

**K.S.R. COLLEGE OF ENGINEERING, TIRUCHENGODE - 637 215
(Autonomous)**

Department of Electrical & Electronics Engineering

**16EE762 - POWER ELECTRONICS FOR RENEWABLE ENERGY SOURCES
(Regulation: 2016)**

(Two Mark Questions with Answers)

B.E. - EEE, IV YEAR, VIIth - SEMESTER



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**DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING
K.S.R. COLLEGE OF ENGINEERING: TIRUCHENGODE – 637 215.**

COURSE / LESSON PLAN SCHEDULE

16EE762 – POWER ELECTRONICS FOR RENEWABLE ENERGY SOURCES

Year / Sem: IV / VII

Staff Name: Dr.C.Karthikeyan

Regualtion: 2016

Mr. S.Gowtham

Lecture Hour	Topics to be covered	Teaching Aid	Source	Page No.
UNIT I: INTRODUCTION				
L1	Environment aspects of electric energy conversion	BB	T1	825
L2	Impacts of renewable generation on environment (cost – GHG Material Emission)	BB	Web site	
L3	Qualitative study of different renewable energy resources: Ocean Energy	BB	Web site	
L4	Biomass Energy	BB	T1	311
L5	Hydrogen energy systems	BB	T1	609
L6	Operating principles and characteristics of: solar PV	BB	T1	47
L7	Fuel cells	BB & PPT	T1	561
L8	Wind Electrical systems	BB	T1	227
L9	Control strategy, operating area	BB	Web site	
UNIT II: ELECTRICAL MACHINES FOR RENEWANLE ENERGY CONVERSION				
L10	Review of reference theory Fundamentals	BB	Web site	
L11	Principle of operation of IG	BB+PPT	Web site	
L12	Analysis of IG	BB	Web site	
L13	Principles of operation of PMSG	BB+PPT	Web site	
L14	Analysis of PMSG	BB	Web site	
L15	Principles of operation of SCIG	BB+PPT	Web site	
L16	Analysis of SCIG	BB	Web site	
L17	Principles of operation of DFIG	BB+PPT	Web site	
L18	Analysis of DFIG	BB	Web site	
UNIT III : POWER CONVERTERS				

L19	Solar : Block diagram of solar photo voltaic system	BB+PPT	T1	178
L20	Line commutated converters(inversion-mode)	BB	Web site	
L21	Boost and buck-boost converters	BB	Web site	
L22	Selection of inverter , battery sizing, array sizing	BB	Web site	
L23	Wind: three phase AC voltage controllers	BB	Web site	
L24	AC-DC-AC converters	BB	Web site	
L25	Uncontrolled rectifiers	BB	Web site	
L26	PWM inverters	BB	Web site	
L27	Grid Interactive inverters-matrix converters	BB	Web site	

UNIT IV : ANALISIS OF WIND AND PV SYSTEMS

L28, L29	Stand alone operation of fixed speed and variable speed wind energy conversion systems	BB	Web site	
L30	Stand alone operation of solar system	BB	Web site	
L31	Grid Connection Issues	BB	Web site	
L32, L33	Grid integrated PSMG Based WECS	BB	Web site	
L34, L35	Grid integrated SCIG Based WECS	BB	Web site	
L36	Grid integrated operation of solar systems	BB	Web site	

UNIT V : HYBRID RENEWABLE ENERGY SYSTEMS

L37, L38	Need for Hybrid Systems	BB	T1	306
L39, L40	Range and type of Hybrid Systems	BB+PPT	Web site	
L41, L42	Case studies of wind	BB	Web site	
L43, L44, L45	PV Maximum Power Point Tracking (MPPT)	BB	Web site	

Text Books :

1. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
2. Rai. G.D," Solar energy utilization", Khanna publishes, 1993

Reference Books :

1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford University Press, 2009.
2. Rashid .M. H "power electronics Hand book", Academic press, 2001.

UNIT I **INTRODUCTION**

1. Name the energy sources available. (Remembering)

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. (Understanding)

Primary energy source: Primary energy source can be defined as source which provides a net supply of energy. The energy that is 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? (Understanding)

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? (Understanding)

- 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? (Understanding)

- 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.
- Phenomena beyond human control.
- Difficulty in transporting such forms of energy.

6. What is meant by commercial energy? (Understanding)

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? (Understanding)

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? (Understanding)

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.

