MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC - 27001 - 2005 Certified)

WINTER – 2016 EXAMINATION

Model Answer **Subject Code: 17645**

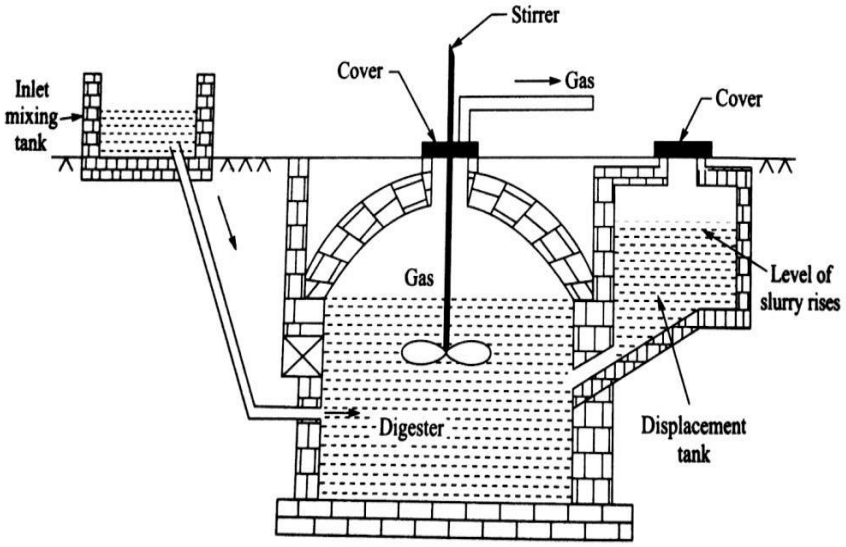
Important Instructions to examiners:

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.

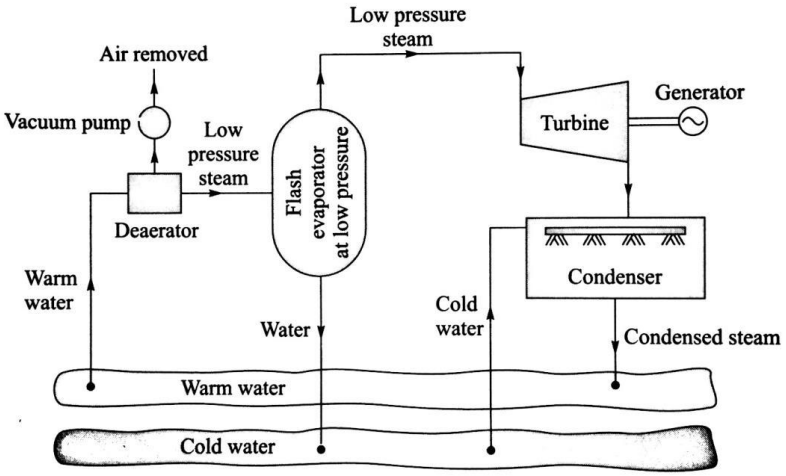
Q.No.	Sub Q.N.	Answer	Marking Scheme
1.	**a)**	**Attempt any THREE of the following:**	**12**
	(i)	**State at least four applications of solar pond. Describe any one in brief.**	***4M***
	Ans.	**Application of solar pond:** a) Heating and cooling of building b) Production of power c) Industrial process heat d) Desalination e) Heating animal housing and drying crops on farms f) Heat for biomass conversion	***Any 4 application ½M for each***
		a) Heating and cooling of building: Because of large heat storage capability in the lower convective zone of the solar pond, it has ideal use for heating even at high latitude stations and for several cloudy days. Many scientists have attempted and sized the solar pond for a particular required heating load for house heating. Calculations have shown that a solar pond with 100m diameter and 1m deep lower convective zone is sufficient to drive either an absorption system or chiller capable of meeting 100% of typical cooling load of a 50 house community.	***Any one explanation 2M***

		b) Production of power: A solar pond can be used to generate electricity by driving a thermo-electric device or an organic Rankine cycle engine- a turbine powered by evaporating an organic fluid with low boiling point. Even low temperatures heat that is obtained from solar pond can be converted into electric power. The conversion efficiency is limited due to its low operating temperatures. Because of low temperatures, the solar pond power plant requires organic fluid which have low boiling point such as halo-carbons. **c)Industrial process heat:** Industrial process heat is the thermal energy used directly in the preparation and of treatment of materials and goods manufactured by the industry. According to scientists the solar pond can play a significant role supplying the process heat to industries thereby saving oil, natural gas, electricity & coal. From the calculation it was concluded that for crop drying & for paper industry, for which economics have been determined, the hest from solar pond is highly competitive with oils & natural gas. **d) Desalination:**The low cost thermal energy can used to desalt or otherwise purify water for drinking or irrigation. Multi-flash desalination units along with a solar pond is an attractive proposition for getting distilled water because the multi-flash desalination plant below 100°C which can well be achieved by a solar pond. This system will be suitable at places where portable water is in short supply and brackish water is available. **e) Heating animal housing and drying crops on farms:** Low grade heat can be used in many ways on farms, which have enough land for solar ponds. Several small demonstration pond in ohio, Iowa, & Illinois have been used to heat green house and hogbarns. **f) Heat for biomass conversion:** Site built solar ponds could provide heat to convert biomass to alcohol or methane. While no solar ponds have been used for this purpose, it is ideal coupling of two renewable energy technologies.	
	(ii) Ans.	**Describe the meaning of terms:** **1) Power coefficient** **2) Thurst on turbines related to wind energy.** **1) Power Coefficient:** The fraction of the free-flow wind power that can be extracted by a rotor is called the power- coefficient; thus	***4M***

