SUMMER – 19 EXAMINATION

Subject Name: Renewable energy sources **Model Answer** Subject Code: 17611

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.

<table>
<tr><th>Q. No.</th><th>Sub Q. N.</th><th>Answer</th><th>Marking Scheme</th></tr>
<tr><td>Q. 1</td><td>A</td><td>Attempt any Three</td><td></td></tr>
<tr><td></td><td></td><td>a) Distinguish between renewable and nonrenewable energy sources
<table>
<tr><th></th><th>Renewable energy sources</th><th>Non Renewable energy sources</th></tr>
<tr><td>1</td><td>Renewable energy sources are essentially inexhaustible</td><td>Non Renewable energy sources are exhaustible and likely to be depleted with passage of time.</td></tr>
<tr><td>2</td><td>Can be harnessed without the release of harmful pollutants</td><td>Produce pollution</td></tr>
<tr><td>3</td><td>Ex. Solar , wind power, geothermal , tidal etc</td><td>Ex: coal , oil , gas etc</td></tr>
</table></td><td>04</td></tr>
<tr><td></td><td></td><td>b) Define the following

i) Solar Declination angle (δ) : It is the angle between a line extending from the centre of the sun to the centre of the earth and the projection of this line upon the earth's equatorial plane.

ii) Solar Hour Angle (ω) : The angle representing the position of the sun with respect to clock hour and with reference to suns position at 12 noon is the hour angle .

iii) Solar Altitude angle (α): It is defined as the angle between the central ray from the</td><td>01 mark each</td></tr>
</table>

sun , and a horizontal plane containing the observer is the Solar altitude angle. At the Sunrise and Sunset the solar altitude angle(α) is zero

iv) **Solar Zenith Angle** : If a vertical line is drawn to the horizontal plane at its centre the line joining sun and the centre of the plane will make an angle ɵ with this vertical . This angle is called the Zenith angle.

c) Write short notes on Algae- a new biomass — 04 marks

Algae fuel or algal biofuel is an alternative to liquid fossil fuels that uses algae as its source of energy-rich oils.Several companies and government agencies are funding efforts to reduce capital and operating costs and make algae fuel production commercially viable/ feasible. Like fossil fuel, algae fuel releases CO2 when burnt, but unlike fossil fuel, algae fuel and other biofuels only release CO2 recently removed from the atmosphere via photosynthesis as the algae or plant grew.

The energy crisis and the world food crisis have ignited interest in alga-culture (farming algae) for making biodiesel and other biofuels using land unsuitable for agriculture.

Advantages:

Among algal fuels' attractive characteristics are that they can be grown with minimal impact on fresh water resources.

They can also be produced using saline and wastewater.

They arebio-degradable and relatively harmless to the environment.

d) State the uses of following — 01 mark each

i) Sunshine recorder :- To measure the hours of bright sunshine in a day

ii) Fyrite : To measure the volume of O_2 , CO_2 and other gases

iii) Pyreheliometer : for measurement of direct beam solar irradiance.

(Irradiance is a measurement of solar power)

iv) Fuel efficiency monitor :-

1. In this instrument the calorific value of the commonly used fuels are fed into

   Microprocessor.

2. When this instrument measures the oxygen and temperature of the flue gas, it

   automatically calculates the efficiency of the combustion

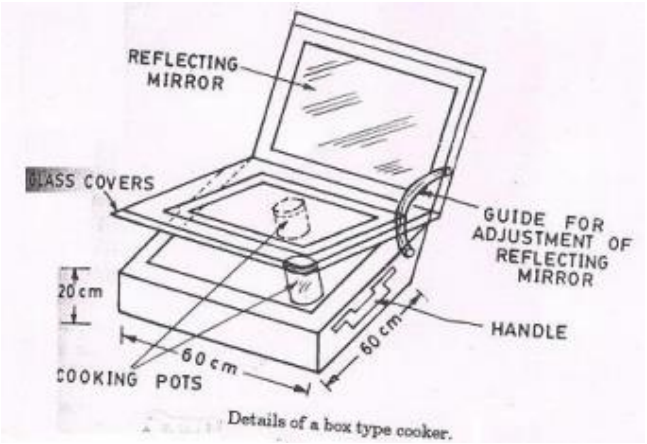
	B	**Attempt any one**	
		a) **What is solar collector? State various types of solar Collector**. Solar collector is a device for collecting or absorbing the solar radiations on a surface called absorber and transfer of a part of radiant energy to fluid like water or air in contact with it. Various types of solar collectors in use are 1. Flat plate collector 2. Concentrating type solar collector	04
		b) Write short notes on i) **Oil shale**: **Oil shale** is an organic-rich fine-grained sedimentary rock containing kerogen (a solid mixture of organic chemical compounds) from which liquid hydrocarbons can be produced. ii) **Tar sand**: **Tar sands** (also known as **oil sands**) are a mixture of mostly sand, clay, water, and a thick, molasses-like substance called bitumen.	02 for each
2		**Attempt any two**	
	a	**State various types of solar cookers. Explain with neat sketch, working of box type solar cooker. Give its advantages & disadvantages**. Following are the types of solar cookers : 1. Domestic (Box type solar cooker) 2. Parabolloidal dish type cooker 3. Advanced solar cooker  Details of a box type cooker.	02 for classification 02 for sketch, 02 for explanation and 02 for adv and dis.adv.