9. What is meant by supplementary sources? (Understanding)

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? (Remembering)

- 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? (Understanding)

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? (Understanding)

The characteristics of wind energy are:

- It is renewable source of energy
- Like all forms of solar energy, wind power systems are non-polluting, so it has no adverse influence on the environment.
- Wind energy systems avoid fuel provision and transport.
- On a small scale, up to a few kilowatt system, is less costly.

13. What are the problems associated with wind energy? (Understanding)

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 kilometers away.
- Large areas are needed to install wind farms for electrical power generation.

14. Name the three categories of Biomass resources. (Remembering)

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 an aerobically to obtain a gaseous fuel called biogas.

15. Define heliostats. (Remembering)

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. (Remembering)

The energy yields ratio of an energy extraction process is defined as follows:

$$\text{Energy yield ratio} = \frac{\text{Energy received from raw energy source}}{\text{Energy spent to obtain raw energy source}}$$

17. State the importance of non-conventional energy source. (Remembering)

- 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? (Understanding)

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. (Remembering)

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 (Remembering)

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
- Co generation

21. List the necessity of energy storage. (Remembering)

- 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. (Remembering)

The relation between useful thermal energy and the available chemical energy in the fuel is expressed by means of the energy utility factor.

Energy Utility Factor = Useful Thermal Energy/ Available Energy in Fuel

23. Comparison of Conventional and non-conventional sources. (Remembering)

Feature	Conventional(non renewable)	Non conventional (renewable)
Technologies	Established	Under development
Plant size	Large(mw range)	Small (kw range)
Main power plants	Suitable	Not sufficient
Energy density of source	High	Low
Pollution problems	More	Less
Energy conserves	Limited will get exhausted soon	Will continue to renew
Cost of generation	Low	High

24. What are the needs of energy conservation? (Understanding)

- Energy conservation is necessary to reduce the wastage of energy.
- It helps to keep the domestic charge payment constant even when the production cost of electricity increase.
- It helps to maintain the profit in industries uniform even if the electricity charge increases.

25. What are the different types of renewable energy sources? (Understanding)

Solar energy	Wind energy
Hydro power	Geo thermal
Biomass	Tidal &
Wave energy	

26. What are the applications of solar energy? (Understanding)

- Heating and cooling residential building
- Solar water heating
- Solar distillation
- Solar engines for water pumping
- Food refrigeration

27. What are the types of wind mills? (Remembering)

- Multi blade type
- Sail blade type
- Propeller type
- Savonius type and
- Darrieus type

28. Write the characteristics of wind energy. (Remembering)

- It is a renewable source of energy
- Non polluting

- Wind energy systems avoid fuel provision and transport
- On a small scale up to a few KW system is less costly

29. State the causes of problems in wind mill (Remembering)

- Wind energy available is dilute and fluctuating in nature. Because of the dilute form, conversion machines have to be necessarily large.
- Wind energy systems are noisy in operation a large unit can be heard many kilometers away.
- Large areas are needed to install wind farms for electrical power generation

30. What is energy plantation? (Understanding)

Selected species of trees would be planted and harvested over regular time period near the power plant.

Eg: Eucalyptus, casuarinas and babool.

31. What are the draw backs on bio gas? (Understanding)

- Biomass combustion produces air pollution
- Large scale production of biomass and its harvesting accelerate soil erosion and nutrient.
- Domestic use of biomass in rural areas creates air pollution

32. What are the applications of bio mass? (Understanding)

- Cooking
- Lighting
- Mechanical power
- Generation of small electricity

33. What are the environmental concerns of geo thermal energy? (Remembering)

- Gases containing H₂S are oxidized to SO₂ and H₂SO₄ and drops down as acid rain.
- Chemicals like sulphates, Chlorides and Carbonates of lead, boron and arsenic pollute soil and water
- Discharge of waste hot water infects rivers and affect drinking water, farming and fisheries
- Noise pollution caused by exhausts is a health hazard and is controlled by using silencers

34. What are the adverse effects produced by geo thermal energy source?

(Understanding)

- Ammonia is used as working fluid in closed cycle OTEC system. Its leakage may cause great damage to the ocean eco system.
- An OTEC plant displaces 4 cumec water/ MW generation. Massive flow disturbs thermal balance, changes salinity gradient and turbidity. It creates adverse impact on marine environment.
- Mining of warm & cold water near the surface develops convection of sinking cold water. It creates a temporary variation at 4°C forcing mortality among coral and fishes.

