MODEL ANSWER

SUMMER - 2017 EXAMINATION

Subject: Renewable Energy Sources **Subject Code: 17645**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

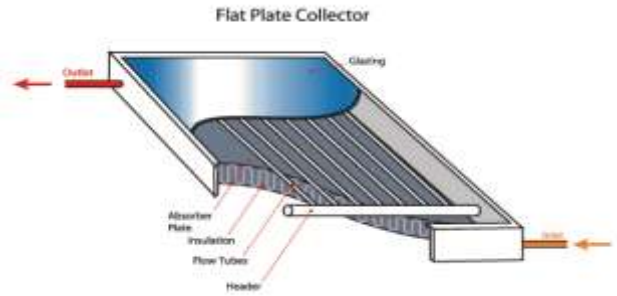
Q. No.	Sub Q.N.	Answer	Marking Scheme
1.	**A)**	**Attempt any three:**	**12**
	a)	**State the need of alternative energy sources in present energy scenario.**	**4M**
	Ans.	**Need of alternative energy sources in present energy scenario:** 1. Conventional sources of energy like oil, gas and coal are depleting very fast. Oil is likely to last up to2025 and coal another 200 years. 2. Oil, gas and coal cause air pollution which is causing global warming and climate changes all over the world. It is also increasing the level of sea, elimination of certain species, impacting the life of plant, animals and marine life. 3. Import of oil bill is increasing due to increasing energy needs. 4. Causing reduction in agricultural production per capita. 5. Scarcity of fresh water supply 6. Causing increased health problems. In view of the above, we need to reduce our dependency on oil, coal and nuclear fuels and their imports. Therefore, we need to increase our oil and gas production and look for alternate sources of energy for our power needs.	***Any four points 4M***

MODEL ANSWER

SUMMER - 2017 EXAMINATION

Subject: Renewable Energy Sources **Subject Code:** **17645**

	b) Ans.	**Define renewable energy sources and give four examples.** **Renewable energy** is energy obtained from sources that are essentially inexhaustible. **Example of renewable energy sources includes:** 1) Solar energy 2) Wind power 3) Geothermal energy, 4) Tidal power 5) Ocean power 6) Hydroelectric power.	**4M** ***Definition 2M*** ***½ M for each example***
	c) Ans.	**Define 'Solar Constant' and state its formula.** **Definition Solar Constant:** The rate at which solar energy arrives at the top of the atmosphere is called the solar constant I_{sc}. This is 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. The distance between earth and the sun varies a little through the year. i.e. the earth is closest to the sun in summer and farthest in the winter. This produces a nearly sinusoidal variation in the intensity of solar radiation. $I_n = I_{sc}[1 + 0.033 \cos\frac{360_n}{365}$ Where n is the day of the year	**4M** ***Definition 2M*** ***Formula 2M***
	d) Ans	**With reference to radiation geometry define:** **Solar azimuth angle, Zenith angle, Incident angle and declination.** **Solar azimuth angle: (γ)** It is the angle subtended in the horizontal plane of the normal to the surface of the horizontal plane. The angle is taken positive if the normal is west of south and negative when east of south in northern hemisphere. **Zenith angle: (Θ_z)** It is the vertical angle between the sun's ray and the line perpendicular to the horizontal plane through the point. It is complimentary angle of the sun's altitude angle. $\theta_z + \alpha = \frac{\pi}{2}$	**4M** ***Each definition 1M***

		Incident angle: (Θ) It is the angle being measured between the beam of rays and normal to the plane. **Declination: (δ)** It is the angular distance of the sun's rays north (or south) of the equator. It is the angle between a line extending from the centre of the sun of the earth and the projection of this line upon the earth's equatorial plane.	
1.	**(B)** **a)** Ans.	**Attempt any one:** **Listout the different types of solar collectors and explain the working of any one.** **Types of solar collectors:** 1) Non concentrating flat plate type solar collector. 2) Concentrating (focusing) type solar collector. a) Cylindrical parabolic collectors (line focusing) b)Paraboloid-trough collectors (point focusing) **1) Flat plate type solar collector**  **Construction & Working**: It consists of solar radiation collector or absorber, glass cover, insulating material and water pipe. The most important part is its solar radiation absorber which derives heat energy from sunrays. The absorbing material is typically a flat metal sheet. Water carrying pipe is attached to this sheet. The absorber plate is insulated at the back and at the side to insulate it from ambience for minimizing the heat losses. At the front side, transparent glass is kept which allows solar radiation to fall on the absorber metal sheet & prevents upward thermal losses. Eventually the insulated absorber plate and pipe / channel assembly is connected to the water tank through pipes as shown in figure.	**6** **6M** ***Classification 2M*** ***Any one collector : Diagram 2M& explanation 2M***

The absorber plate receives the solar radiation and gets heated. The heat is then transferred to the water channel and water therein. Hot water has low density as compared to the cold water. Due to this density difference, cold water at inlet pushes the hot water in the water channel, sending it up all the way to out let and to the water tank. This water circulation pattern gets set automatically due to density difference.

2) **Cylindrical parabolic collectors (line focusing)**

A schematic diagram of a typical line focusing concentrating collector is shown in fig. The collector consists of a concentrator and a receiver. The concentrator shown is mirror reflector having the shape of a cylindrical parabola. It focuses the sunlight on to its axis, where it is absorbed on the surface of the absorber tube and transferred to the fluid flowing through it. A concentrating glass cover around the absorber tube helps in reducing the convective and radiative losses to the surrounding. In order that the sun rays should always be focused on to the absorber tube, the concentrator has to be rotated. This movement is called tracking.

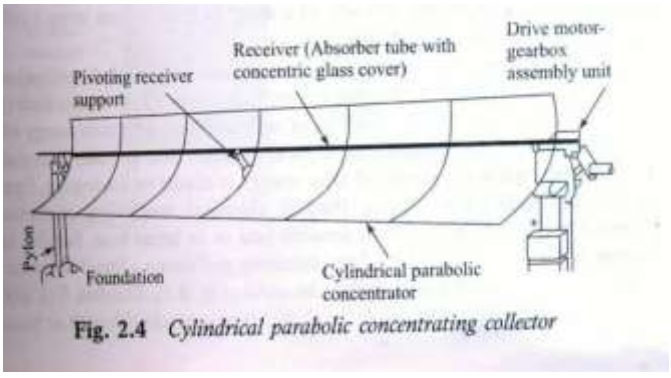


Fig. 2.4 *Cylindrical parabolic concentrating collector*

3) Paraboloid-trough collectors (point focusing)

Fluid temperature up to 400°C can be achieved in cylindrical parabolic focusing collector systems. The generation of still higher working temperature is possible by using paraboloid reflectors as shown in fig which have a point focus. These require two axis tracking so that the sun is in line with focus and vertex of the paraboloid.