		Figure shows the box type solar cooker. The solar rays penetrate through the glass covers and absorbed by a blackened metal tray kept inside the solar box. Two glass covers are provided to again minimize the heat loss. The loss due to convection is minimized by making the box air tight by providing a rubber strip all rounds between the upper lid and the box. When the cooker is placed in the sun, the blackened surface starts absorbing sun rays and temperature inside the box starts rising. The blackened cooking pots get heat energy and food will be cooked in a period of time. Advantages : 1. Simple in construction 2. Less cooking time Disadvantages: 1. Cannot cook food products like chapattis, purees	
	b	**State the ways of improving boiler and furnace efficiency.** Ways of improving boiler efficiency: Some of the ways to improve boiler efficiency are related to combustion process, to reduce the heat losses, reduction in power consumption. These are : utilization 1. Control of Temperature of exhaust gases at entry to chimney and of flue gases a) Air preheater b) Feed water heating in the economizer 2. Control of excess air to ensure complete combustion of fuel 3. Reduction in radiation and convention heat losses 4. Control of steam pressure in boiler 5. Preheating combustion air 6. Reducing blow down 7. Stopping dynamic operation 8. Switching to lower cost fuel **Ways of improving furnace efficiency:** 1. Complete combustion with minimum excess air 2. Proper distribution of heat 3. Furnace must operate at optimum temperature 4. Heat losses due to furnace opening 5. Heat losses from walls 6. Heat recovery from walls 7. Heat recovery from hot flue gases leaving the furnace	04 for each

	c	**i) State the classification of hydroelectric power plant** 1. The classification according to Quantity of water available is i) Run-off river plants without pondage ii) Run-off river plants with pondage ii) Reservoir Plants 2. The classification according to availability of water head is i) Low-Head (less than 30 meters) Hydro electric plants ii) Medium-head(30 meters – 300 meters) hydro electric plants iii) High-head hydro electric plants 3.The classification according to nature of load is i) Base load plants ii) Peak load plants	04
	d	**State advantages & disadvantages of wind energy conversion system:** Advantages: 1. It is available free and inexhaustible 2. It is clean and non polluting 3. Have low maintenance cost 4. Has low cost of power generation Disadvantages: 1. Capital cost is high 2. Wind energy available is dilute 3. Large variation in wind speed 4. Design of system is difficult 5. Efficiency is lower 6. Sound pollution	02 for each

3		**Attempt any four**	
	a	**Differentiate between conventional fuel and biomass**	01 mark each any four

	conventional fuel	biomass
1	It is non renewable form of energy	It is non renewable form of energy because plants renew after their cycle
2	It is natural source of energy which is stored in the earths interior after thousands of years	It is a form of solar energy which is used indirectly to grow plants and these are generated round the year
3	Large energy is released on combustion	Energy is obtained either by direct combustion or by various processes.
4	It yields high energy per unit quantity	Yield of energy per unit quantity is low
5	It is highly polluting	It is less polluting
6	It is exhaustible	It is inexhaustible