PART-B

1. What are the prospects of non-conventional energy sources in India? Explain.
2. Compare the energy consumption pattern in various sections in India. Discuss the growth rate of energy requirements and power generation in India.
3. a) Name and explain briefly the various sources of Non-conventional Energy.
b) Briefly describe about energy conservation act 2003.
4. What are the unconventional sources of energy? How would you use them for energy supply options? Why we these need to develop them?
5. Analyze the availability and efficiency of conversion of non-conventional energy sources in India. State the important features of availability and efficiency as found from this analysis.
6. Briefly discuss about the primary and commercial energy resources. Also discuss about the energy consumption pattern and growth rate in India.
7. Discuss briefly renewable energy sources. Explain their availability, economics and efficiency with reference to Indian context.
8. Describe the various non-conventional energy resources available in India and its potential to supplement the conventional energy sources.
9. What are the conventional and non-conventional energy resources? Describe them.
10. Write briefly on energy consumption pattern and growth rate of energy consumption in India. What do you conclude from this?
11. Explain environmental aspects of energy utilization.
12. Explain the impact of renewable energy generation on environment in detail.
13. How does environment get affected by the use of the renewable energy? and also discuss GHG emissions from the various energy sources.
14. Discuss the influence of different renewable energy sources with special reference to the global warming context.
15. Describe the consequences of greenhouse effect.
16. Explain the working principle of various types of concentrating solar collectors with neat sketch.
17. Compare the power extraction aspects of solar PV system with wind energy system.
18. Describe various types of wave energy conversion device and explain how to generate electrical power from waves.
19. Describe the principle of generation of Bio gas and mention the factors affecting its generation.
20. Explain the design and principle of operation of general Fuel cell and Fossil Fuel cell.
21. Explain the following with neat schematic
 - i. Wind energy conversion system ii. Energy from the Ocean

UNIT- II

ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION

1. What is meant by Solar Energy? (Understanding)

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. (Understanding)

- 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. (Remembering)

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. (Remembering)

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.

$$\text{Solar time} = \text{Standard time} \pm 4 (\text{Lst}-\text{Lloc}) + E$$

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. (Understanding)

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. (Understanding)

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? (Remembering)

- 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? (Remembering)

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 (Remembering)

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 (Remembering)

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? (Remembering)

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? (Remembering)

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. (Understanding)

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 signaling equipment
- Battery charging
- Street lighting

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

(Remembering)

Advantages

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

Disadvantages

- High cost
- In many applications energy storage is required because of no insulation 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. (Understanding)

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. What are the zones in solar pond? (Remembering)

- ¬ 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? (Remembering)

- ¬ 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? (Remembering)

- ¬ 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? (Remembering)

- Need for pumping occurs
1. Greatest.
 2. during the summer when solar radiation is during periods of low
 3. From crops also low.
 4. Radiation when pumping reduce evaporation losses

21. What is the need for solar crop drying? (Remembering)

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.

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 (Understanding)

- ¬ Evaporative cooling
- ¬ Absorption cooling and
- ¬ Passive desiccant cooling

24. What are the 4 units of absorption type solar cooler? (Remembering)

- ¬ Generator

- ¬ Condenser
- ¬ Evaporator

25. What are the advantages of solar cells? (Remembering)

- ¬ 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

26. What are the disadvantages of solar cell? (Remembering)

- ¬ 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.

27. What are the components of basic solar pumping system? (Remembering)

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

28. List the types of heat engines used in solar system (Remembering)

- ¬ Rankine engine
- ¬ Reciprocating engine
- ¬ Vapor engine
- ¬ Stirling hot gas engine
- ¬ Brayton cycle gas turbine
- ¬ Rotary piston engine

29. Write the equation for over all efficiency of solar pump? (Remembering)

$$\eta_{\text{so}} = \eta_{\text{e}} \eta_{\text{c}}$$

Over all efficiency= Efficiency of the engine* Efficiency of the collectors

30. List the working fluids used in solar pumps (Understanding)

- ¬ Foluene
- ¬ Monochloro benzene
- ¬ Frifuluroethanol
- ¬ Hexa flura benzene

31. What are the two types of flat plate collectors? (Remembering)

- ¬ Liquid heating collectors
- ¬ Solarairheaters

32. What is Green house effect? (Remembering)

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 heat and conducts it to surrounding materials (air, water or liquids) or reradiates into other materials of low temperature as long wave radiation.