MODEL ANSWER

SUMMER - 2017 EXAMINATION

Subject: Renewable Energy Sources **Subject Code: 17645**

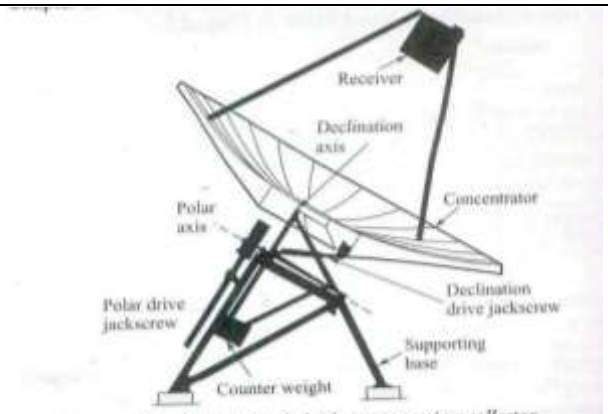


Fig. 2.5 *Paraboloid concentrating collector*

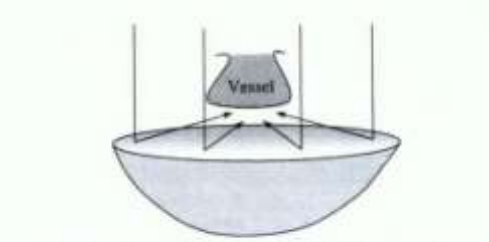
b) **State components, specifications and operation of Dish type Solar cooker.** **6M**

Ans.

Components & Specification table 3M

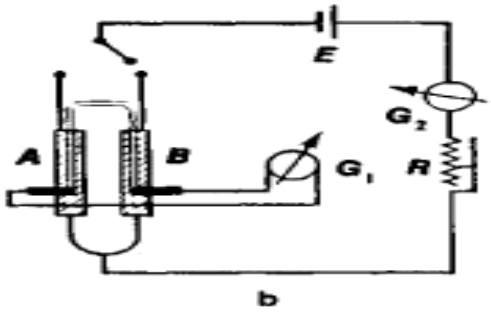
Materials and their comparison for use in dish type of solar cookers

System Components	*Specifications*		*Comments*
	Material	*Properties*	
Reflector Flat mirror pieces Metal foil	Glass Anodized aluminium	Reflectivity should be high to achieve higher optical efficiency, useful for high temperature	Mirrors are difficult to get in curved shape, also they are fragile. Mostly anodized aluminium is used. Special coating should be done on reflective surface to protect it from scratches.
Supporting stand	GI, Mild steel	Enough to support the dish	Powder coated for durability
Cooking utensils	Aluminium, copper or stainless steel	Must be coated with black material to absorb more heat	

		 FIGURE 4.6 Dish type concentrator solar cooker. **Operation:** In Dish type solar cooker the concentration of solar radiation is manifold greater than normal solar radiation (about 20 to 50 times, or could be much higher depending on the requirement). This is effectively a two dimension concentration ,i.e light is concentrated from two dimensions and brought to a point. A schematic diagram of dish type concentrator is shown in fig.	***Diagram 1M*** ***Operation 2M***
2.	**a)** Ans.	**Attempt any four:** **Discuss the environmental aspects associated with the energy utilization.** 1) Use of fossil fuels gives rise to production of Greenhouse gas which contains methane, hydrogen and other hydrocarbons. This affects the environment species and leads to pollution. Due to which there is a need of alternate energy sources such as renewable. 2) Energy pattern is economic growth. Resources are used to meet human needs as well as preserving environmental issue for generation. 3) The rate of fossil fuel being used is phenomenal and is no way the nature can replace them. This will lead to a situation of scarcity of fuel. 4) The fuel used by power plants such as coal, gas, oil are producing pollutants which disturb environmental stability . 5) Emphasis on use of renewable sources of energy can prevent the environmental disaster. Use of hydropower, wind, solar energy can give some retrieve. 6) Similarly excessive use of land, water, forest and living resources can lead to irrespirable harm to environment.	**16** **4M** ***Any 4 pts 1M for each***
	b) Ans.	**List the equipments used for solar radiation measurement and explain any one in brief.** There are two basic types of instruments used for solar radiation measurement:	**4M**

A) Pyrheliometer
B) Pyranometer

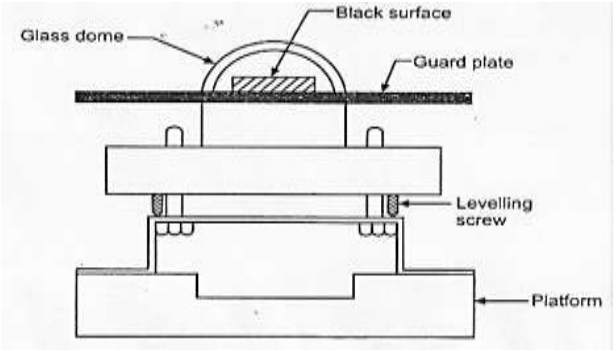
A) Pyrheliometer:



b

Construction & Working: In this instrument, two identical blackened managing strips A and B are arranged in such a way that either can be exposed to radiation at the base of collimator tube by moving a reversible shutter. One strip is placed in radiation and a current is passed through the shaded strip to heat it to the same temperature as the exposed strip. When there is no difference in temperature, the electrical energy supplied to shaded strip must be equal the solar radiation absorbed by the exposed strip. Solar radiation is then determined by equating the electrical energy to the product of incident solar radiation, strip area and absorptance.

B) Pyranometer:

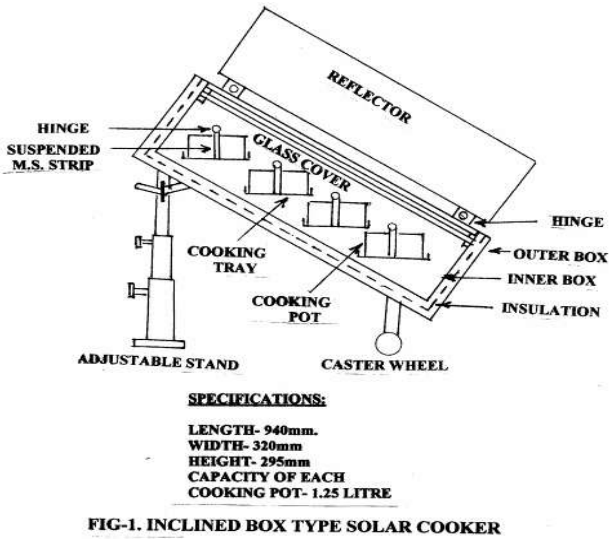


Construction & working: A pyranometer is an instrument which measures total or global radiation over a hemispherical field of view. It consists of a "black surface" which receives the beam as well as