		Power coefficient = $\frac{Power\ of\ wind\ rotor}{Power\ available\ \ in\ the\ wind}$ Where power available is calculated from the air density, rotor diameter, and free wind speed. The maximum theoretical power coefficient is equal to 0.593. **2) Thurst on turbine:** There are two types of forces which are acting on the blades. One is circumferential force acting in the direction of wheel rotation that provides the torque and other is the axial force acting in the direction of the wind stream that provides an axial thrust that must counteracted by proper mechanical design	***Power Coefficient:2M*** ***Thurst on turbine: 2M***
	(iii) Ans.	**State the various bio-energy sources.** **Different Biomass Energy Resources:** a) **Forests:** Natural or cultivated forests are source of wood, charcoal, producer gas, forest waste, certain seeds which can be used to produce biofuel. b) **Agricultural Residues:** Straw, rice husk, groundnut shell, coconut shell, sugarcane bagasse c) **Energy Crops:** Sugar plants, Starch plants, oil producing plants d) **Urban waste:** Garbage, Municipal solid waste, sewage or liquid waste. e) **Aquatic Plants:** Water hyacinth, seaweed, algae, kelp.	***4M*** ***Any 4 points, 1M for each***
	(iv) Ans.	**State four disadvantages of geothermal energy over other energy forms.** a) Low overall power production efficiency about 15%, as compared to 35-40% for fossil fuel plants. b) The withdrawal of large amounts of steam or water from a hydrothermal reservoir may result in surface subsidence. c) The gases coming out of earth along with steam or hot water are hazardous, hence need to be removed by chemical action, before they are discharged. d) Drilling operation is noisy. e) Large areas are needed for exploitation of geothermal energy.	***4M*** ***Any 4 disadvantages, 1M for each***
1.	**b)** **(i)** Ans.	**Attempt any ONE of the following:** **Describe with neat diagram the working of fixed dome type biogas plant.** **Fixed dome type biogas plant:** It consists of an enclosed digester combined with a dome shaped gas holder. This economical design is made of bricks, cement and masonry. It has no moving parts, so working life of the plant is more.	**6** ***6M*** ***Explanation 3M***

		Dung and water is mixed in inlet tank and the slurry so formed is fed into the digester through the inlet pipe. A stirrer is provided in the digester tank to mix the slurry inside the digester, which also helps in mixing of scum floating on the slurry. The produced gas accumulates in the fixed dome of the digester and it is taken out by an outlet pipe. The residual digested slurry is taken out from an opening in the digester. As the pressure of gas in the fixed increases, the level of the slurry inside the digester goes down and it forces the slurry to rise in the displacement tank.  Fixed dome type biogas plant.	***Diagram 3M without labeling 2M***
	(ii) Ans.	**Describe with schematic diagram, the construction and operation of open cycle/closed cycle OTEC plant.** **Construction & Operation:** In this system, the warm water is converted into steam in an evaporator. The steam drives steam turbine coupled to generator, thus generating electricity. Figure shows schematic layout of open OTEC plant. The warm water from ocean surface is admitted through a deaerator to the flash evaporator, which is maintained under high vacuum. As a result, low pressure steam is generated due to throttling effect and the remainder warm water is discharged back to the ocean at high depth. The deaerator also removes the dissolved non-condensable gases from water before supplied to the evaporator. The low pressure steam having very high specific volume is supplied to turbine where it expands and the mechanical power so developed is	***6M*** ***Explanation 3M***

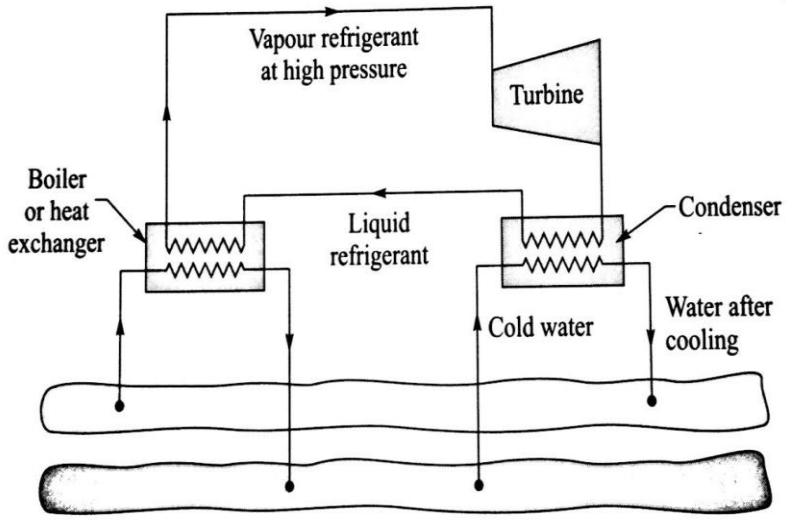
converted into electric power by the generator. The exhaust steam from the turbine is discharged into a direct contact type condenser, where it is mixed with cold water from ocean. The mixture of the condensed steam and ocean cold water are discharged into the ocean. Since the condensate is not directly fed to the evaporator for reuse, this cycle is called "open" cycle.



