbines.
5. Illustrate the operation of IC Engine with neat sketch.
6. Express floating drum type biogas plants. Write and Explain the classification of biogas plants.

**UNIT V**

**GEO THERMAL ENERGY**

**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 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 favorable 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, 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.

- Vapour dominated or dry steam fields.
- Liquid dominated system or wet steam fields and
- Hot water fields

Geopressure 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.

**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

**15. Mention some uses of Stirling engine.**

Uses of Stirling engine are:

Automobile engine

- Low air pollution levels that are possible
- Low noise levels because there are no explosions as in internal combustion engines and
- 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.

**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 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.

**18. List down the advantages of geothermal energy over other energy form.**

A)Environmentally Friendly. Geothermal energy is more environmentally friendly than conventional fuel sources

such as coal and other fossil fuels. B)Renewable. Huge Potential. ...C) Sustainable / Stable. ...D) Heating and Cooling. ...E) Reliable. ...F) No Fuel Required. ... G)Rapid Evolution.

**19. What is wave energy? How power available in waves is calculated?**

The energy of a mechanical wave and the power are proportional to the amplitude squared and to the angular frequency squared (and therefore the frequency squared).  $I = P 4 \pi r^2$

**20. What is OTEC Technology? Which Thermodynamic cycle is used in OTEC?**

Ocean Thermal Energy Conversion (OTEC) is a renewable energy technology that uses the natural temperature difference in oceans to produce clean, reliable electricity, day and night, year-round. The heat from the warm ocean surface and cold from the deep ocean drives a **Rankine Cycle**, which produces electricity.

**21. What are the advantages and disadvantages of Tidal Power?**

Advantages of Tidal Energy	Disadvantages of Tidal Energy
Clean and Renewable	Environmental Impact
Predictable and Reliable	High Construction Costs
Long-lasting Equipment	Scarcity of Suitable Locations
Effective at Low Speeds	Inconsistent

**22. Mention the advantages of MHD generator.**

**A high conversion efficiency of around 50%.** A large amount of power is generated. Better utilisation of fuel. Since it has no moving parts, so it is more reliable.

**23. Which of the disadvantages of the current power generator system can be overcome by DEC devices? What are these DEC devices?**

Disadvantages **High energy losses in some cases due to waste heat.** Chemical energy storage converts low-energy substances into high-energy ones.

**Digital Equipment Corporation**, or DEC (pronounced "deck"), was a computer company headquartered in Maynard, Massachusetts. It was best known for its minicomputers, especially its PDP and VAX lines.

**24. Name the types of turbine used in tidal power station**

Kinetic energy turbines, also called free-flow turbines, generate electricity from the kinetic energy present in flowing water rather than the potential energy from the head. The systems can operate in rivers, man-made channels, tidal waters, or ocean currents.

**PART B:**

1. Describe magneto hydro dynamic systems with neat diagram.
2. Explain the applications, and advantage and disadvantages of Geothermal Energy.
3. Explain the geopressed resource and describe about hybrid geothermal fossil fuel systems.
4. What is OTEC system? Explain with the help of neat sketches working principle of closed cycle and open cycle OTEC system. Describe the advantages of closed system over open system. How the site for OTEC plant is selected.
5. What is the basic principle of Tidal Energy? Explain the Principle of working of Simple Tidal Energy Conversion plant with the help of a neat sketch. What is the status of Tidal power plants in the world and in India?
6. What is the Geothermal Energy? What are the various methods of harnessing this energy? What is the potential of Geothermal Energy in India?