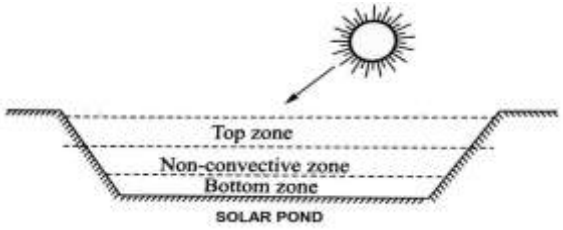
½ M for each instrument

Diagram 1M

Explanation 2M Explain any one instrument

		diffuse radiations which produce heat. A "glass dome" prevents the loss of radiation received by the black surface. A "thermopile" is a temperature sensor and consists of a number of thermocouples connected in series to increase the sensitivity. The "supporting stand" keeps the black surface in a proper position. The sun's radiation is allowed to fall on a black surface to which the hot junctions of a thermopile are attached. The cold junctions of the thermopile are located in such a way that they do not receive the radiation. As a result, an emf proportional to the solar radiation is generated.	
	c) Ans.	**Explain construction and operation of Advanced Solar Cooker.** ***(Note: Any other relevant design can be considered)*** **Inclined Box Type Solar Cooker:**  **FIG-1. INCLINED BOX TYPE SOLAR COOKER** The detailed constructional feature of the cooker is shown in above figure. The cooker box consists of a top open black painted inner box kept inside of the box and the space between the two boxes is filled with glass wool insulation. The upside of this cooker box is covered by two layers of transparent glass keeping a gap in between and the supporting frame of the cover is hinged with cooker box for keeping glass cover in inclined position to handle the cooking pots. So the cooker box is similar to conventional box type cooker, but the shape of the box is different from common type. The length of the box in presently proposed type is at about three times of its width and depth is equal to the width.	**4M** ***Advanced Solar Cooker (New Design), 2M for Diagram & 2M for Operation***

		The cooker is to be placed facing sun, keeping longer side vertically inclined position and the inclination of the cooker box can easily be changed from 15 degree to 45 degrees with respect to the ground by the adjustable stand, attached at the back side of the box. Two mirror reflectors are used in this cooker, however even up to four reflectors can be conveniently arranged in this box type cooker (provided the reflectors are light weight). The reflectors are set along the length of the cooker box cover, one in each side, by hinge and holding strip. So length of reflectors are equal to the length of the glass cover. The widths are equal to the width of the glass cover .When the cooker is in use, each reflector is kept at the inclination of about 115 degree with the face of the box cover .In this position the reflections from the top edge of the reflectors touch the outer longitudinal edge of cover glass when the cooker is placed in perpendicular direction to the solar rays .If four reflectors are used then other two reflectors are to be hinged at the top of the inner reflectors, one in each side at an angle of nearly 15 degree with the inner one All the reflectors can be folded for keeping on the top of the cooker box cover when not in use. The face of the cooker is to be placed perpendicular to beam radiation to collect the maximum energy. This perpendicular position can be easily achieved simply by the rotation of the cooker towards the sun with the help of caster wheels ,suitably attached at the bottom side of the cooker and by changing the inclination of the cooker by adjustable stand of the back side .But the position of the reflectors remain unchanged throughout the working period.	
	d) Ans.	**State the working principle and applications of Solar Pond.** **Principle:** In general pond, when water is heated up by the sun rays the heated water rises to the top of the pond. The hot water loses heat to the atmosphere & so the net temperature at the top of the pond remains nearly at atmospheric temperature. The solar pond technology ensures that heated brine water remains at the bottom of the pond due to more brine concentration and density in it.	**4M** ***Principle of solar pond 2M***

		 **Application of solar pond:** a) Heating and cooling of building b) Production of power c) Industrial process heat d) Desalination e) Heating animal housing and drying crops on farms f) Heat for biomass conversion	***Any 4 application ½M for each***
	e) Ans.	**State the meaning of following terms:** **Power in the wind, Max.power, Power coefficient, Wind-energy conversion.** **1) Power in wind** It relates kinetic energy of wind, harnessed & directed to perform a task mechanically. It depends on wind speed, location etc. **2) Maximum Power** Theoretical power generated by wind turbine. It depends on power coefficient. **3) Power Coefficient:** The fraction of the free-flow wind power that can be extracted by a rotor is called the power- coefficient; thus Power coefficient = $\frac{\text{Power of wind rotor}}{\text{Power available in the wind}}$ **4) Wind energy Conversion:** A wind energy conversion system (WECS) or wind energy harvester is a machine that, powered by the energy of the wind, generates mechanical energy that can be used to directly power machinery (mill, pump) or to power an electrical generator for making electricity.	**4M** ***1M for each definition***
	f) Ans.	**State criteria to be considered in selecting the site for wind mills.**	**4M**

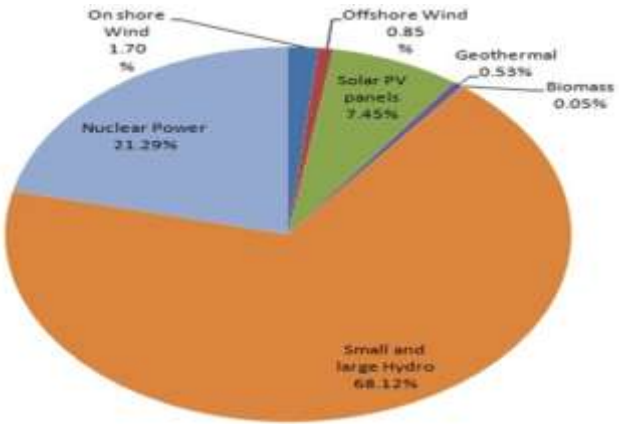
		i) High annual average wind speed: The fundamental requirements to the successful use of WECS, obviously, is an adequate supply of wind. The wind velocity is critical parameter. It is obviously desirable to select a site for WECS with high wind velocity. **ii) Availability of anemometry data:** The anemometer high above ground, accuracy, linearity, location on the support tower, shadowing and other readings, icing inertia of roter whether it measures the horizontal velocity component or vertical, and temperature effects are a few of the many difficulties encountered. This anemometry data should be available over some time period. **iii) Availability of wind curve at the proposed site:** this is important curve determines the maximum energy in the wind and hence is the principle initially controlling factor in predicting the electrical output. The curve also determines the reliability of delivered WECS generator power. Its curve goes to zero, there will be no generated power during that time. **iv) Wind structure at the proposed site:** For ideal site wind structure should be such that a smooth steady wind that blows all the time. But this ideal site is not possible. **v) Altitude of the proposed site:** it affects the air density and thus the power in the wind and hence the useful WECS electric power output. Wind must have higher velocities at higher altitude. **vi)Terrain and its aerodynamic:** One should know about terrain of the site to be chosen. If the WECS is to be placed near the top but not on the top of a not too blank hill facing the prevailing wind, then it may be possible to obtain high speed up of the wind velocity over what it would otherwise be. Also use hills or mountains which channel the prevailing winds. **vii) Local ecology:** If the surface is bare rock it may lower have lower hub heights hence lower structure cost. It trees or grass or vegetation are present, all of which tend to destructure the wind, then higher hub heights will be needed. **viii) Distance to Roads or railways:** This is another factor the system engineer must consider for heavy machinery, structures, materials, blades and other apparatus will have to be moved into any chosen WECS site. **ix) Nearness of site to local centre / users:** This obvious criterion minimizes transmission lines length and heavy losses and costs. After applying all the previous siting criteria, hope fully as one narrows the	***Any four points, 1M each***