b **Explain solar distillation process.**

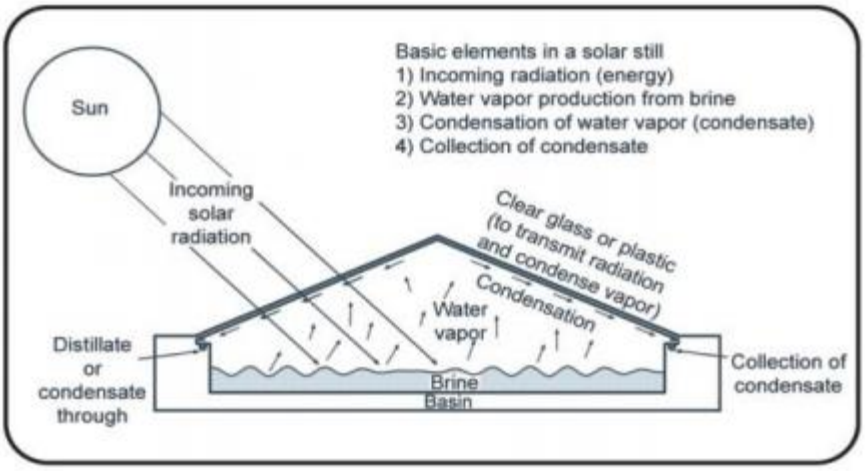
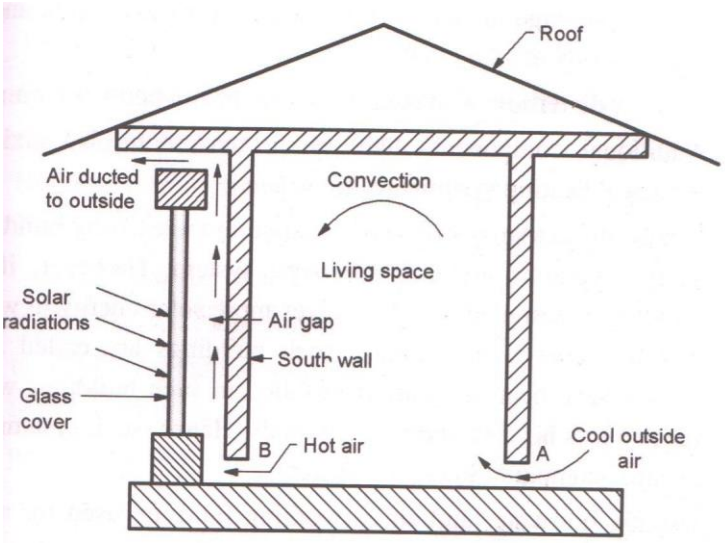


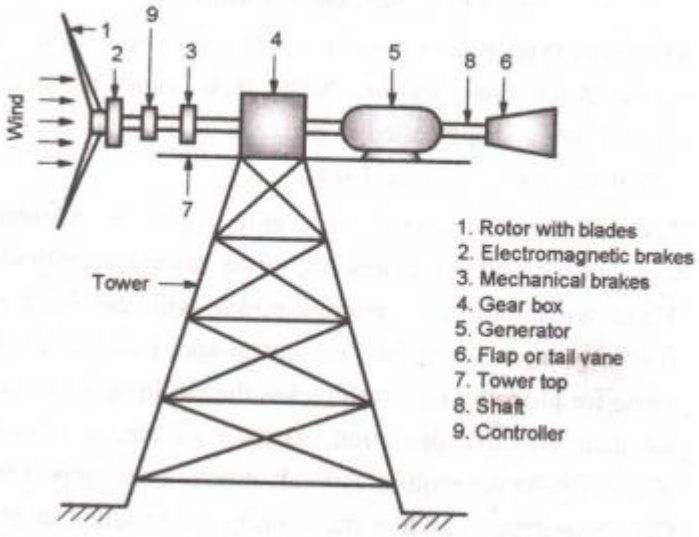
Fig- **Solar distillation**

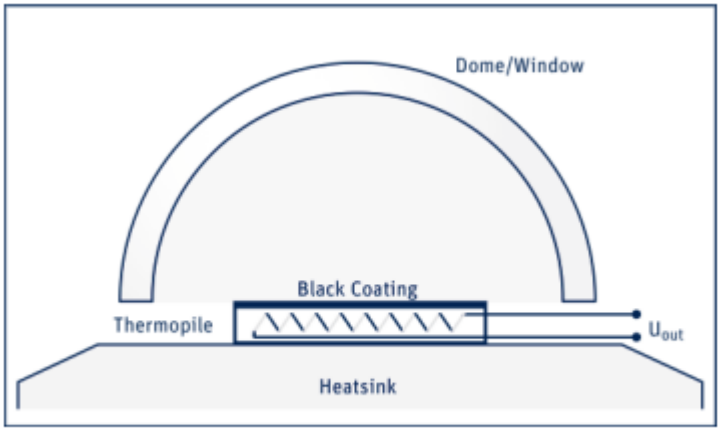
Figure shows various components of conventional double slope type solar distillation system. It is a air tight basin usually made up of concrete or special fiber with a transparent cover to accept radiation from the sun. The inner surface of solar still is blackened to absorb maximum solar radiation. The blackened surface is known as basin liner. The saline water is taken into basin for purification. The depth of the water is around 5 to 10 cms. Solar radiations after going through the still kept absorb by the blackened surface

