WINTER– 16 EXAMINATION

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.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1a	i	(02 mark for conventional and 02 for non conventional Any four each) i. Non Conventional energy sources : 1. Solar energy 2. Wind energy 3. Tidal energy 4. Geothermal energy 5. Bio mass ii. Conventional energy sources : 1. Thermal energy 2. Nuclear energy 3. Coal 4. L.P.G 5. Crude oil	02+02
	Ii	**1) 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. **2)** Azimuth angle (ϒ) : it is the angle of deviation of the normal to the surface from the local meridian the zero point being south, east positive and west negative. **3) Solar altitude (α):** It is defined as the angle between the central ray from the sun , and a horizontal plane containing the observer is the Solar altitude angle. At the	01 for each

	iii	Sunrise and Sunset the solar altitude angle(α) is zero **4)** Day length (t_d): It is the time elapsed between sunrises to sunset. By knowing the values of sunrise and sunset hour angle, we can calculate the day length. (One mark for each) (Any four) Parameters of site selection of wind mill: 1) Availability of higher constant wind speed 2) Availability of wind at site through year 3) Altitude of the site 4) Availability of land 5) Connectivity to grid 6) Connectivity to the road 7) Easy access to locality/infrastructure 8) Ecology 9) Ground condition	

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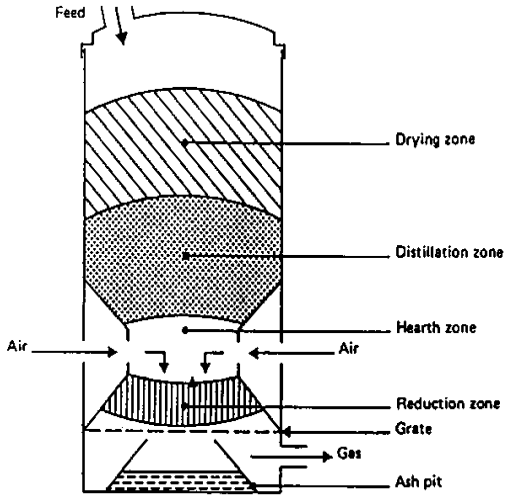
Q. No.	Sub Q. N.	Answer	Marking Scheme
	iv	1) Lux meter: To measure illumination level 2) Pitot tube : To measure the pressure 3) Pyrheliometer : To measure beam radiations only 4) Fyrite : To measure the volume of O_2 , CO_2 and other gases	01 for each
1b)	i	Need of orientation in concentrating type collectors : In flat plate collectors solar direct and diffuse radiations without sun tracking are collected for heating. It causes the loss of energy during sunshine period since the solar radiations will not be normal to the surface and the temperature achieved are only 100 O C . For temperatures above these concentrating type collectors are needed. A cylindrical parabolic collector is oriented with its focal axis pointed either in the east-west or the north-south direction. In the east-west orientation the focal axis is horizontal while in the north-south orientation, the focal axis may be horizontal or inclined. Different methods for sun tracking : i. The focal axis is east-west and horizontal ii. The focal axis is north-south and horizontal iii. The focal axis is north-south and inclined at a fixed angle equal to the latitude.	03+03
	ii	Gasification Gasification of solid biofuel The gasification process in general involves the reaction of solid fuels with hot steam and air or oxygen and the subsequent production of gaseous fuel by partial oxidation. The figure explains the process of gasification of biofuel. Explanation: 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 saqme direction. The main advantage of a down draught gasifier is the	03+03

production of gas with a low tar content which is nearly suitable for engine applications.



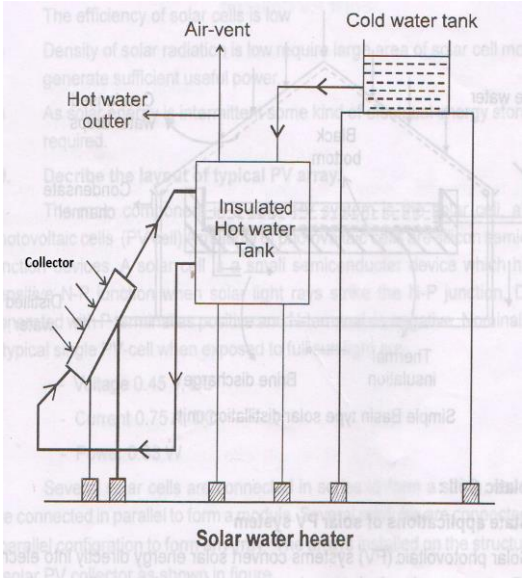
2 a

Flat Plate Solar water heater as a Natural Circulation Solar water heater 03+03+02