proposed WECS sites.
x) Nature of ground: Ground condition should be such that the functions for a WECS are secured. Ground surface should be stable. Erosion problem should not be there.
xi) Favourable and cost: Total cost should be favorable as this along with siting cost enters into the total WECS system cost.
xii) Other conditions such as icing problem, salt spray or blowing dust should not be present at the site.

3. **Attempt any four:** **16**

a) **With the help of pic-chart explain the potential of renewable energy sources uptill now.** **4M**

Ans.



For pie chart 2M

Renewable energy status and potential:

Sr. No.	Sources	Potential (in MW)	Installed (in MW)
1	Wind energy	48,561	10464
2	Small Hydro Power	14292	2461
3	Biogas	5000	1555
4	Bio- Power	61000	773
5	Waste energy	7000	59
6	Solar Photovoltaics	20	2
	Total	135853	14914

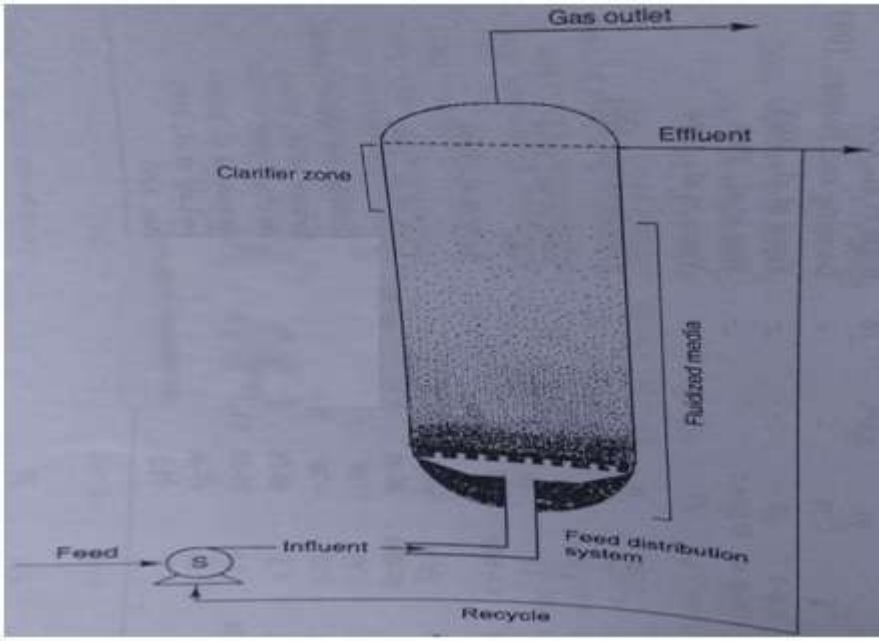
Explanation 2M

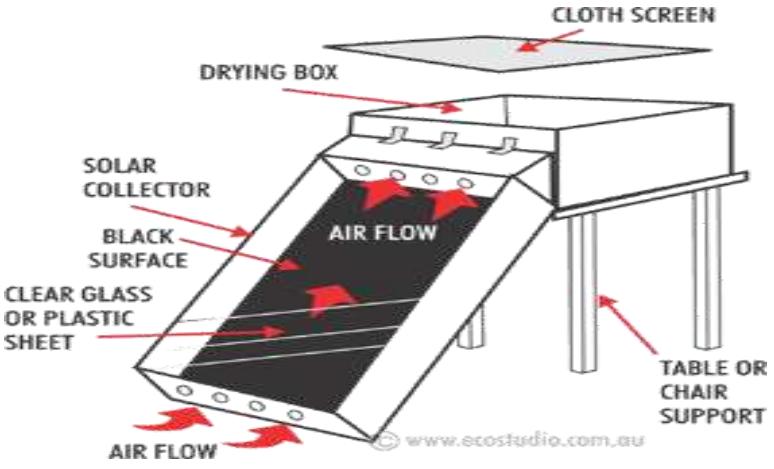
b) **Define tilt factor for beam radiation and state factors on which it depends.** **4M**

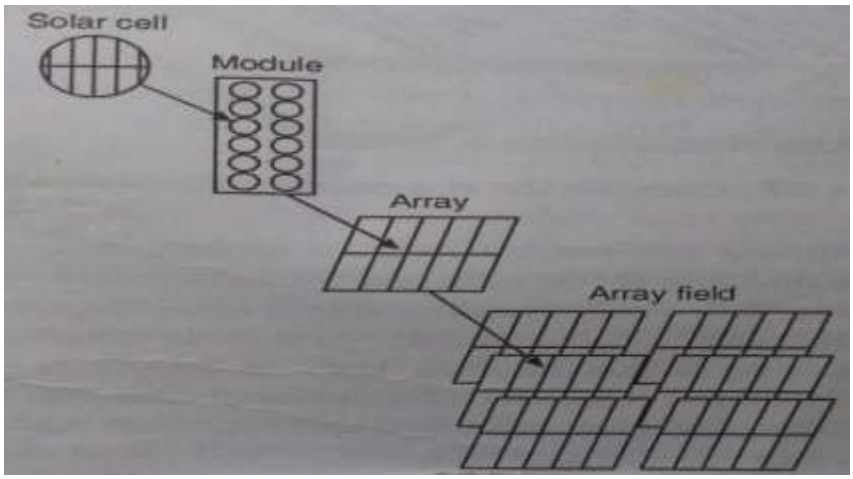
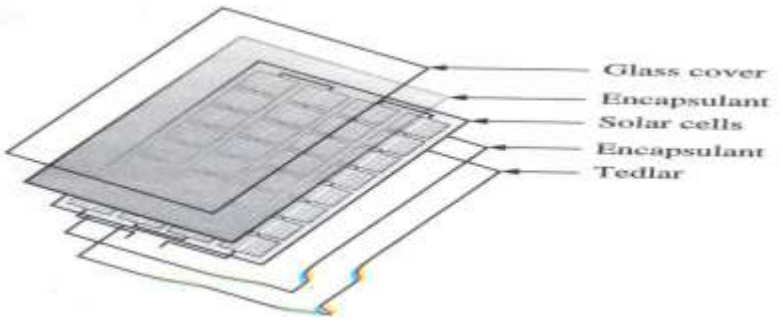
Ans.