33. What is concentration ratio? (Remembering)

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

34. List the five advantages of solar energy(Understanding)

- ¬ 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 ratios are energy and in 300 to 1500 and are highly efficient both in collecting converting energy

35. List any four disadvantages of solar energy (Understanding)

- ¬ 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

1. Explain in detail how solar energy can be effectively utilized in day-to-day life.
2. Draw illustrative diagram showing all the important components of solar heating and solar cooling unit. Explain the working principles of these devices.
3. Explain with necessary diagram the construction, principles of operation and applications of solar collector.
4. Explain with neat diagram solar space cooling and solar pond electric power plant.
5. Write short notes on:
 - a) Solar pumping b) Solar desalination
6. Describe the photovoltaic principles of solar power generation. Compare the different types of solar cells with respect to power output and efficiency.
7. Write briefly about characteristics and principles of any three different types of solar collectors. Draw diagrams illustrating the constructional features of these collectors.
8. Draw and explain different types of solar cookers.
9. Explain with neat diagram about solar pond and its characteristics.
10. Discuss briefly about

- a) Solar drying b) solar cells
- 11. Draw schematic diagram of solar thermal power plant used for power production and explain the operation of this system in detail.
- 12. a) Give merits and demerits on solar energy.
b) State some important the applications of PV.

1. Draw the schematic of Permanent Magnet Synchronous generator and explain the construction and principle of operation in detail. Also discuss the characteristics and issues briefly.
2. Explain the principle of operation and constructional features of squirrel cage induction generator with a neat diagram. Analyse the merits and demerits of the above.
3. Explain construction, principle of working and characteristics of IG with neat sketches.
4. Explain the principle of operation of DFIG used for renewable energy conversion.
5. Explain machine capacity factor and capacity utilization factor. Explain the principle of operation of double output induction generator system with neat diagram.
6. Draw the circuit model of self-excited induction generator and explain the methods used for steady state analysis.
7. Explain about DFIG based energy conversion system
8. Explain construction, principle of working and characteristics of SCIG with neat sketches.
9. Explain the analysis of Induction Generator used for Wind Energy Conversion System.
10. Draw the circuit model of PMSG and explain the methods used for steady state analysis.

UNIT-III

POWER CONVERTERS

- 1. List out the factor led to accelerated development of wind power. (Remembering)**
- 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? (Remembering)**

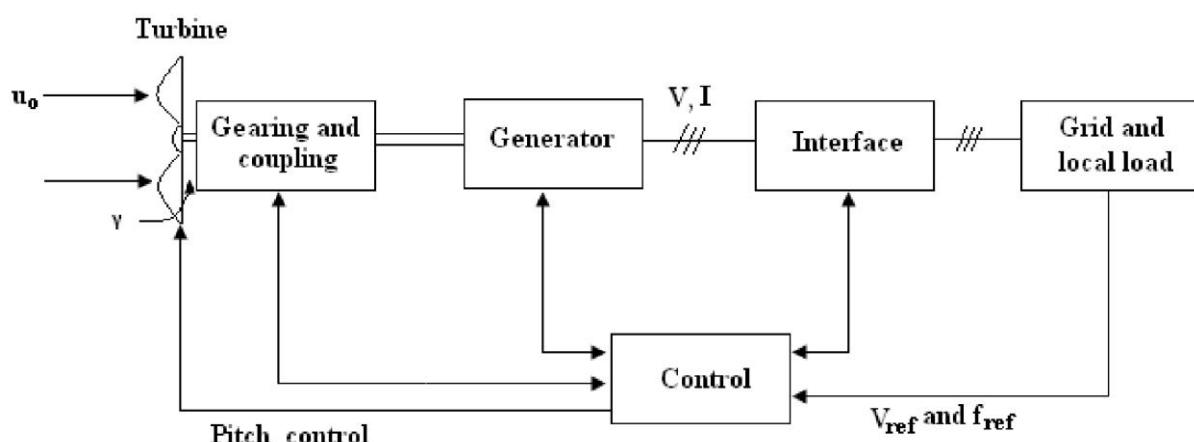
- No tall obstructions for some distance in the upwind direction and also a
- low a roughness as possible in the same direction A wide and open view
- i.e., opens plain, open shore line or offshore locations.
- Top of smooth well-rounded hill with gentle slopes on a flat plain
- An island in a lake or 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.