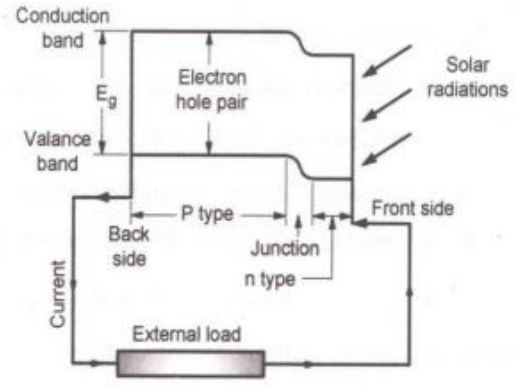
02 for sketch and 02 for explanation

		of the basin and thus temperature of water increases. Evaporated water increases the percentage of moisture which later on gets condensed on the cooler underside of the glass and then it is collected by means of condensate channel. in this way with the use of solar energy distillation process is completed.	
	c	**Explain importance of energy conservation** Energy conservation means reduction in energy consumption without making any sacrifice of quality and quantity of production or for same energy consumption getting higher production. It may be achieved through efficient energy use. importance of energy conservation It may result in increase of financial capital, security, and human comfort. Individuals and organizations that are direct consumers of energy may want to conserve energy in order to reduce cost and promote economic security.	04
	d	**What is the need to switch over renewable energy sources?** Because of the following reasons there is a need of developing, tapping, using the different alternate energy sources from future demand point of view. 1. The supply of crude oil will fail to meet increasing demand. 2. Demand for energy is continuously growing. To meet this alternate energy source is essential 3. Coal reservoirs are unable to fulfill the energy demand 4. Nuclear energy, hydroelectric energy, wind energy, solar energy sources are utilized but they are also unable to meet energy demand. 5. India is blessed with a variety of renewable energy sources, the main ones being biomass, biogas, the sun, wind and small hydro power. 6. Municipal and industrial wastes can also be useful sources of energy, but are basically different forms of biomass. Biogas plants, improved wood stoves, solar water heaters solar cookers, solar lanterns can be used at large. 7. Different forms of biomass such as municipal and industrial wastes are the useful sources of energy. New technologies such as biogas plants improved wood stoves, solar water heater, solar cookers, solar lanterns, street lights. 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 energy for our power needs.	04

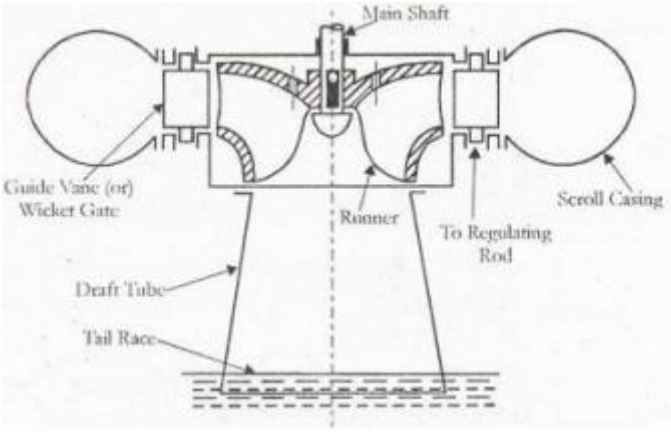
	e	**Which are the factors considered for site selection of hydroelectric power plant?** 1.Water availability and method of storage 2.Availability of head 3.Distance of power station from power demand centre 4.Availability of construction materials 5.Access to site, 6.Availability of transport facilities etc 7.Availability of labour power 8.Heavy rain fall area	01 mark each any four
4	A	**Attempt any three**	
	a	**Explain solar space cooling with neat sketch** The solar space cooling system through ventilation uses the principle of chimney draught. The system is quite effective in case with moderate outside temperatures. The air between the glass cover bad south walls gets heated due to solar radiations penetrating through the glass cover. This heated air rises up and it moves out of the ducts provided at the top of glass cover. This heated air is replaced by the cool air from the surroundings which enters form the bottom air vent a on the other side of the living space. Thus a natural draught is created like a chimney draught for cooling of living space  	02 for sketch and 02 for explanation
	b	**Explain with neat sketch working of horizontal axis wind turbine**	02 for