Open cycle OTEC plant.

Diagram 3M without labeling 2M

OR



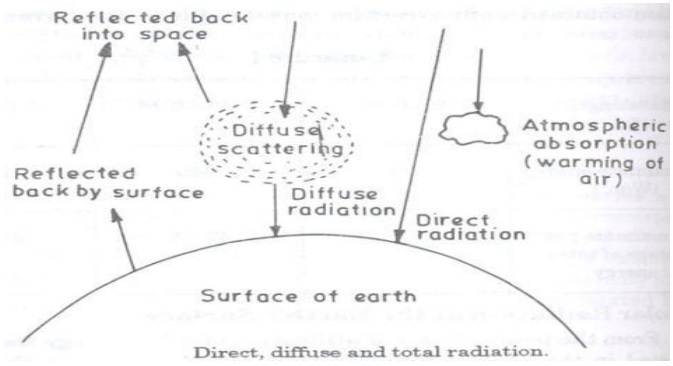
Closed cycle OTEC plant.

Diagram 3M without labeling 2M

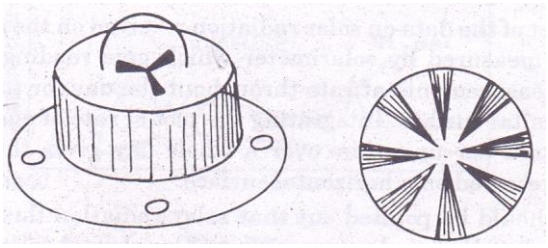
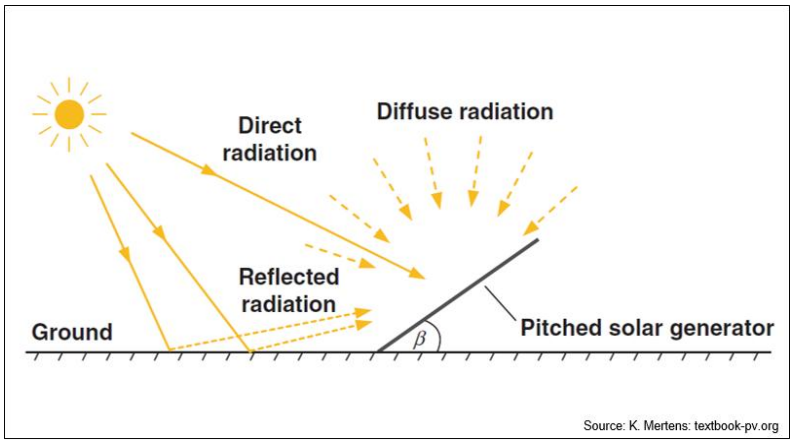
		Construction & Operation: A schematic layout of closed cycle OTEC plant is shown in the figure. The heat exchangers such as evaporator and condenser are key ingredients. This cycle requires a separate working fluid of low boiling point, such as ammonia, propane, Freon etc. These systems are located offshore on large floating platforms or inside floating halls. The warm water from the ocean surface is circulated through a pump to a heat exchanger which acts as a boiler to generate working fluid ammonia vapour at high pressure. This vapour then expands in the turbine to develop mechanical power, which in turn runs the electric generator to produce electrical power. The working fluid vapour from turbine at low pressure is condensed in the condenser with the help of cold water drawn from the depth of ocean through a pump. The condensate is then supplied to evaporator for reuse. Since the working fluid is reused, this cycle is called "Closed" cycle.	***Explanation 3M***
2.		**Attempt any FOUR of the following:**	**16**
	a)	**Describe the environmental aspects of energy and sustainable development.**	***4M***
	Ans.	**Environmental Aspects of energy& sustainable development:** 1) Energy development that meet the need of present ability and future generation to meet their own needs. 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 pollutant which disturbs environment 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	***Any 4 points 1M for each***
	b)	**Define primary energy sources and secondary energy sources with two examples of each.**	***4M***
	Ans.	1) **Primary energy sources:** The energy sources which provide net supply of energy are called primary energy sources. Its examples are coal, oil, gas, uranium etc. These are available in nature in raw form and need to processed and converted into a suitable form before use.	

		2) **Secondary energy sources:** The energy sources which are obtained from primary energy sources by processing. These sources produce no net energy. The processing transforms the primary sources into secondary or usable energy form so that it can be utilized by consumers. Its examples are electricity, steam, petrol, diesel, LNG, CNG etc.	***Definition of each 1M, two examples of each 1M***
	c) Ans.	**Describe different renewable sources of energy with special reference to the Indian context.** Hydro-electric potential indicates that the exploitable potential is about 400 TWh of annual energy generation. The energy potential of 40 TWhhave already been constructed. The 360 TWh of annual energy generation is located in northern and north-eastern region. The intensity of use of electrical energy in the Indian economy has shown a steady increase. This trend necessitated substantial increase in the share of investment. According to the assessment by Ministry of Non-conventional Energy Sources (MNES), India has potential of 135,853 MW from renewable energy sources, while 14,914 MW has been installed. Renewable sources can provide both grid connected power and off-grid power for lighting, pumping, thermal and heat generation and transportation.	***4M*** ***Description 3M*** ***Table 1M***
	d) Ans.	**Describe the necessity of alternate energy sources.** 1. Conventional sources of energy are depleting oil is likely to last up to 2025 and coal another 200 year.	***4M***