(Three marks for sketch, three marks for explanation)

(Three marks for sketch, three marks for explanation ,two marks for advantages)

Flat Plate Solar water heater: A tilted flat plate solar collector with water as heat transfer fluid is used in solar water heater system. A thermally insulated hot water storage tank is mounted above the collector. The heated water of the collector rises up to the hot water tank and equal quantity of cold water enters the collector. The cycle repeats, resulting in all the water of the hot water tank getting heated up. When water is taken out from hot water outlet, the same is replaced y cold water from cold water tank, fixed above the hot water tank.



Advantages : It does not require any pumping system

It can be used with auxiliary heating system

2 b

i

(1/2 mark for each, any eight)

Criteria for site selection of small hydro electric 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

04

ii

(04 marks for sketch)

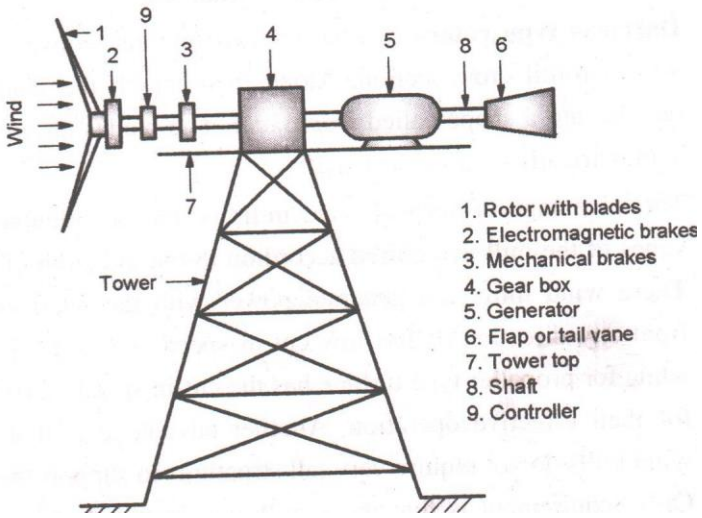


Fig- **Horizontal axis wind turbine**

02+02

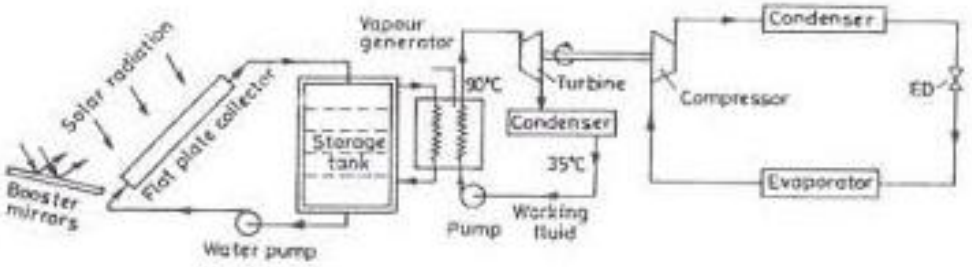
(Two marks for definition and two for advantages)

04

2c	i	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 be growing plants on large scale is called energy plantation. Advantages a) Virtually there is no maintenance b) It is economical c) It is non polluting d) It acts as a best solar collector	02+02
	ii	Ways to recover energy from biomass: a. Combustion b. Anaerobic digestion c. Pyrolysis d. Hydrolysis and ethanol fermentation e. Gasifier	04
3	a	**Principles of photovoltaic power generation :** **Photovoltaic electric conversion**: 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. Photovoltaic cell: A solar cell or photovoltaic cell is a device that converts solar energy into electricity by the photovoltaic effect. Photons in sunlight hit the solar panel and are absorbed by semiconducting materials such as silicon. Electricity can be produced by solar cells whose principal component consists of a semiconductor that is typically made of silicon. Solar cells are often electrically connected and encapsulated as a module often has a sheet of glass. To make practical use of solar generated energy the electricity is most often fed into electricity grid using inverters. **Main elements of SPV :** 1) Photovoltaic array 2) Inverter 3) Energy storage 4) System charge control 5) Balance of system (BOS) components	02+02
	b	A Solar vapor compression refrigeration system is shown in figure. It consists of mainly solar collector and storage tank for heat exchange in the exchanger. The turbine power is used to	

run the compressor of usual VCR system.