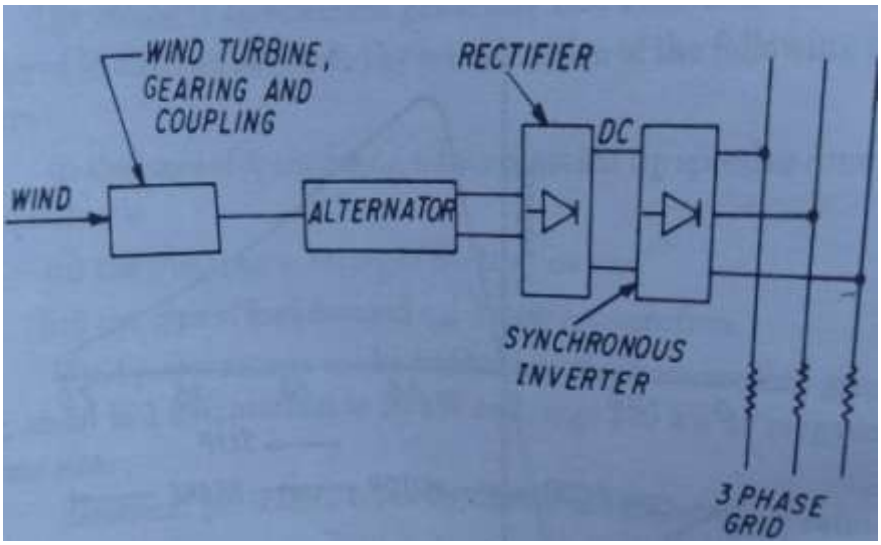
Definition of tilt factor:
The ratio of the beam radiation flux falling on a tilted surface to that

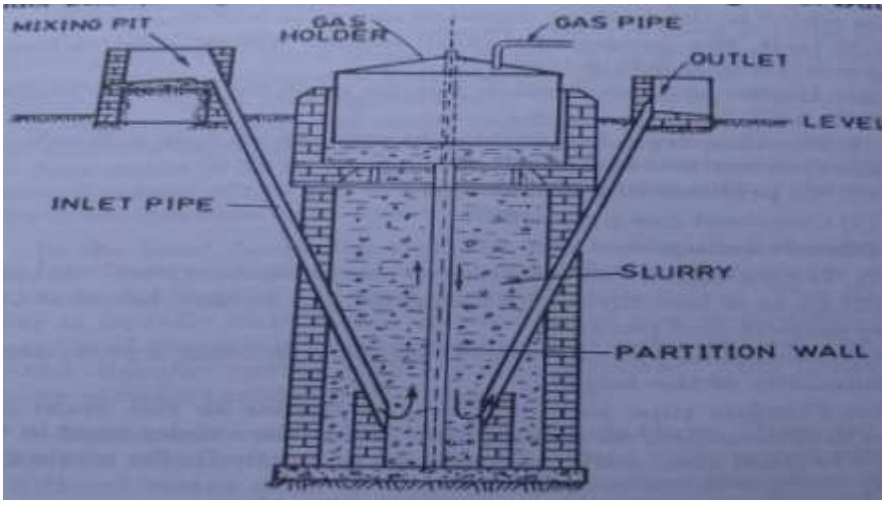
		falling on a horizontal surface is called the tilt factor for beam radiation. **Tilt factor for beam radiation depends on:** 1. Horizontal tilt 2. Surface Azimuth 3. Declination Angle 4. Latitude	***Definition 2M*** ***Factors ½ M each***
	c) Ans.	**State and explain the following methods to obtain energy from biomass:** **Anaerobic digestion** **Gasification.** **Anaerobic digestion**: The process which converts decaying wet biomass and animal waste into biogas through the decomposition process by the action of anaerobic bacteria (bacteria that is live & grow in the absence of oxygen) is called anaerobic digestion. The air tight equipment used to convert the wet biomass into biogas by digestion or fermentation is called digester. The biochemical process of conversion from biomass to biogas is as in three stages: (i) Hydrolysis of organic matter: The biomass is broken due to the action of water (hydrolysis) into simpler soluble compounds. (ii) Anaerobic & facultative microorganism: These bacteria start growing to produce acetic & propionic acids. The output of process is the production of carbon dioxide. (iii)Digestion: Anaerobic bacteria slowly digest the biomass slurry to produce biogas the process is completed in two weeks **Gasification** A solid fuel is converted by a series of thermo chemical process like drying, pyrolysis, oxidation and reduction to a gaseous fuel i.e. producer gas. If the atmospheric air is used for the gasification then the producer gas consist of mainly carbmonoxide, hydrogen and oxygen. This gas is more versatile than solid biomass, it can be burnt to produce process heat and steam, or used in internal combustion engines or gas turbine to generate electricity. The gasification process renders the use of biomass which is relatively clean and acceptable in environmental terms.	**4M** ***Anaerobic method 2M*** ***Gasification method 2M***