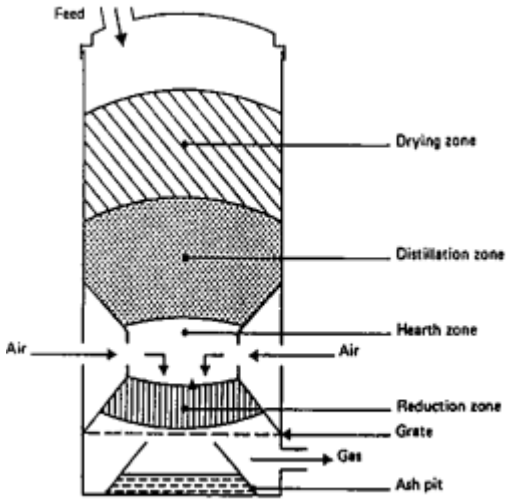
		Working of Horizontal axis wind turbine: The wind energy is converted into mechanical energy by aero turbine. This mechanical power is transmitted through gears to the generator to increase its speed. Since rotor speeds are low an overdrive is necessary to match the synchronous speed of the generator. The generator converts the mechanical power into electrical power.  	sketch and 02 for explanation
	c	**Explain process of anaerobic digestion.** Anaerobic digestion is a biochemical process in which the particular kinds of bacteria digest biomass in an oxygen free environment. The process of anaerobic digestion occurs in a sequence of stages involving distinct types of bacteria. Hydrolytic and fermentative bacteria first break down the carbohydrates, proteins and fats present in biomass feedstock into fatty acids, carbon dioxide, hydrogen, ammonia and sulfides. This stage is called hydrolysis. Next, acetogenic bacteria further digest the products of hydrolysis into acetic acid, hydrogen and carbon dioxide. Methanogenic bacteria then convert these products into biogas. The combustion of digester gas can supply useful energy in the form of hot air, hot water or steam. After filtering and drying, digester gas is suitable as a fuel for an I.C. engine, which combined with generator, can produce electricity.	04
	d	**Explain working of pyranometer**	02 for sketch and

		 **Fig- Pyranometer** The thermoelectric detection principle is used in Pyranometer, whereby incoming radiation is almost completely absorbed by a horizontal blackened surface, over a very wide wavelength range. The resulting increase of temperature is measured via thermocouples connected in series or series-parallel to make a thermopile. The active (hot) junctions are located beneath the blackened receiver surface and are heated by the radiation absorbed in the black coating. The passive (cold) junctions of the thermopile are in thermal contact with the Pyranometer housing, which serves as a heat-sink. More recent, higher performance, Pyranometer use a Peltier element. This is also thermoelectric, but the dissimilar metals of a thermocouple / thermopile are replaced by dissimilar semiconductors.	02 for explanation
	B	**Attempt any one**	
	a	**What do you understand by energy audit? Explain detailed audit methodology.** Energy Audit: An energy Audit is the first step in energy management programme. It shows how efficiently energy is being used and highlights opportunities for energy cost savings. It also shows ways to improve productivity. Types of energy Audit : 1. Preliminary audit 2. Detailed Audit Detailed Energy Audit Methodology: It is a comprehensive analysis of an energy project and offers the accurate estimate of energy savings and cost. It covers the detailed study of present energy consumption, the use of energy for various processes with calculations of energy efficiency and to evaluate the improvements which can be carried out in its energy use. Detailed audit finally recommends the energy conservation proposals with cost of investment needed. It also presents the detailed study of expected savings in energy cost. The detailed energy audit report consists of the following : 1. Details about plant 2. Description of production processes involved 3. Description of energy and utility system 4. Detailed process flow diagram and energy 5. Calculation of energy efficiency and process systems 6. Recommendations for energy conservation	03+03