It is to be noted that there is no requirement of external electrical power supply to the compressor as it is given by the turbine running on solar energy. 04



C Micro hydal power plant is a type of hydroelectric power that typically produces from 5 kW to 100 kW of electricity using the natural flow of water. These installations can provide power to an isolated home or small community, or are sometimes connected to electric power networks, particularly where net metering is offered. There are many of these installations around the world, particularly in developing nations as they can provide an economical source of energy without the purchase of fuel. 04

Micro hydro is frequently accomplished with a **Pelton** wheel for high head, low flow water supply. The installation is often just a small dammed pool, at the top of a waterfall, with several hundred feet of pipe leading to a small generator housing.

D **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. 04

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.+

Factors affecting bio digestion: Following factors are affecting the biodigestion:

1) pH or the hydrogen-ion concentration
2) temperature

3) total solid content of the feed material
4) loading rate
5) seeding uniform feeding
6) Diameter to depth ratio
7) Carbon to nitrogen ratio
8) Nutrients
9) Retention time
10) Types of feed stock

e

Advantages of renewable Energy sources

1. These energy sources are sustainable and will never exhaust
2. It is available in abundance.
3. It has low operating and maintenance cost.
4. No fossil fuels are needed. No elaborated arrangements are required for transportation, handling and storage of fuels as needed in conventional power plants.
5. It can directly be converted into electrical energy using photovoltaic cells.

These energy sources produce no waste products, so it has no impact on environment.
It is pollution free

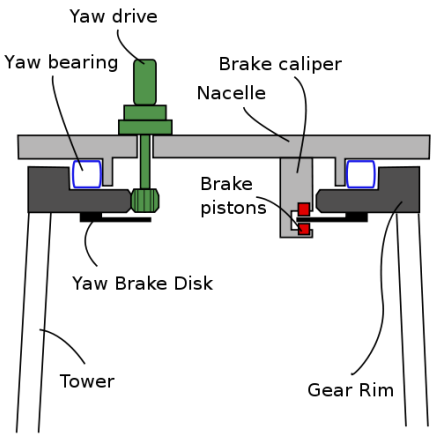
04

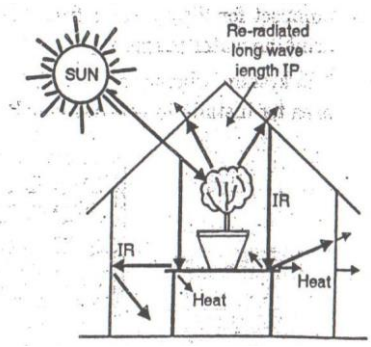
f

Difference between non concentrating and concentrating collector

Sl.no	Non concentrating collector	Concentrating type collector
1	It is less efficient solar collector	It is the most powerful type of collector.
2.	Maximum Temperature of fluid is 300^{o}C	Fluid temperatures up to around 5000^{o}C can be achieved
3	It can be used in water heating.	It can be used in solar furnaces and solar power plants
4.	less initial cost	more initial cost