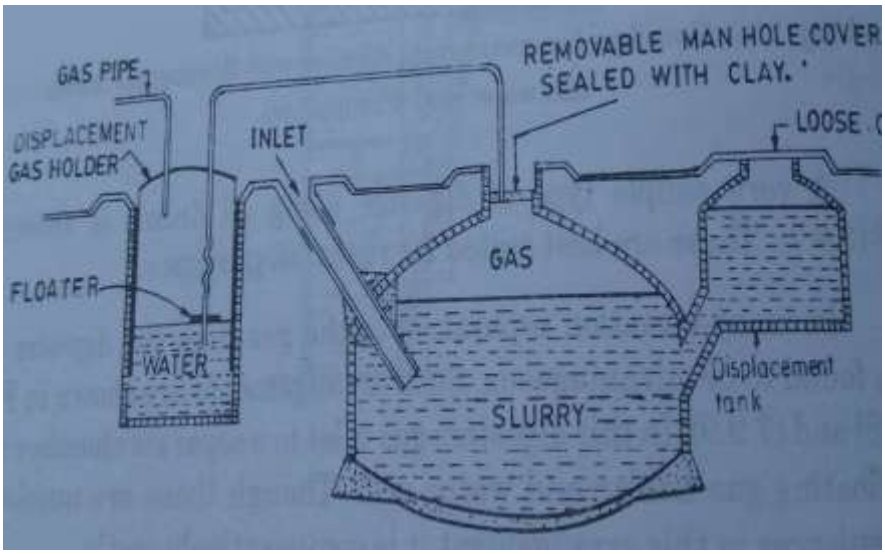
	d) Ans.	**Draw neat labelled schematic diagram of fluidized bed biomass gasifier.**  	**4M** ***Correct diagram with labeled 4M***
	e) Ans.	**Give the advantages and disadvantages of geothermal energy.** **Advantages of Geothermal Energy:** i) Geothermal energy is cheaper, compared to the energies obtained from other sources both zero fuels and fossil fuels. ii) It is versatile in its use. iii) It is the least polluting compared to the other conventional energy sources. iv) It is amenable for multiple uses from a single resource. v) Geothermal power plants have the highest annual load factors of 85% to 90% compared to 45% to 50% for fossil fuel plants. vi) It delivers greater amount of net energy from its system as compared to other alternative **Disadvantages of Geothermal Energy:** i) Low overall power production efficiency about 15%, as compared to 35- 40% for fossil fuel plants. ii) The withdrawal of large amounts of steam or water from a hydrothermal reservoir may result in surface subsidence. iii) The gases coming out of earth along with steam or hot water are	**4M** ***Any four advantages and disadvantages 2M each***

		hazardous, hence need to be removed by chemical action, before they are discharged. iv) Drilling operation is noisy. v) Large areas are needed for exploitation of geothermal energy	
	f) Ans.	**State the thermal classification of biomass.** In thermal gasification, solid fuel is converted into gaseous fuel by series of thermo chemical processes like drying, pyrolysis, oxidation, and reduction. Biomass gasifiers are classified as per the direction of gas flow: 1. Down draught gas generator 2. Up draught gas generator 3. Cross draught gas generator Biomass gasifiers are classified as per output power as : 1. Small size gasifiers with output upto 10kw. 2. Medium size gasifiers with output in the range of 10kw- 50kw. 3. Large size gasifiers with output in the range of 50 kw- 300 kw. 4. Very large gasifiers with outputs 300 kw and above. Gasifiers may also be classified as per the type of bed: 1. Fixed bed gasifier 2. Fluidised bed gasifier	**4M** ***For statement 1M*** ***For classification (any three) 3M***
4.	**A)** **a)** Ans.	**Attempt any three:** **State construction and operation of solar dryer.**  	**12** **4M** ***Diagram 2M***

		Solar dryer consisting of a solar collector and a drying chamber, without direct exposure of the content to the environment, drying is more hygienic as there is no secondary contamination of the products through rain, dust, insects, rodents or birds. The products are dried by hot air only. There is no direct impact of solar radiation (sunshine) on the product. The solar energy produces hot air in the solar collectors. Increasing the temperature in a given volume of air decreases the relative air humidity and increases the water absorption capacity of the air. A steady stream of hot air into the drying chamber circulating through and over the meat pieces results in continuous and efficient dehydration.	***Explanation 2M***
	b) Ans.	**With the help of neat labelled diagram explain the construction of solar PV Module.**   **Diagram: Protection of solar PV cell** Solar cells are fixed on a board and connected in series and parallel	**4M** ***Diagram 2M***

		combinations to provide the required voltage and power to form a PV module. Solar PV module generates electricity in DC form. But many of our home appliances or industrial appliances use AC power for operation. Therefore, there is a need to convert PV module generated DC power into AC power. This can be achieved by using equipment called DC to AC converter (or inverter). Therefore, the use of inverter is also an important part of PV energy systems. One also needs to protect the battery from overcharging or discharging beyond the limit. In both cases, battery life decreases. This protection requires a device called charge controller. Usually charge controller is in-built in the inverter itself but it can also be purchased separately.	***Explanation 2M***
	c) Ans.	**Draw neat block diagram of variable speed constant frequency, wind-electric generation system.**  	**4M** ***Each block 1M*** ***Four block 3M***
	d) Ans.	**State the difference between closed cycle and open cycle ocean thermal electric power generation.** **Sr. No.** | **Closed cycle OTP** | **Open cycle OTP** 1 | This cycle requires separate working fluid that receives and rejects heat to the | Open cycle refers to the utilization of sea water as the working fluid, wherein sea	**4M**

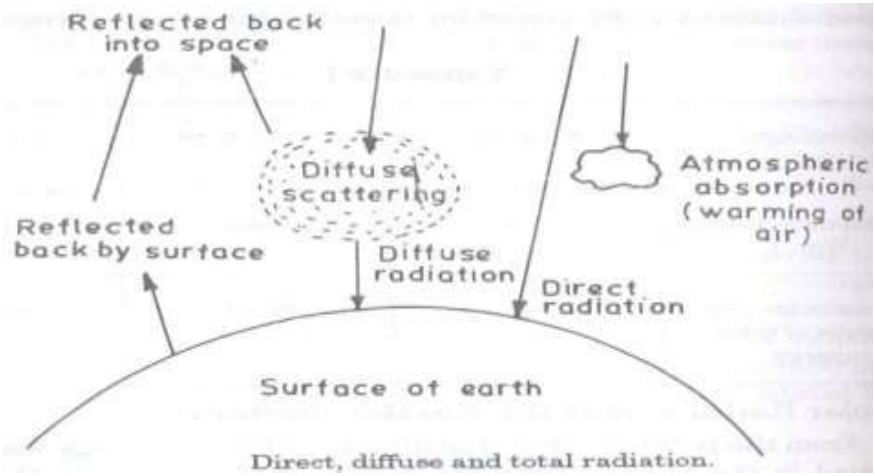
			source and sink via heat exchanger	water is flash evaporated under a partial vacuum	***Any four differences each 1M***
		2	The working fluid may be ammonia, propane, or a Freon.	Sea water itself is a working fluid.	
		3	Operating pressures of working fluid at boiler is much higher	Operating pressure of working fluid at boiler is much lower	
		4	Condenser temperature is much higher	Condenser temperature is much lower	
		5	Turbines are much smaller	Turbines are larger	
		6	The cost of closed cycle system for providing substantial number of megawatts is lesser	More costly as the turbine cost is half the cost of power system.	
		7	Requires very large heat exchanger	Requires smaller heat exchanger	
4.	**B)** **a)** Ans,	**Attempt any one:** **Draw neat diagram of dome and drum type biomass plant.**  **OR**			**6** **6M** ***Correct diagram with labeled 6M***

			
	b) Ans.	**State the components of tidal power plant and state their functions.** **A barrage**: A barrage is a small wall built at the entrance of a gulf in order to trap water behind it. It will either trap it by keeping it from going into the gulf when water levels at the sea are high or it will keep water from going into the sea when water level at the sea is low **Turbines:** they are the components responsible for converting potential energy into kinetic energy. They are located in the passageways that the water flows through when gates of barrage are opened. **Sluices:** sluice gates are the ones responsible for the flow of water through the barrage. **Embankments**: they are caissons made out of concrete to prevent water from flowing at certain parts of the dam and to help maintenance work and electrical wiring to be connected or used to move equipment or cars over it	**6M** ***2 Components ½M each*** ***Any 4 function 1M each***