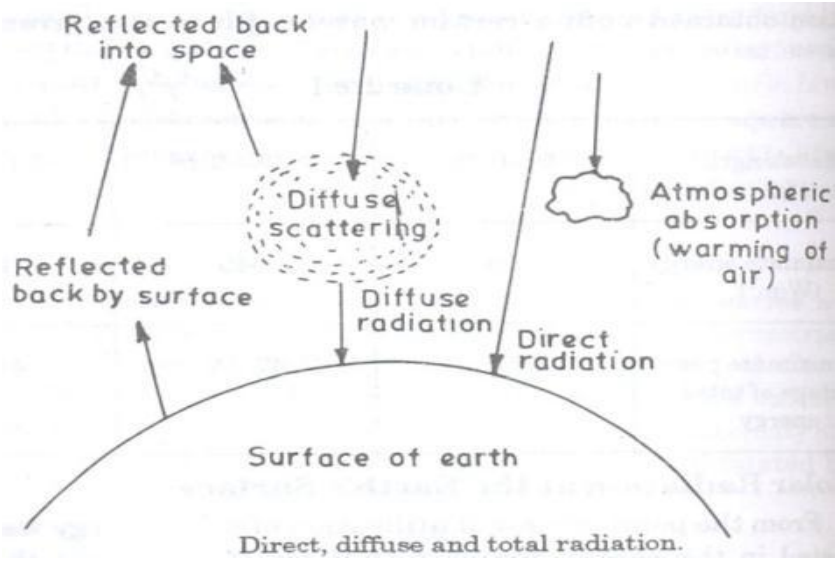
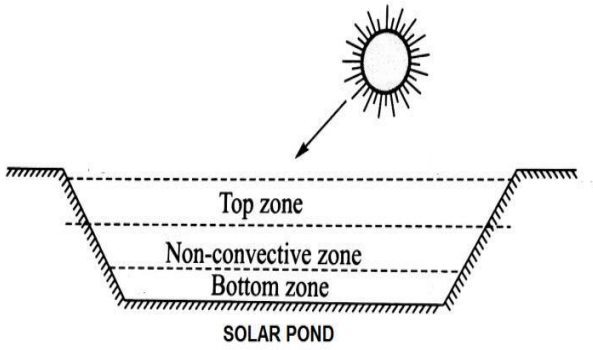
Renewable power status and potential: Sr. No.	Sources	Potential (MW)	Installed (MW)
1	Wind Energy	48,561	10,464
2	Small hydropower	14,292	2,461
3	Biogas	5,000	1,555
4	Bio-power	61,000	773
5	Waste Energy	7,000	59
6	Solar photovoltaics (SPU)	20	2
	Total	135,873	15,314

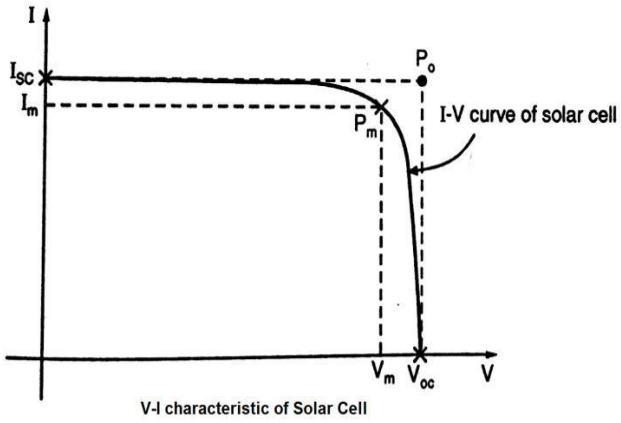
		2. Oil, gas and coal cause air pollution which is causing global warming and climate changes all over the world. It is also increasing the level of sea, elimination of certain species, impacting the life of plant, animals and marine life. 3. Import of oil bill is increasing due to increasing energy needs. 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***
	e) Ans.	**Define the solar constant. State the standard value for solar constant in terms of watt per square meter and Kcal per square meter per hour.** **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. Solar constant in terms of watt/m^2: 1353 w/m^2---------- Solar constant in terms of Kcal/m^2/hr: 1165 kcal/m^2/h --------	***4M*** ***Definition 2M*** ***1M*** ***1M***
	f) Ans.	**Describe with schematic representation, the distribution of solar energy as direct, diffused and total radiation.**  Direct, diffuse and total radiation.	***4M*** ***Diagram 2M***