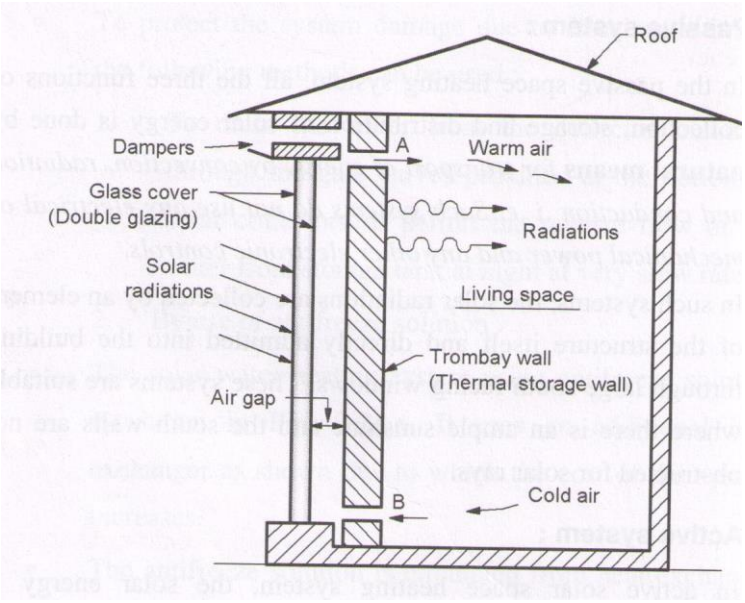
04

4a	i	Yaw mechanism in wind mill: Each yaw drive consists of powerful electric motor (usually AC) with its electric drive and a large gearbox, which increases the torque. A yaw control mechanism is provided to adjust the naclelle around vertical axis to keep it facing the wind. In small windmills a flap or tail vane is provided on the naclelle for automatic positioning of turbine axis. In large windmills survo mechanism alongwith wind direction sensors are provided. **Importance**- To ensure the wind turbines is producing the maximum amount of electrical energy at all times, the yaw drive is used to keep the rotor facing into facing into the wind as the wind direction changes.  	02+02 02+02
	ii	i. Pyrolysis: It is the heating of biomass in a closed vessel at temperatures in the range of 500 ^{o} C to 900 ^{o} C in absence of O_2/ air or with steam. It produces solid, liquid and gases. This process can use all type of organic materials including plastic and rubbers. ii. Fermentation: Fermentation is a process of decomposition of complex molecules of organic compound under the influence of micro organism (ferment) such as yeast , bacteria, enzymes etc	04
	iii	Global Warming: It is also called as climate change. It refers to the long term fluctuations in temperature, precipitation, wind and earth elements of the earth climate system. Carbondioxide produced by power plants has no ill effect on human life but increase concentration of CO2 leads to climate change, it increases heat trapping quality leading to green house effect. Heating of earths atmosphere due to this trapping is due to long wavelength infrared radiations by the CO2 layer in the atmosphere. This effect is used in growing the green plants in an enclosure made of glass and other transparent material so that heat is trapped in cold atmosphere even.	



02

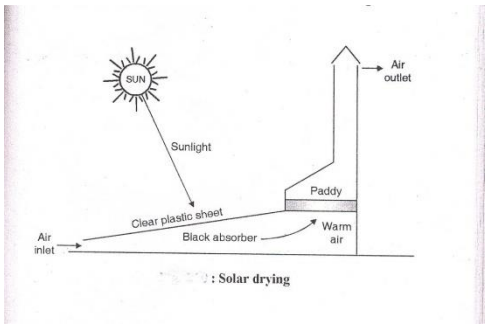
iv i)Passive solar space heating system:



Passive solar space heating system:

02

ii)Solar drying for foods in agriculture.



: Solar drying

4b

i

Energy conservation means reduction in energy consumption, without making any sacrifice of quantity and quality of production. In the same energy consumed, higher production is done. It is not fixing the limit of consumption qualitatively or quantitatively but insist the use efficiently thus decreasing the cost of your production to some extent by the way of reduction in the energy bill.

02+04

Ways of improving boiler efficiency

- **Reducing** excess air
- **Installing** economizer
- **Reducing** scale and deposits
- **Reducing** blow down
- **Recovering** waste heat from blow down
- **Stopping** dynamic operation
- **Reducing** boiler pressure
- **Operating** at peak efficiency
- **Preheating** combustion air
- **Switching** from steam to air atomization
- **Switching** to lower cost fuel