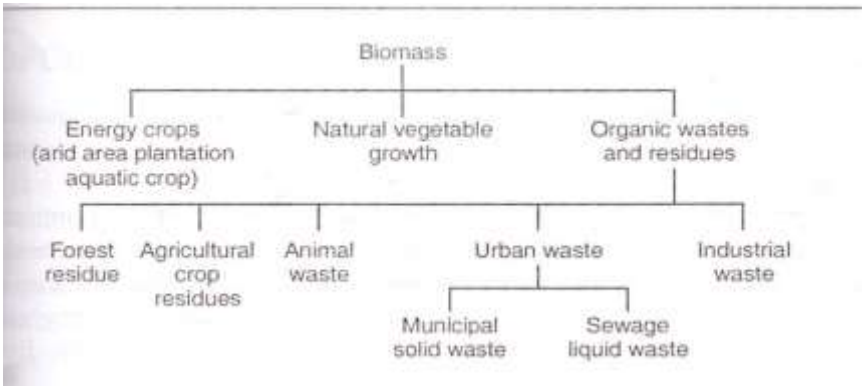
MODEL ANSWER

SUMMER - 2017 EXAMINATION

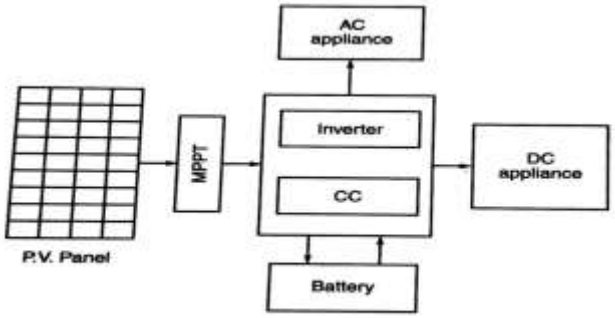
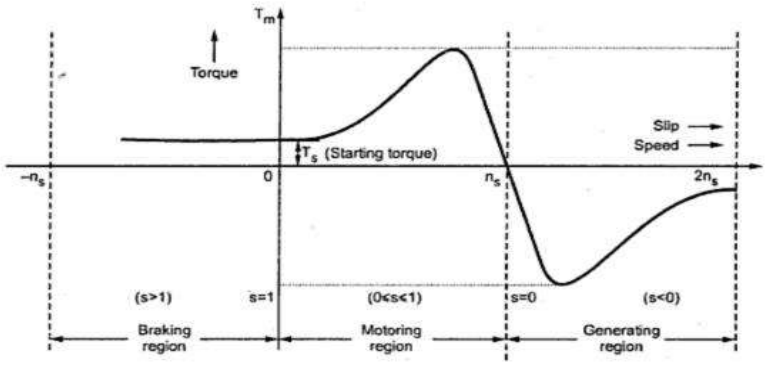
Subject: Renewable Energy Sources **Subject Code:** **17645**

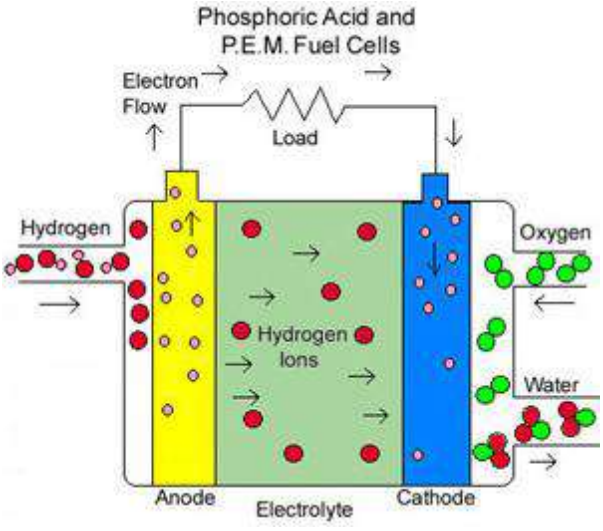
5.		**Attempt any four:**	**16**
	a)	**Draw neat schematic representation of distribution of solar energy.**	**4M**
	Ans.	 Direct, diffuse and total radiation.	***Completely Labelled Diagram 4M*** ***(Partly labelled 3M, Unlabelled Diagram 2M)***
	b)	**State the limitations of pyrheliometer for measurement of beam radiation.**	**4M**
	Ans.	**Limitationsof pyrheliometer for measurement of beam radiation:** • It can measure only direct solar radiation at normal incidence. It cannot measure diffused radiation. • It cannot be used in tilted position; like pyranometer therefore it can not receive ground reflected radiation. • Shading ring arrangement is not provided as in case of pyranometer • Accuracy of measurement is not as good as pyranometer.	***Any 4 limitations of pyrheliometer each 1M***
	c)	**State the difference between horizontal axis and vertical axis wind turbines.**	**4M**
	Ans.	**Horizontal axis wind mill** / **Vertical axis wind mill** 1.More power capture(for same tower height) / 1. Less power capture(for same tower height) 2. No effect of fatigue in such structure / 2. The structure suffers from fatigue effect. 3. No appearance of the unwanted power periodicity / 3. appearance of the unwanted power periodicity 4. Less noise problem / 4. More noise problem 5. There exists complexity of / 5. No such problem of	***Any 4 points each 1M***

		yaw mechanism	complexity in yaw mechanism	
		6.More complex design	6. Less complex design	
	d) Ans.	**State any two advantages and two limitations of hydrogen energy.** **Advantages of hydrogen energy:** 1. Very high energy content 2. Burning is non polluting 3. Hydrogen produced from biomass and supplied to consumers in the transport sector 4. Fuel cell operated bus; hydrogen produced from biomass can compete well with gasoline operated vehicles. 5. It is a superior fuel for turbojet aircraft due to greater economy or lower noise level and little pollution 6. Hydrogen as a vehicular fuel can reduce dependence on fossil fuel which is increasing in cost every year. 7. Hydrogen can easily be transported and distributed through pipeline 8. Hydrogen being a high density fuel. Its low transport cost high product cost to make it can economically viable fuel **Limitationsof hydrogen energy:** 1. Commercial production of hydrogen at cheap cost. 2. Effective energy utilization 3. Difficulty in storage since it is highly explosive 4. Lock of safety and management	**4M** ***Any two advantages 2M*** ***Any two limitations 2M***
	e) Ans.	**State the difference between Dome type and Drum type biomass plants (any 4).** **Dome type Biogas plant** / **Drum type Biogas plant** Constant volume in digester / Constant pressure in digester Danger of explosion exists as pressure is high / No danger of explosion of gas as pressure in the digester is low Due to high pressure, there is danger of leakage of gas / No danger of leakage gas Less costly / Cost is more due to floating steel drum provision No such danger / Corrosion of steel floating drum is likely No maintenance needed / More maintenance needed due	**4M** ***Any 4 points 1M each***