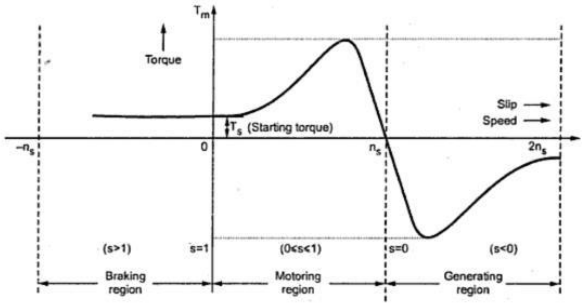
		Solar radiation pass through the earth's atmosphere and are subjected to scattering and atmospheric absorption. A part of scattered radiation is reflected back into space. Short wave ultraviolet rays are absorbed by ozone and long wave infrared rays are absorbed by CO_2 and water vapor. Scattering is due to air molecules, dust particles and water droplets. When the sky is clear, earth's surface receives maximum radiations. **Beam radiation or direct radiation (I_b)**: Solar radiation that directly reached the earth's surface without changing the direction is called beam or direct radiation. **Diffuse radiation (I_d):** The radiation that received on a terrestrial region (scattered by dust particles & aerosols) from all parts of the sky dome is known as diffuse radiation. **Total radiation (I_T):** The sum of direct and diffuse radiation (I_b+I_d) is referred as total radiation. When measured at a location on the earth's surface it is called 'solar insolation' at the place.	***Explanation 2M***
3.		**Attempt any FOURof the following:**	**16**
	a)	**What is the difference between pyrheliometer and a pyranometer? Describe the principle of any one type of pyranometer.**	***4M***
	Ans.	A pyrheliometer is an instrument which measures beam radiation whereas pyranometer is an instrument which measures total or global radiations over a hemispherical field of view. There are following types of pyranometers: (i) Eppleypyranometer, (ii) Yellotsolarimeter (photo-voltaic solar cell, (iii) Moll-Gorczyheskisolarimeter, (iv) Bimetallic Actionographs of Rabitzsch type, (v) Velochmepyranometer, (vi) Thermoelecticpyranometer etc.	***2M for difference***
		(i) Eppley pyranometer: It is based on the principle as stated above that there is a difference between the temperature of black surfaces (which absorb most solar radiation) and white surfaces (which reflect most solar radiation). The detection of temperature difference is achieved by thermopile. It uses concentric silver rings 0.25mm thick, appropriate coated black and white, with either 10 or 50 thermocople junctions to detect temperature differences between coated rings. Later models use wedges arranged in a circular pattern, with alternate black and white coatings. The disks or wedges are enclosed in a hemispherical glass cover. Similar, instruments are manufactured in Europe under the same Kipp. The Eppleypyranometers, and similar	***2M for Prinicple of any one type of pyranometer***

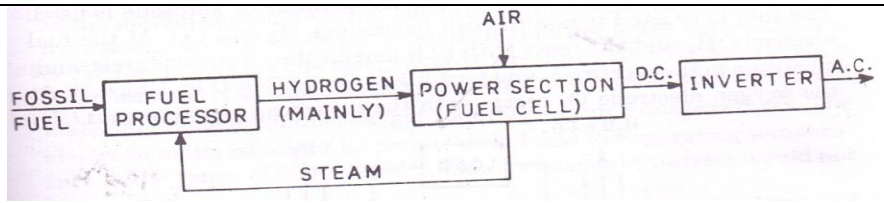
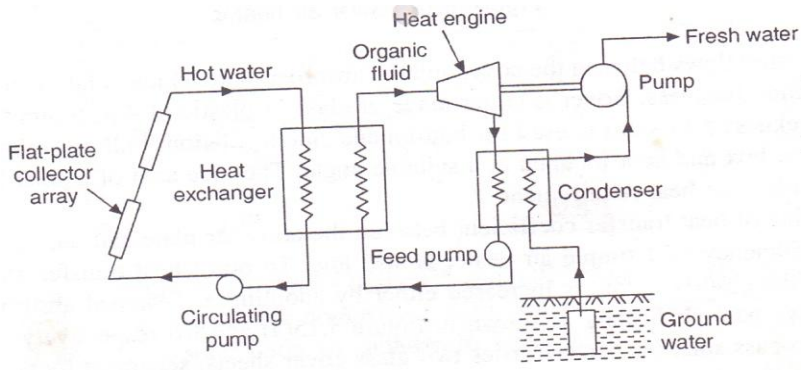
		instruments are calibrated in a horizontal position. Calibration of these instruments will vary to some degree if the instrument is inclined to measure radiation on other than a horizontal surface.  **(ii)Yellot Solarimeter (photovoltaic solar cell):** Pyranometers have also been used on photovoltaic (solar cell) detectors. Silicon cells are the most common for solar energy. Silicon solar cells have the property that their light current (approximately equal to the short circuit current at normal radiation levels) in a linear function of the incident solar radiation. They have the disadvantages that the spectral response is not linear, so instrument calibration is a function of the spectral distribution of the incident radiation.	
	b) Ans.	**Describe the solar radiation on tilted surfaces with neat diagram.**  **Solar Radiation on Tilted Surface:** **The total solar radiation incident on a tilted surface has three components:** (i)Beam radiations (ii) Diffuse Radiation (iii) Reflected radiations	***4M*** ***1M diagram***