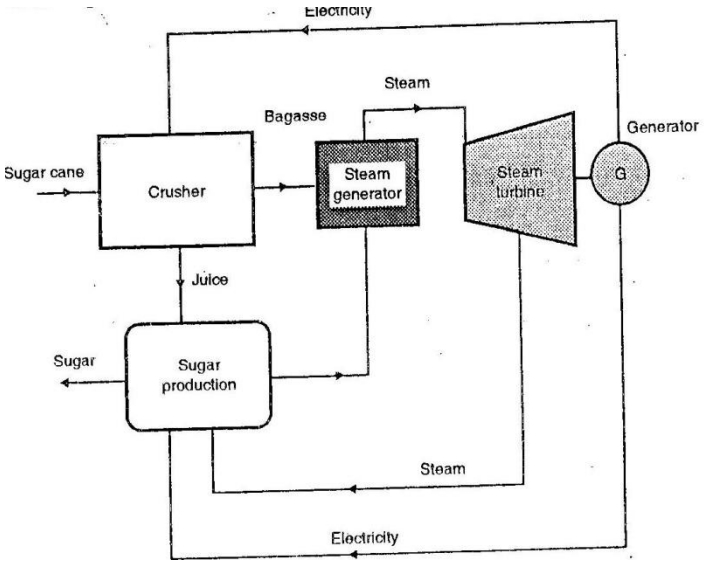
ii

Co-generation process in Sugar factory

Co generation in Sugar factory: In sugar factory juice is extracted from cane and bagasses are burnt to generate steam. This steam is send to steam turbine to generate electricity. Extracted steam and low pressure steam from turbine is used in the process of sugar manufacturing.

In this way both electricity and steam, generated and used at the same place hence overall efficiency is increased.

02+04 for figure



		Co generation in sugar industry	
5a			
	I	Photosynthesis : It is the process in which solar energy is converted into biomass energy. Photosynthesis process occurs only in green plants. It is the process of combining CO2 from the atmosphere with water in the presence of light energy to produce carbohydrates and oxygen. The photosynthesis process is complex but overall photosynthesis process can be represented by the following process $6CO_2 + 6H_2O$ + light energy $= C_6H_{12}O_6 + 6\ O_2$ Total energy stored in the photosynthesis process is about 4500 kJ	04
	Ii	Non solar renewable energy sources : Energy sources which are not obtained directly from sunlight but are obtained indirectly from sun. Ex: Hydro and wind power, biomass ,geothermal , tidal , ocean thermal , etc (01 mark for definition and 03 marks for example)	01+03
b		**Need & future prospects of alternate energy sources**	04
	i	Because of the following reasonsthere 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; pumps wind electric	

		generators biomass gasifiers are becoming commercially available. 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.	
	ii	Classifications of Wind mill : : (Any two) a) According to their axis of rotation 1) Horizontal axis wind mill 2) Vertical axis wind mill a) According to size of capacity 1) Micro size 2) Small size 3) Medium size 4) Large size b) According to applications 1) interconnection with utility grid 2) connected to power backup 3) pumping windmill 4) grain grinding windmill c) Based on type of rotor 1) Propeler type 2) Multiple blade type 3) Savonius type 4) Darrieus type	01+03

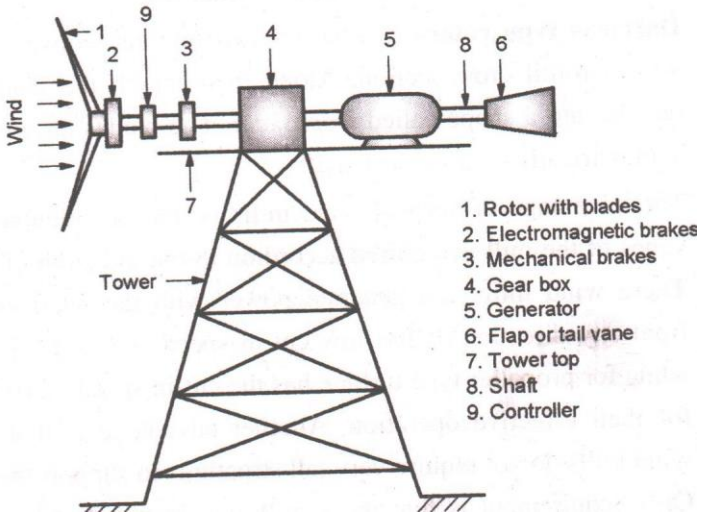


Fig- Horizontal axis wind turbine
(02 marks for classification and 02 marks for figure)

5c | I | Biodiesel Transesterification: Biodiesel is an alternative diesel fuel. Vegetable oil is too thick to flow through modern diesel engines without causing damage, so we can lower its viscosity through a process called Transesterification. | 04

Transesterification is the chemical process which replaces one type of alcohol for another in an ester. An ester is made by combining an alcohol with an acid.