			to sliding metallic drum	
		Low gas production due to high pressure in digester	High gas production due to lower pressure in digester	
		Installation is difficult	Installation is simple	
	f) Ans.	**Give the classification of bio-energy sources and explain each with example.** Biomass resources for energy production are widely available in forest ares,rural farms ,urban refuse and organic waste from agro industries. Biomass classification is illustatred in following fig.  **Forests**: Forests, natural or cultivated are rich sources of Timber,fuel wood, charcoal and raw material for paper mills and others industries. **Agricultural crop residues:** Crop residues are available in abundance as natural resources, easily collected and stored. These are rice husk, wheat straw, corn cobs, cotton sticks, sugar cane bagasse, groundnut and coconut shells. These are converted into briquettes or pellets for use as clean fuel. These are called biofuels which are high efficiency solid fuels. **Energy crops:** Energy farming refers to the cultivation of fast growing plants which supply fuel wood, biomass that can be converted into gaseous and liquid fuel like biogas, vegetable oil and alcohol. To which are saline, wind eroded lands in arid areas and water – lagged lands. **Vegetable Oil crops :** Oil can be extracted from fertile area crops such as ,sunflower, cotton seed, groundnut, rapeseed, palm and coconut . These oils after purification can be blended with diesel oil suitable as engine fuel. **Aquatic Crop:** Aquatic crop constitutes three water plants, namely	**4M** ***2M Classification*** ***2M Explanation***

		algae, water hyacinth and sea weeds. These plants grow abundantly in water bodies and provide organic matter for biogas plants. **Animal Waste:** animal waste, an organic material with combustible property ,is a rich source of fuel. Dung cakes prepared with animal waste are used for cooking in rural and semi –urban areas. It is also a raw material for biogas plants. **Urban Waste**: Urban waste is of two types: (i) Municipal Solid Waste (MSW) which includes excreta household garbage and commercial waste. (ii) (ii) Liquid waste from domestic sewage and effluents from institution activities. **Industrial Waste:** Energy recovery from industrial waste was taken up in 1993 are implemented with technical assistance of national laboratories. Pulp and paper Industry Effluents, Starch and glucose Industry waste, Palm Oil Industry, Distillery waste and tanneries waste. These wastes are treated for production of bio-energy which can be used for power generation.	
6.		**Attempt any two:**	**16**
	a)	**With the help of block diagram explain operation of solar home lighting system and state its applications.**	**8M**
	Ans.	**Photovoltaic Power Generating System:** **Operation:** Solar PV panel converts solar energy to electrical energy in dc form. The electrical energy is generated when sunlight falls on the PV panel. There is no sunlight during cloudy days and night hours, so battery is used here Electricity supplied to the appliance and also for battery charging when sunlight is there. Some of appliances are of dc type and can utilize dc output of PV panel directly but many of the appliances are of ac type, hence dc supply of PV panel is converted into ac with the help of inverter. Overcharging and over discharging of battery shortens its life so this needs battery protection by a device called charge controller (cc). Which prevents Overcharging and over Over discharging of battery. Maximum power point tracker (MPPT) is an impedance matching device which is used alongwith PV panel to extract maximum power.	***3M operation***

		 Block diagram of photovoltaic system **Applications:** A solar PV system can be designed to supply power for lighting application of household appliances like fan, TV, refrigerator, solar lantern etc.	***3M for diagram*** ***2M Application***
	b) Ans.	**State the salient features and characteristics of induction generator used in wind mills.** **Salient Features of Induction Generators used in Wind Mills:** i) Simpler construction than synchronous generators ii) Easy to operate and maintain iii) Simple controls as compared to synchronous generators iv) No synchronization problems. v) Less costly i.e economical **Characteristics of Induction Generators:**  The torque-speed or slip characteristic of induction generator is shown in the figure. When the load drives the rotor at speed higher than the synchronous speed i.e slip is negative, the induction machine receives the mechanical energy and converts it into electrical energy operating as induction generator.	**8M** ***Any 4 features 1M each*** ***2M characteristics*** ***2 M explanation***

	c) Ans.	**With reference to fuel cell, explain its principle, construction, operation and applications.** **Principle of fuelCell**: Fuel cells are electrochemical devices in which the chemical energy of fuel is converted into electrical energy. The chemical energy is the free energy of reactants used. This conversion takes place at constant temperature and pressure **Construction:** The main components of fuel cell are: (i) a fuel electrode (anode) (ii) an oxidant or air electrode (cathode) and (iii) an electrode. In most of the fuel cell hydrogen (pure or impure) is the active material at the negative electrode and oxygen (from the oxygen or air) is active at the positive electrode. Since hydrogen and oxygen are gases a fuel cell requires a solid conductor to serve as a current collector and to provide a terminal at each electrode. Electrode material is porous, nickel and carbon are generally used electrode materials. Platinum and other precious metal are used in military and space applications. **Operation Of Fuel cell:**  1. The fuel gas diffuses through the anode and is oxidized, this releasing electron to the external circuit.	**8M** ***2M Principle*** ***2M Construction*** ***2M operation***

		2. The oxidizer diffuses through the cathode and is reduced by the electrons that have come from anode by products out of the external circuits. 3. The fuel cell is a device that keeps the fuel molecules from mixing with the oxidizer molecules, permitting, however the transfer of electrons by a metallic path that may contain a load. 4. The available fuels, hydrogen has so far given the most promising results. Although cells consuming coal, oil or natural gas would be economically much more useful for large scale applications. **Applications:** Domestic use: Fuel cell generate dc Current which can be used for electric lamps and some small applications such as heat pumps, motor etc., conversion into alternating current by means of inverter might be necessary (1) Central Power station: A long term possibility is a central power plant in which coat is gasified and the gas is used to generate electricity directly by means of fuel cell. (2) Automotive vehicles: The hydrogen-Oxygen (air) fuel cell might be used for electric vehicle propulsion. (3) Special applications: Fuel cells are under development are for special application where convenience is of a paramount importance, cost is secondary. Hydrogen oxygen and hydro carbon oxygen cells will be used in special military and space project.	***2M Applications***