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

(Remembering)

- 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 assemble on the ground and lifted to the shaft without complicated manoeuvres during the lift

- 4. Draw the block diagram of WECS. (Remembering)**



5. What are the types of generator drive for the operation of WECS? (Remembering)

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

- DC generator Synchronous
- Generator Induction
- generator

6. Define gusts. (Remembering)

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.

7. What are the features of VAWT? (Remembering)

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.

8. Define power coefficient(Remembering)

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

9. List out the merits of WECS (Remembering)

- 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 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.

10. List out the demerits of WECS (Remembering)

- 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 30 to 300W range.

11. What are the components of wind turbine generator units? (Remembering)

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.,

11. Classify the schemes available for electric generation. (Remembering)

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)

13. Define wind turbine. (Remembering)

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.

14. What is cut in speed and cutout wind speeds for turbine? (Remembering)

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 wind speed.

Cut out speed: While operating	- 20m/s
While stopping	- 17m/s
Rated speed	- 14m/s

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

(Remembering)

Winds are ~~natural~~ 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 ~~surfaces~~ during day and night.

17. Name the characteristics in which the speed of a wind turbine rotor depends.

(Remembering)

- 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 (Remembering)

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?

(Remembering)

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? (Remembering)

The main environmental aspects are:

- Indirect energy use and emissions
- Bird life
- Visual impact Telecommunication
- interference Safety
- Effects on ecosystem.

21. What are the types of rotors for HAWT? (Remembering)

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? (Remembering)

The different types of rotor for HAWT are:

- Cup type rotor
- Savonious rotor
- Darrieus rotor
- Musgrove rotor
- Evans rotor

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

A site should have a high annual wind speed 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 (Remembering)

- ¬ A rotor
- ¬ A gear box

- ¬ An enclosure
- ¬ A tail vane

25. Explain the principles of wind energy conversion(Remembering)

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? (Remembering)

Drag in the direction of air flow

Lift perpendicular to the direction of air flow

Lift

Generation of lift always causes certain amount of drag to be developed
devices are more efficient than drag devices

27. List wind speed types. (Remembering)

- ¬ 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? (Remembering)

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

29. What are the types of wind power plants? (Remembering)

Hybrid

Remote

Grid connected system

30. What are the advantages of wind energy systems? (Remembering)

No pollution

Inexhaustible fuel source

Reduces

Often an excellent supplement to other renewable sources fossil fuel consumption

Increases local tax revenues

Wind power plant create may jobs

It's free Least reliance on foreign oil

31. What are the disadvantages of wind energy systems? (Remembering)

- ¬ Large areas are needed
- ¬ Suitable for wind power generation
- ¬ Relatively expensive to maintain
- ¬ Large numbers of wind generators are required to produce useful amount of

heat or electricity

32. What are the safety systems in wind energy system? (Remembering)

- Emergency stop
- The computer
- Lightning
- Revolution counters

33. What are the environmental impacts of wind energy systems? (Remembering)

- Noise
- Electromagnetic interference
- Visual effect

34. List the classification of wind mills according to size. (Remembering)

- ¬ Small scale (up to 2Kw)
- ¬ Medium size machines

35. List classification according to output power (Remembering)

- ¬ DC output
- ¬ AC output
- a) Variable frequency variable or constant voltage AC
- b) Constant frequency, variable or constant voltage AC

36. What are the types of horizontal axis machines? (Remembering)

- ¬ Single bladed
- ¬ Multi bladed
- ¬ By cycle multi blade type

37. What are the vertical axis machines? (Remembering)

- ¬ Savonius or S type rotor mill
- ¬ Davieus type rotor mil

PART-B

1. Is wind energy a better alternative source of energy for Indian demand? Explain in detail how wind energy is produced.
2. Explain in detail about the performance and efficiency of different types of wind mills.
3. Describe with a neat sketch the working of a wind energy conversion system (WECS) with its main components.
4. a) What is the origin of wind and what are the various factors which govern wind energy and direction?
b) determine the overall power coefficient for a wind turbine with a rated power of 3 MW, speed 18m/s and blade diameter 40 metre.
5. Explain the preliminary design of wind electric system.
6. 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.