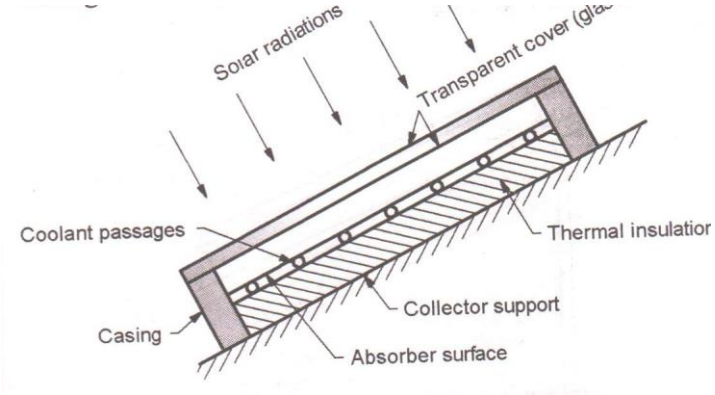
	b	**Explain thermal energy storage.** Thermal energy storage is like a battery for a building's air-conditioning system. It uses standard cooling equipment, plus an energy storage tank to shift all or a portion of a building's cooling needs to off-peak, night time hours. During off-peak hours, ice is made and stored inside Ice Bank energy storage tanks. Heating of a solid or liquid which does not change phase is called sensible heat storage. Energy can be stored in the form of latent heat caused by phase change during heating either from solid to liquid or liquid to vapour.	06
5		**Attempt any two**	
	a	**Explain construction and working of photovoltaic energy conversion. State its advantages and applications of solar photovoltaic system.** Photovoltaic energy conversion: It is the process in which solar energy is converted into electrical energy. When photon is absorbed, its energy is given to an electron in the crystal lattice. The energy given to this valence bond excites it into the conduction band. Solar Photovoltaic electric conversion: A pair of positive and negative charges called electron hole pairs are created in the solar cells by absorbed solar radiations. The suitable materials for absorbing the energy of photons of sunlight are semi conductors like silicon, gallium with dopants. In a semi conductor the valence band has electrons at lower level of energy which is fully occupied. The difference in minimum energy of electrons in conductor band and the maximum energy of electrons in the valence band is called band gap energy. When solar radiation fall, the difference of photon energy of sun light and the band gap energy are absorbed by the cell material. These electrons in the conduction band and holes in the valence band can be made to flow in an external circuit if the potential difference exists within the cell.  **Fig- Photovoltaic energy conversion** Advantages : 1. It converts solar energy directly to electrical energy 2. Solar cells are reliable, modular, durable and maintenance free 3. Compatible with environment 4. Can be installed at the place of utility 5. More long lasting for a period of more than 20 years 6. Flexibility in power capacities is more	02 02 02

		Applications of solar photovoltaic system. 1. Solar lantern 2. Solar home system 3. SPV street light 4. SPV traffic signal system 5. SPV power plants 6. Building integrated power system 7. SPV pumping system 8. Solar operated system TV system 9. Solar signal system for navigation 10. Weather monitoring 11. Battery charging	02
	b	**i) With neat sketch explain construction and working of Francis turbine** In Francis Turbine water flow is radial into the turbine and exits the Turbine axially. Water pressure decreases as it passes through the turbine imparting reaction on the turbine blades making the turbine rotate. Francis Turbine has a circular plate fixed to the rotating shaft perpendicular to its surface and passing through its center. This circular plate has curved channels on it; the plate with channels is collectively called as runner. The runner is encircled by a ring of stationary channels called as guide vanes. Guide vanes are housed in a spiral casing called as volute. The exit of the Francis turbine is at the center of the runner plate. There is a draft tube attached to the central exit of the runner. Francis Turbines are generally installed with their axis vertical. Water with high head (pressure) enters the turbine through the spiral casing surrounding the guide vanes. The water looses a part of its pressure in the volute (spiral casing) to maintain its speed. Then water passes through guide vanes where it is directed to strike the blades on the runner at optimum angles. As the water flows through the runner its pressure and angular momentum reduces. This reduction imparts reaction on the runner and power is transferred to the turbine shaft.	02 for sketch and 02 for explanation