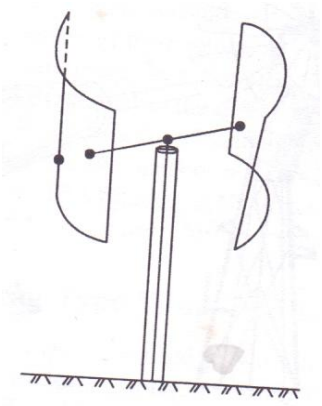
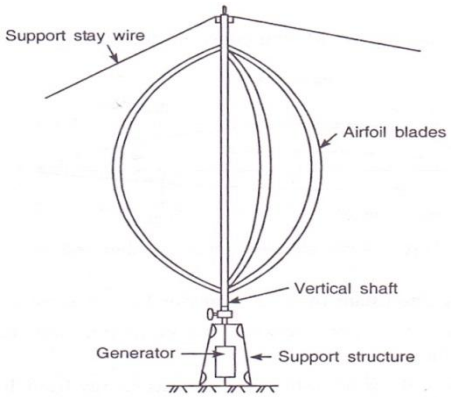
		To obtain maximum solar radiations and solar energy the flat plate collectors always faces the sun using sun tracking equipment. It therefore infers that the solar radiation collecting appliances are tilted at an angle to the horizontal.IT therefore becomes necessary to calculate the flux which falls on a tilted surface. **Total Radiation**: The total radiations falling on an inclined surface at any instant is expressed as $$I_T = I_b R_b + I_d R_d + (I_b + I_d) R_r$$ Where I_T = Flux falling on a tilted surface R_b = Tilt factor for beam Radiation R_d = Tilt factor for diffuse Radiation R_r = Tilt factor for reflected Radiation I_b = hourly beam Radiation I_d = hourly diffuse Radiation	***3M explanation***
	c) Ans.	**State any four advantages and limitations of solar furnaces for industrial applications.** **Advantages of Solar Furnace:** In a solar furnace heating is carried out without any contamination and temperature is easily controlled by changing the position of the material in focus (i) It gives an extremely high temperature (ii) It provides very rapid heating and cooling (iii) Various property measurements are possible on an open specimen (iv) Contamination by ions does not occur in fusion which might happen in case of plasma or oxy hydrogen flame (v) Proper desirable atmosphere can be provided to the specimen **Limitations:** (i) Its use is limited to sunny days and to 4-5 hours only(maximum bright sun shines hours), and (ii) It has high cost.	***4M*** ***2M advantages,*** ***2M limitations***
	d) Ans.	**Draw the diagram of distribution of solar energy as direct, diffused and total radiation.**	***4M***

		 Direct, diffuse and total radiation.	***4M for labeled diagram 2M for unlabeled diagram***
	e) Ans.	**Write the principle and working of solar pond.** **Solar Pond:**  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*** ***2M for principle***

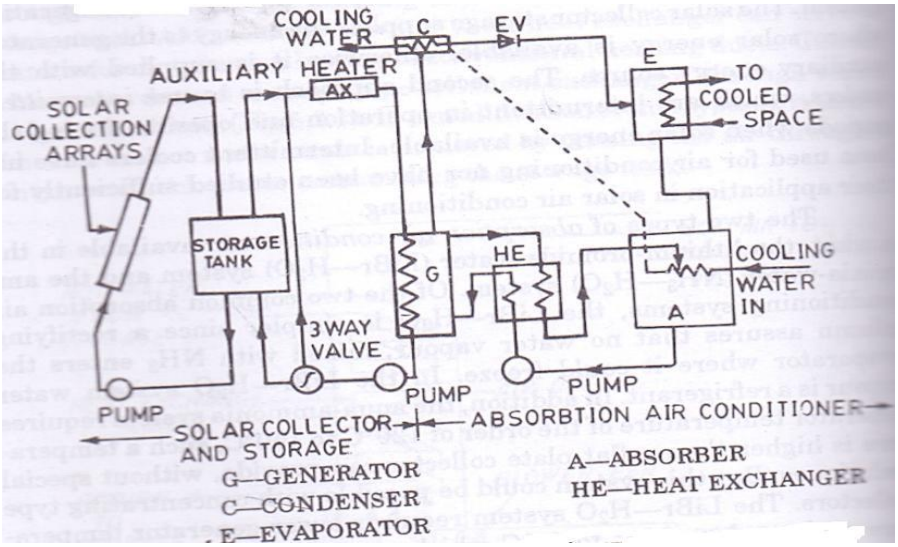
		Working: The solar pond consists of a large size brine pond (depth almost about 1 meter) which has salt concentration gradient in such a way that most concentrated and dense part of the brine solution is at the bottom of the pond & brine concentration gradually reduces from bottom to top of the pond based on the	***2M for working***
4.	**a)**	**Attempt any THREE of the following:**	**12**
	(i)	**Draw V-I characteristics of solar cell and state the formula for conversion efficiency of solar cell.**	***4M***
	Ans.	 V-I characteristic of Solar Cell Figure shows the V-I characteristic of a solar cell.	***2M for diagram***
		Efficiency of Solar PV Cell: Power conversion efficiency of solar cell is defined as the ratio of generated electricity to the incoming light energy. The formula for the power conversion efficiency PCE is given by $$PCE = \frac{I_{sc} * V_{sc} * FF}{P_{light}}$$ Where, FF = Fill factor I_{sc} = short ckt current V_{sc} = Short ckt voltage	***2M for definition***
	(ii)	**State the salient features and characteristics of synchronous generator and induction generators used in wind mills.**	***4M***
	Ans.	**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	***½M for each of any four features***