7. a) Explain the principle of electric power generation from wind mill.
b) Discuss its types and components. Also indicate the best site for locating them.
8. Explain the principle of operation of any two types of wind mill with neat diagram and discuss its characteristics and constraints if any.
9. Discuss briefly about
 - a) Performance of wind mills
 - b) Wind power generation in India.
10. Describe the saronious type of rotor in wind mill.
11. Compare the performance of horizontal and vertical axis wind mills.
12. How wind energy conversion systems are classified? Discuss in brief. What are its advantages and disadvantages?
13. Explain the safety and environmental aspects of wind energy.

1. Explain the converters used for solar energy conversion.
2. Describe the grid interactive inverters in detail.
3. Explain with neat diagram the philosophy of operation of a solar source fed boost converter.
4. Describe how a three phase line commutated converter is operated as an inverter.
5. Explain the operation of line commutated converter under inversion mode with the help of a neat circuit diagram and necessary waveforms.
6. Write short notes on the grid interactive inverters.
7. Consider a buck boost converter of input voltage $E_{dc}=14V$. The duty cycle $\alpha=0.6$ and the switching frequency is $25kHZ$. The inductance $L=180\mu H$ and the filter capacitance $C=220\mu F$. The average load current $I_o=1.5A$. Compute the average output voltage and peak current of the device.
8. A single phase full bridge inverter has a resistive load of $\Omega R=3\Omega$ and the DC input voltage is $E_{dc}=50V$. Compute the RMS output voltage at the fundamental frequency, the output power, the average and peak currents of each thyristor and peak reverse blocking voltage of each thyristor.
9. Describe working of AC-DC-AC converter with circuit and wave form for wind energy conversion.
10. Analyse the principle of working of buck-boost converter with time ratio and current limit control. Draw the circuit and necessary waveforms.
11. Describe principle of operation of PWM inverter and describe how it is used for wind energy conversion.
12. Draw the block diagram of the solar PV system and explain the principle of operation in detail.

13. Draw the schematic diagram of Buck-Boost converter and explain the operation in detail.
14. Explain the following in detail:
 - i. AC voltage controller ii. Voltage control in PWM inverters.

UNIT-IV

ANALYSIS OF WIND AND PV SYSTEMS

- 1. What is meant by biomass energy and biomass energy resource? (Remembering)**

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. (Remembering)**

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.,

- 3. What do you mean by fossil fuels? (Remembering)**

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? (Remembering)**

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. (Remembering)**

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. (Remembering)**

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.

7. List out the biomass energy resources from waste. (Remembering)

The waste to energy processes convert organic wastes to intermediate or secondary energy forms such as heat, biogas, alcohol, fuels, chemicals, etc.The waste is classified as

- Urban (municipal) waste
- Industrial organic waste, process waste
- Agricultural farm waste
- Rural animal waste
- Forest waste
- Fishery,poultry,butcharry waste
- Animal and human excreta

8. What is meant by biogas plant? (Remembering)

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 (Remembering)

- 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 (Remembering)

- 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 determines 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? (Remembering)

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

12. Classify the biogas plant. (Remembering)

The biogas plant are classified into

- Continuous and batch types The
- dome and drum types

13. List the factors affecting biodigestion or generation of gas. (Remembering)

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

14. Why the biogases are mainly utilized? (Remembering)

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(Remembering)

- 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. (Remembering)

- ↔ The gas production in it is intermittent, depending upon the clearing of the digester.
- ↔ It needs several digesters or chambers for continuous gas production, these are fed alternatively.
- ↔ Batch plants are good for long fibrous materials
- ↔ This plant needs addition of fermented slurry to start the digestion process.
- ↔ This plant is expensive and has problems comparatively; the continuous plant will have less problems and will be easy for operation.

17. Mention some advantages of fixed dome type plant(Remembering)

- 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.

18. Mention some disadvantages of fixed dome type plant(Remembering)

- 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.

19. What are the techniques or methods of maintaining biogas production?

(Remembering)

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? (Remembering)

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. (Remembering)

Types of cogeneration principles are:

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

The Bottoming Cycle: primary heat at high temperature is used directly for industrial process requirements. The remaining low grade heat is then used for electrical power generation, e.g. high temperature cement kiln.

24. Three general types of cogeneration systems(Remembering)

The three general types of cogeneration principles systems are:

- Waste heat utilization
 - space heating and cooling
 - warm water in agriculture
 - warm water in aquaculture
- Total/Integrated energy system for residential complex Total
- energy system (TES) for industry.