Vegetable oil is an ester of glycerol with long chain fatty acids. The formula for vegetable oil is C3H5(RCOOH)3, with the fatty acids represented by RCOOH attached to a glycerol (C3H5(OH)3) molecule. Examples of fatty acids are Stearic acid, Palmitic acid, Linoelic acid, and Oleic acid. Methanol (CH3OH) is used to replace glycerol (C3H5(OH)3). A strong alkali is used as a catalyst to break apart the fatty acids from the glycerol. In commercial production we typically see Sodium Methylate (CH3NaO) dissolved in methanol used as the catalyst.

The chemical formula for biodiesel transesterification is: C3H5(RCOOH)3 + 3CH3OH <-> 3RCOCH3O + C3H5(OH)3

The biodiesel transesterification process is slightly reversible making it difficult to get 100% conversion. To push the reaction to it most complete status we use LeChtelier's Principle and offset the reactants to drive the reaction in a more favorable direction.

ii | 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	
6	a	Instruments used to recover waste heat are : 1. Recuperator 2. Regenerator 3. Economizer 4. Heat pipe 5. Incenetors, etc Regenerator The Regeneration which is preferable for large capacities has been very widely used in glass and steel melting furnaces. Important relations exist between the size of the regenerator, time between reversals, thickness of brick, conductivity of brick and heat storage ratio of the brick. In a regenerator, the time between the reversals is an important aspect. Long periods would mean higher thermal storage and hence higher cost. Also long periods of reversal result in lower average temperature of preheat and consequently reduce fuel economy. Accumulation of dust and slagging on the surfaces reduce efficiency of the heat transfer as the furnace becomes old.	04

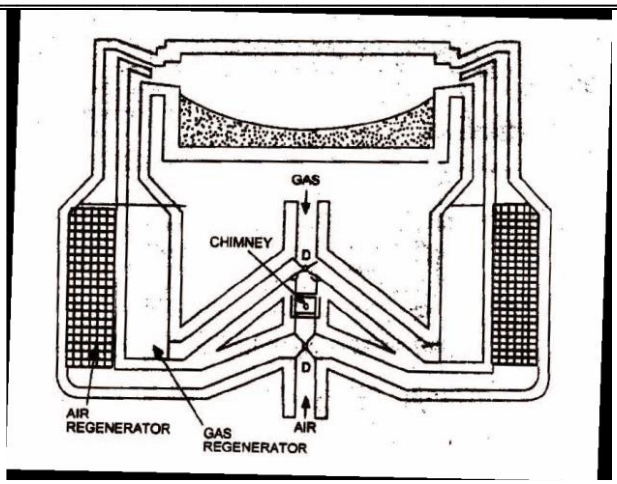


Figure -Regenerator

Recuperator

In a recuperator, heat exchange takes place between the flue gases and the air through metallic or ceramic walls. Duct or tubes carry the air for combustion to be pre-heated, the other side contains the waste heat stream. A recuperator for recovering waste heat from flue gases is shown in Figure 02. The simplest configuration for a recuperator is the metallic radiation recuperator, which consists of two concentric lengths of metal tubing as shown fig

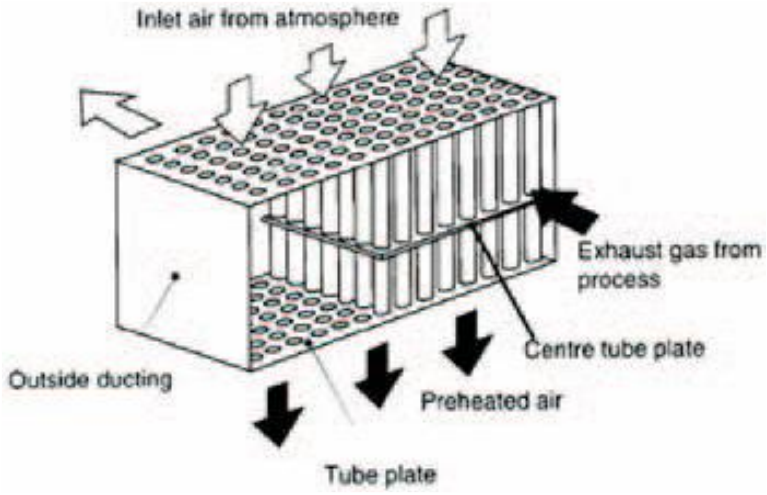


Figure- Recuperator

Heat Pipe-

The Heat Pipe comprises of three elements - a sealed container, a capillary wick structure and a working fluid. The capillary wick structure is integrally fabricated into the interior surface of the container tube and sealed under vacuum. Thermal energy applied to the external surface of the heat pipe is in equilibrium with its own vapour as the container tube is sealed under vacuum. Thermal energy applied to the external