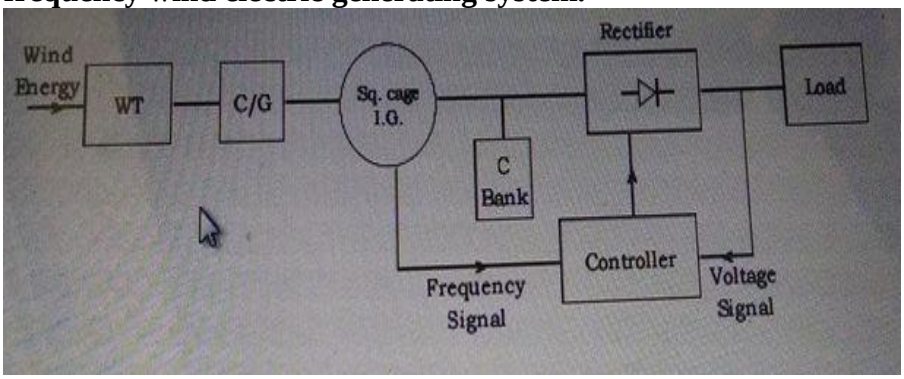
		iv) No synchronization problems.  **Characteristics of Induction Generators:** The torque-speed or slip characteristic of induction generator is shown in the figure. When the load drives the rotor at speed higher than the synchronous speed i.e slip is negative, the induction machine receives the mechanical energy and converts it into electrical energy operating as induction generator.	***1M for diagram*** ***1M for explanation***
	(iii) Ans.	**Describe the thermal gasification of biomass.** **Thermal gasification of biomass:** A solid fuel is converted by a series of thermochemical 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. A typical composition of the gas obtained from wood gasification on volumetric basis is as follows: Carbon monoxide - 18 - 22% Hydrogen - 13 – 19% Methane - 1 - 5% Heavier hydro carbons - 0.2 – 0.4% Carboxdioxide - 9 - 12% Nitrogen - 45 – 55% Coater vapour - 4% 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*** ***Description 3M*** ***% of gasses 1M***
	(iv) Ans.	**Describe with block diagram, the fuel cell based electrical power generation scheme.**	***4M***

		 **Block diagram fuel cell based electric power generation scheme** **1.** The fuel gas diffuses through the anode and is oxidized, this releasing electron to the external circuit. **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.	***2M diagram*** ***2M explanation***
4.	**b) (i)** Ans.	**Attempt any ONE of the following:** **Describe with neat diagram, the operation of solar water pumping system. State advantages and limitations of solar water pumping system.**  **Solar water pumping system** A typical solar powered water pumping system is shown in the fig. The primary components of the system are an array of flat plate collector and anRankine engine with organic fluid as working substance.	**6** ***6M*** ***2M for diagram*** ***2M for explanation***

		During operation a heat transfer fluid (which is pressurized water) flows through the collector array. Depending up on the collector configuration, solar flux and the operating conditions of the engine the fluid will be heated in a collector to the high temperature and the solar energy is converted into Thermal Energy .Further fluid flows into heat Exchanger (boiler), due to temperature gradient and come back to the collector. This water yields its heat to the intermediate fluid in the boiler. This fluid evaporates and expands in the engine before reaching to the condenser where it condenses at low pressure. The condenser is cooled by the water to be pumped. This fluid is then reinjected in the boiler to close the cycle. The expansion engine or Rankine engine is coupled to the pump and further to the electric generator. **Advantages of solar water pumping system:** 1) More irrigation water is required in summer when solar energy is available most. 2) Pumping can be carried out intermittently without any problem 3) Surplus pumped water can be stored in a reservoir / pond / tank 4) The requirement of water decreases during period of low radiations. 5) It is relatively inexpensive. 6) Running and maintenance cost is low. **Limitations:** 1.It involves high capital investment. 2. Output depends up on availability sun light. Or Lower output in cloudy days	***2M for advantages and limitations***
	(ii) Ans.	**Describe with diagram the construction and working of vertical axis wind turbine and state its advantages.**  **Savonious vertical-axis rotor**  **Darrieus rotor**	***6M*** ***2M for diagram***

		The vertical axis wind turbines blades are attached to a central vertical shaft which has specific advantages over horizontal wind turbine. All the main components are close to the ground .Also the wind turbine is near to the ground unlike horizontal axis turbine where everything is on the tower. There are two types of vertical axis turbines rotors a) Savonious rotor b) Darrieus rotor The savonius rotor consists of hollow cylinder (approximately elliptical in shape) sliced in half , the two halves being fixed to a vertical axis with a gap in between to make a S shape. Torque is produced by the the pressure difference between the two slices of the half facing the wind. The Darrieus rotor is shaped like an egg beater. It is consist of two three blades having an aero foil cross section .Along the length, the blades are curved into a shape called a troposkein. Is the shape a rope would take up if rotated about a vertical axis. Both types run independently of the direction of wind because they rotate about vertical axis. **Advantages of vertical axis turbine:** • They will react to wind from any direction and therefore do not need yawing equipment to turn the rotor in to wind • They require less structural support because heavy components (like gear box and generator) can be located to ground level. This configuration also eases installation and maintenance. • Since the blades do not turn end over end, the rotor is not subjected to continuous cyclic gravity loads.	***2M for construction and working*** ***2M for any two advantages***
5.		**Attempt any FOUR of the following:**	**16**
	a)	**What is the MPPT? Describe the need of MPPT in solar PV system.**	***4M***
	Ans.	MPPT means Maximum Power Point Tracker is an electronic DC-DC converter that optimizes the match between the solar array (PV panels), and battery bank or utility grid. **Need of MPPT in solar PV system:** Solar energy systems generally suffer from their low efficiencies and high costs. In order to overcome these drawbacks, maximum power should be extracted from the PV panel using different MPPT techniques to optimize the efficiency of overall PV system. MPPT is a real-time control scheme applied to the PV power converter in order to extract the maximum power possible from the PV panel. A Maximum Power Point Tracking algorithm is required to increase	***Definition2M*** ***Need 2M***