25. What is meant by incineration? (Remembering)

Organic matter can be burnt in presence of oxygen/air to produce heat and by products. This is the well known process called combustion. Complete combustion to ashes is called incineration.

26. What are the types of Gasifiers? (Remembering)

In down draft gasifier fuel and air move in a co current manner

In updraft gasifier fuel basic reaction zones remain and air move in a counter current manner.

27. What are the types of biomass resources? (Remembering)

- Forests
- Energy crops
- Agricultural crops residues
- A quatic crop
- Vegetable oil crops
- Urban waste
- Animal waste
- Industrial
- Waste

28. What is Transesterification? (Remembering)

Process where the raw vegetable oils are treated with alcohol (Methanol or ethanol with a catalyst) to form methyl or ethyl esters.

29. What are the advantages of bio-diesel as engine fuel?

- ¬ Biodegradable produces 80% less and co2 100% less So2 emissions
- ¬ Renewable
- ¬ Higher octane number
- ¬ Can be used as neat fuel or mixed in any ratio with petro diesel
- ¬ Has a higher flash point making it safe to transport

30. What are the components of cogeneration system? (Remembering)

- ¬ Prime mover
- ¬ Generator
- ¬ Heat recovery
- ¬ Electrical interconnection

31. What are the types of prime movers? (Remembering)

- ¬ Reciprocating engine
- ¬ Combustion of gas functions
- ¬ Steam turbines
- ¬ Micro turbines
- ¬ Fuel cells

32. Write any two benefits of cogeneration (Remembering)

- ¬ Increased efficiency of energy conversion and use
- ¬ Lower emission to the environment in particular of co2, the main green house gas
- ¬ Biomass fuels and some waste materials such as refinery gases, agricultural wastes are used. They serve as fuels for cogeneration schemes increases the cost effectiveness and reduces the need for waste disposal

33. What are the types of cogeneration system? (Remembering)

- ¬ Steam turbine cogeneration system
- ¬ Gas turbine cogeneration system
- ¬ Reciprocating engine cogeneration system

PART – B

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.
3. What is the principle involved in the production of biogas and what is the chemical composition of the gas? What are the various applications of this gas? Draw a sketch to illustrate the constructional features of a typical biogas plant and describe its operation.
4. a) Compare the advantages and disadvantages of power generation from industrial wastes, municipal waste and agricultural wastes.
b) How do we get energy from various types of wastes?
5. a) Name the various model of biogas plant.
b) What are the main problems in straw fermentation?
6. Sketch and describe any one type of bio-mass gas generation plant. Mention 4 uses of the biogas produced.
7. How are biogas plant classified? Explain continuous and batch type plants and compare them with regard to operation and efficiency.
8. Write short notes on
 - a) Continuous type plant
 - b) Flexible dome type plant
9. What is community biogas plant? What is the main problem encountered with operation?
10. List out the various points to be carried out for selection of site for a biogas plant.
11. Draw schematic diagram of biogas power plant and explain its operation. State and justify the potential of this in satisfying energy demand of our country.
12. Write briefly on power production from agricultural waste. Draw relevant sketches and point out the relative merits of this technique.
13. What is biomass gasification? Explain its classification with neat diagram.
14. How ethanol is produced from biomass? Explain its major classification.
15. What is meant by cogeneration? How they are classified? Explain its principles.
16. Explain the following cogeneration systems.
 - a) Steam turbine b) Gas turbine
17. Explain the following cogeneration systems.
 - a) Reciprocating IC Engine b) Combined cycle.
18. Enumerate the application of the following.
 - a) Cogeneration in Utility sector b) Biomass

UNIT –V

HYBRID RENEWABLE ENERGY SYSTEMS

1. What is meant by tidal current energy? (Remembering)

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? (Remembering)

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 (Remembering)

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 (Remembering)

- 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 (Remembering)

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. (Remembering)

- 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. (Remembering)

- 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(Remembering)

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 (Remembering)

- 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.

d) 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? (Remembering)

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
 - Valcanoes.

11. What is meant by OTEC? (Remembering)

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? (Remembering)

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. (Remembering)

- 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? (Remembering)

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 (Remembering)

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. (Remembering)

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.