			
		ii) Write a short note on lift and drag i) **Lift**: F_L which is normal to the direction of approach velocity. It is responsible for an aero plane to maintain its lift. It is caused due to unbalanced pressure distribution over aerofoil surface. ii) **Drag**: F_D which is parallel to the direction of approach velocity. It represents the friction forces. Lift is useful component which gives rotation to the turbine.	02 02
	c	List the methods of obtaining energy from biomass. Explain any one with neat sketch. Various methods for obtaining energy from biomass are listed as below I. Combustion II. Anaerobic digestion III. Pyrolysis IV. Hydrolysis and ethanol fermentation V. Gasifier. In down draught gasifier biomass is fed at the top and the air intake is also at the top or from the sides. The gas leaves at the bottom of the reactor, so the fuel and the gas move in the same direction. The main advantage of a down draught gasifier is the production of gas with a low tar content which is nearly suitable for engine applications..	02 03

			03
6	a	**What is thermal insulation? Explain critical thickness of insulation.** The term thermal insulation can refer to materials used to reduce rate of heat transfer or the methods and processes used to reduce heat transfer. Heat energy can be transferred by conduction, convection, radiation or when undergoing a phase change. The flow of heat can be retarded by addressing these mechanisms. critical thickness of insulation The condition of which heat transfer is maximum is given as $r_2 = r_c = k/h$ where r_c is called critical radius of insulation. To reduce heat losses in steam pipes , the insulation radius should be greater the r_c and to transfer maximum heat as the case of electrical conductors, $r_2$should be less than r_c	02 02
	b	**State advantages & disadvantages of nuclear.** Advantages of Nuclear 1. No emission of pollutant gases (Co_2 and others) that would be generated by burning of fossil fuels. 2. The amount of fuel needed is very small as compared to fossil fuels. This saves on raw materials and also in transport & handling. 3. Production of electric energy is continuous. 4. As an alternative to fossil fuels need not consume as much of carbon fuels like oil, so therefore the problem of global warming is reduced. Disadvantages of nuclear 1. A major drawback is the generation of nuclear waste and the difficulty to manage and it takes	02 02

		many years to lose its radioactivity and danger. 2. Nuclear reactors, once constructed, have an expiration date. After this date, they must be dismantled 3. Nuclear plants have a limited life afterwards disposal is very tedious. 4. Current nuclear reactors work by fission nuclear reactions. These chain reactions occur so that if the control systems should fail every time more and more reactions would occur to cause a radioactive explosion that would be virtually impossible to control. 5. Shortage of trained technical manpower. 6. High capital cost.	
	c	**Write a short note on energy plantation.** Energy plantation: There are certain plants which can be planted and harvested over regular period of time to have high yield per unit area. Thus the method of tapping maximum solar energy is growing plants on large scale is called energy plantation. Main plants proposed for energy plantation: Following plants are suitable for large scale plantation in Indian conditions having high yield a) **Casuarina** : These are suitable for plantation in coastal areas b) **Eucalyptus** : These are very fast growing trees. It grows to about 15m in three years c) **Sorghums** : These energy crop is suitable for alcohol production d) **Other suitable trees** : These are babool, Leucaena, Jajoba etc	04
	d	**What is microhydel plant? Which turbine is best suited for it?** In order to meet the present power crisis up to certain extent micro hydel power plants can be built along a a stream of river in our country. These plants work in the range of 5 to 20 m of head or less than that. . These plants in small capacity can easily be constructed in a much shorter time. This type of microhydel plants use special type of turbine called bulb type turbine.	04

	e	**Explain solar constant.** Sun's energy reaches to earth purely by radiation only. By applying the heat transfer relations and geometrical shape, the average radiation from sun reaching the earth's could be worked out. This is called as solar constant. It is equal to 1353 W/m3. It is defined as the rangy received from the sun per unit time on unit area of surface , perpendicular to the direction of propagation of the radiation at the earth's mean distance from sun outside the atmosphere	04
	f	Explain with neat sketch flat plate collector.  Flat plate collector Important parts of liquid flat plate collector are shown 1. Transparent cover 2. Absorber plates 3. Tubes fixed to absorber plate to form coolant passages 4. Thermal insulation 5. Casing or container. 6. It is a box like structure. It consists of an absorber plate which receives beam as well the diffuse solar radiations through transparent glass covers. The absorbed radiations are partly transferred to the liquid flowing through tube which is either fixed to the absorber plate or they form an integral part of it. Remainder part of the radiation solar energy absorbed by the absorber plate is either re radiated to the surroundings through the top surface or lost by convections	02 for sketch and 02 for explanation