surface of the heat pipe causes the working fluid near the surface to evaporate instantaneously. Vapour thus formed absorbs the latent heat of vapourisation and this part of the heat pipe becomes an evaporator region. The vapour then travels to the other end the pipe where the thermal energy is removed causing the vapour to condense into liquid again, thereby giving up the latent heat of the condensation. This part of the heat pipe works as the condenser region. The condensed liquid then flows back to the evaporated region

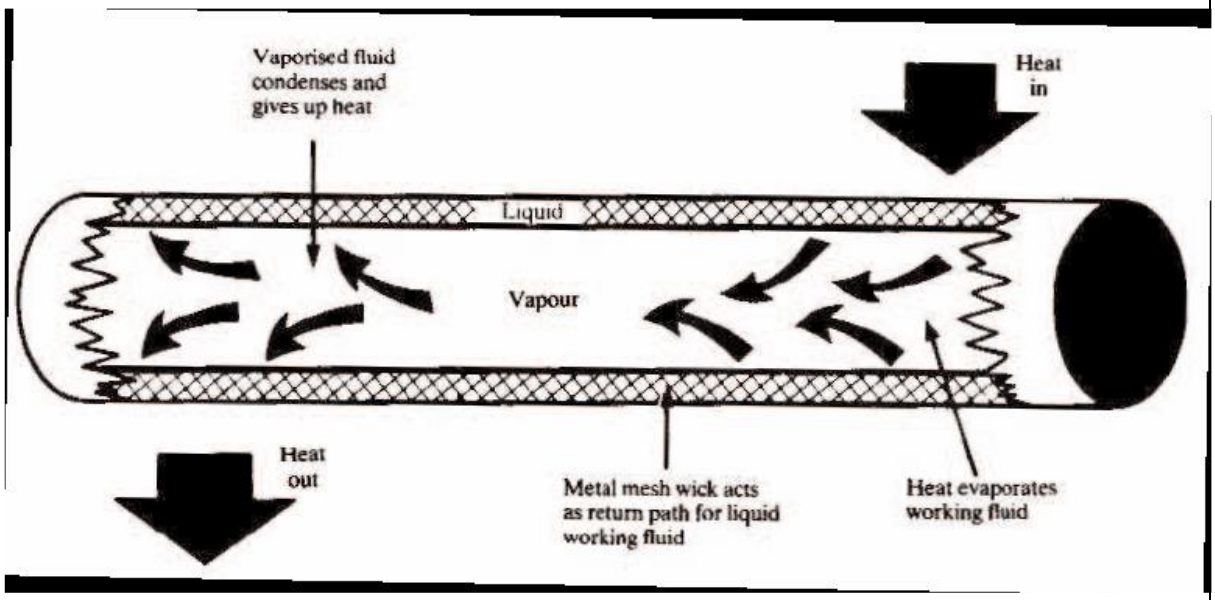


Fig-heat pipe

Detailed construction and working and application of any one of above.

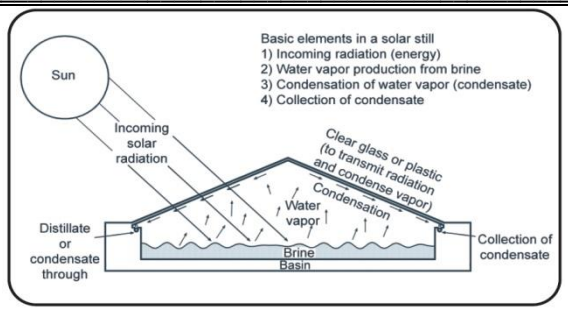
(Answer should be supported with legitimate sketch)

b) The classification according to **Quantity of water** available is
(i) Run-off river plants withoutpondage : These plants does not store water; the plant uses water as it comes. The plant can use water as and when available. 04

(ii) Run-off river plants with pondage : In these plants pondage permits storage of water during off peak periods and use of this water during peak periods.Depending on the size of pondage provided it may be possible to cope with hour to hour fluctuations.