17. What are the types of tidal power plants? (Remembering)

- ¬ 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? (Remembering)

Sluice gates

Barrage

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? (Remembering)

- ¬ 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? (Remembering)

- ¬ 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? (Remembering)

- ¬ Wave energy equipment must be capable of withstanding very reverse peak stress and storms
- ¬ Wave energy equipments 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(Remembering)

Each water layer of identical thickness absorbs an equal fraction of light that passes through it. The intensity of heat decreases with the increase in water depth.

24. What are the types of OTEC plants? (Remembering)

- ¬ Open
- ¬ Closed and
- ¬ Thermoelectric

25. What is Biofouling? (Remembering)

The raw ocean water which is pumped in for evaporator and condenser contains micro organisms 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 (Remembering)

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 (Remembering)

Stations upto 1000KW output – micro hydroplant

Stations upto 5000KW output- mini hydroplant

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

- ¬ Depending on capacity
- ¬ Depending on load
- ¬ Based on scheme

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

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

30. What are the three parts of earth? (Remembering)

- ¬ Crust
- ¬ Mantle and
- ¬ Core

31. What are the two parts of the crust? (Remembering)

- ¬ Solid crust
- ¬ Ocean crust

32. What are plate tectonics? (Remembering)

Movement of crust caused by the movement of the lithosphere over the asthenosphere

33. What are the types of geo thermal resources? (Remembering)

- ¬ Hydrothermal
- ¬ Vapour dominated resource
- ¬ Hot dry rock resource
- ¬ Geo pressured resource
- ¬ Magma resource

34. Define magma? (Remembering)

Magma is a molten rock at temperature ranging from 700°C to 1600°C . This hot viscous liquid comes out at active volcanic vents and solidifies.

35. What are the types of geothermal power generation? (Remembering)

- ¬ Liquid dominated
 - Flashed steam engine
 - Binary cycle system
- ¬ Vapour dominated resource

36. Write the field of utilization of geothermal energy (Remembering)

- ¬ Power generation
- ¬ Space heating
- ¬ Extraction and refining at borax and sulphur
- ¬ Green house heating
- ¬ Refrigeration

37. What are the advantages of geothermal energy? (Remembering)

- ¬ Versatile in its use
- ¬ It is cheaper compared to the energies obtained from other sources both zero fuels and fossil fuels
- ¬ It delivers greater amount of net energy from its system than other alternative of conventional systems
- ¬ It has the highest annual load factor at 85% to 90% compared to us 50% for fossil fuel plants
- ¬ Pollution produced is least.

38. What are the disadvantages of geothermal energy? (Remembering)

- ¬ Over all efficiency is 15% compared to 35-40% for fossil fuel plants
- ¬ The withdrawal of large amount of steam or water from a hydrothermal reservoir may result in surface subsidence
- ¬ Drilling operation is noisy
- ¬ Large areas are needed for exploitation of geothermal energy as much of it is diffused

39. Define fuel cell (Remembering)

It is an electrochemical device that converts chemical energy of fuel in of fuel in to electricity with out involving a combustion cycle

40. What are the technical parameters of a fuel cell? (Remembering)

Individual cell -0.55 to 0.75V

Given No of cells arranged in stacks provides required level of voltage
power- electrode size & number of cells

41. What are configurations of stirling engine? (Remembering)

- ¬ Single acting
- ¬ Dual acting

Part - B

1. Explain in detail the general arrangements for generating units in tidal power plants. What are its merits and demerits?
2. Describe the construction and working principle of geothermal power plants in detail.

Enumerate the advantages and disadvantages of geothermal plant.

3. Explain the working of a tidal power plant and the two way operating cycle for its units.
4. Explain the theory of the origin of geothermal energy. Draw the layout of geothermal power plant and explain its operation.
5. a) Compare tidal power plant with geothermal power plant.
b) With relevant diagram, explain the operation of tidal power plant.
6. Explain in detail any one type of geothermal power plant. Compare its efficiency with tidal power plant.
7. a) Define tidal plant
b) With a neat sketch explain the working principle of two pool tidal system.
8. Draw the schematic and explain the vapour dominated geo thermal plant.
9. Draw the layout of the micro-hydro scheme and explain its components. What are its advantages and disadvantages?
10. Draw and explain the following cycles
 - a) Open OTEC
 - b) Closed OTEC
11. What is Stirling engine? Explain its types.
12. What is wave energy? Explain the wave energy components with neat diagram. List out the merits and demerits.