(iii) Reservoir Plants :A reservoir plant is that which has a reservoir of such size as to

		permit carrying over storage from wet season to the next dry season.Water is stored behind the dam and is available to the plant with control as required. The classification according to availability of **water head** is (i) Low-Head (less than 30 meters) Hydro electricplants :"Low head" hydro-electric plants are power plants which generally utilize heads of only a few meters or less. (ii) Medium-head(30 meters - 300 meters) hydro electricplants :These plants consist of a large dam in a mountainous area which creates a huge reservoir. (iii) High-head hydro electricplants :"High head" power plants are the most common and generally utilize a dam to store water at an increased elevation. The use of a dam to impound water also provides the capability of storing water during rainy periods and releasing it during dry periods. The classification according to nature of load is (i) Base load plants :A base load power plant is one that provides a steady flow of power regardless of total power demand by the grid. These plants run at all times through the year. (ii) Peak load plants :Power plants for electricity generation which, due to their operational and economic properties, are used to cover the peak load. Gas turbines and storage and pumped storage power plants are used as peak load power plants.The efficiency of such plants is around 60 -70%.	
	c)	**Solar distillation plant**: 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 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.	02+02



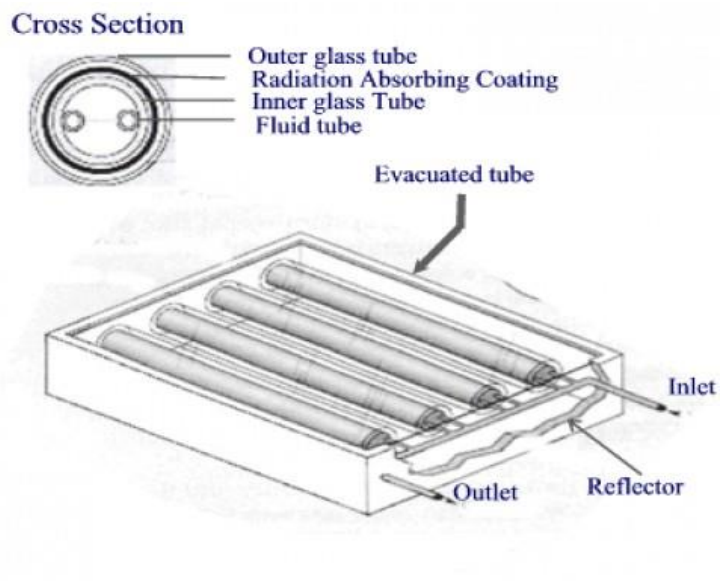
Solar Evacuated Tube collector: (ETC):

d)

ETC evacuated tube solar collectors convert energy from the sun into usable heat in a solar water heating system. This energy can be used for domestic and commercial hot water heating, pool heating, space heating or even air conditioning. 04

Construction:

The ETC solar collector is comprised of four main parts:



Evacuated Tube (ET)

Absorbs solar energy and converts it to usable heat. A vacuum between the two glass layers insulates against heat loss.

The Heat Transfer Fin helps to transfer heat to the Heat Pipe.

Heat Pipe (HP)

Copper vacuum pipe that transfers the heat from within the ET up to the manifold.

Manifold

Insulated box containing the copper header pipe. The header is a pair of contoured copper pipes with dry connect sockets that the heat pipes plug into.

Mounting Frame

Strong and easy to install with a range of attachment options.

e)

Energy saving potential in various stratas of its use like domestic industrial social etc. the answer should cover energy saving utilities and its impact in above areas.

Eg: domestic energy potential

Table - Potential Savings in TWh

Appliance Savings TWh:

Incandescent bulb 18.58

Tube light 8.43

Refrigerator 6.16

Stand-by-power 6.02

Fan 5.48

Television (TV) 5.04

Air conditioner 4.24

Water heaters 3.22

Air cooler 0.15

Total 57.32

02+02

f)

	Biomass	Biogas
1	Biomass is the amount of living matter	Biogas is created by fermenting biomass
2	biomass is the organic matter	Biogas is a mixture of gases
3	it is a solid fuel	biogas is a gas fuel(mixture of methane and corbon)
4	Biomass is obtained from solar energy.	Biogas is obtained by degradation of animal waste or plants i.e. from Biomass
5	ex.cow dunk,wood	ex.Methane

(01marks for one point)

04