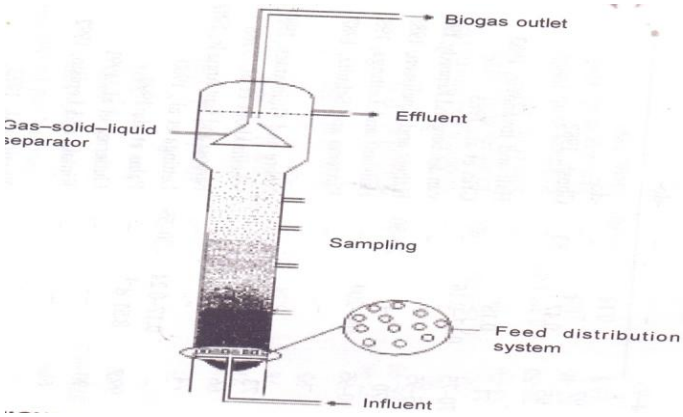
		the efficiency of the solar panel. MPPT is a method that compensates for that changing voltage and current characteristic of solar panel and maximum utilization of solar energy from panel.	
	b) Ans.	**Describe with diagram, operation of solar operated absorption air conditioner system.** The solar energy is gained through the collector, and is accumulated in the storage tank. Then, the hot water in the storage tank is supplied to the generator to boil off water vapour from a solution of Lithium Bromide and water. The water vapour is cooled down in the condenser and then passed to the evaporator where it again is evaporated at low pressure, thereby providing cooling to the required space. Meanwhile, the strong solution leaving the generator to the absorber passes through a heat exchanger in order to preheat the weak solution entering the generator. In the absorber, the strong solution absorbs the water vapour leaving the evaporator. Cooling water from the cooling tower removes the heat by mixing and condensation. Since the temperature of the absorber has a higher influence on the efficiency of the system than the condensing temperature, the heat rejection (cooling water) fluid, is allowed to flow through the absorber first, and then to the condenser .An auxiliary energy source is provided, so that hot water is supplied to the generator when solar energy is not sufficient to heat the water to the required temperature level needed by the generator  	***4M*** ***2M description*** ***2M diagram***

	c) Ans.	**Describe with diagram, the working of variable speed variable frequency wind electric generating system.**  This scheme is suitable for loads that are frequency insensitive such as heating load. Depending upon the wind speed, squirrel cage Induction Generator generates power at variable frequency. Such generators are excited by Capacitor-bank. The magnitude and frequency of the generated E.M.F. depends upon the wind turbine speed, excitation capacitance and load impedance. If load requires constant dc voltage, output of generators is converted into d.c. using chopper controlled rectifiers. Feedback system can be used to monitor and control to get desired performance.	***4M*** ***2M diagram*** ***2M description***
	d) Ans.	**State the main considerations in selecting the site for wind generators.** Main considerations in selecting the site for wind farm are: 1. Adequate and uniform average wind velocity through out the year. Freedom from cyclones, floods and lightening strokes. 2. Availability of vacant land free from forests, townships, etc. 3. Availability of distribution substation connected to the electrical grid, within a short distance.(< 10km). 4. Suitable terrain and soil for installing wind turbine. 5. Approach roads upto site for movement of erection equipment and the wind turbine sub assemblies. 6. Environmental clearances.	***4M*** ***Any four 1M each***
	e) Ans.	**Differentiate between drum type and dome type biomass plant.** **Drum Type Biomass Plant** / **Dome type Biomass Plant** **Construction**: A fixed-dome plant consists of a digester / Floating-drum plants consist of an underground	***4M***

			with a fixed, non-movable gas holder, which sits on top of the digester.	digester and a moving gas-holder. The gas-holder floats either directly on the fermentation slurry or in a water jacket of its own	***Any four 1M for each***
		Economy	The costs of a fixed-dome biogas plant are relatively low	The steel drum is relatively expensive and maintenance-intensive.	
		Maintenance	The plant is constructed underground, protecting it from physical damage and saving space and labour.Lesser maintenance cost.	the susceptibility of steel parts to corrosion, regular maintenance costs for the painting of the drum.	
		Operation &Labour	The construction of fixed dome plants is labor-intensive, thus creating local employment.	Construction is relatively easy, construction mistakes do not lead to major problems in operation and gas yield. Less labor is required.	
		Life	No moving parts and no rusting steel parts. If well constructed, fixed dome plants have a long life span.	Removing rust and painting has to be carried out regularly. The life-time of the drum is short .	
6.		**Attempt any <u>TWO</u> of the following:**			**16**
	a)	**State the complete classification of solar thermal collectors. What are the main components of flat plate solar collector? Explain the function of each.**			***8M***
	Ans.	Solar thermal collectors are classified into two categories as: 1. Stationary collectors 2. Sun tracking concentrated collectors **1. Stationary collectors** are again classified as: • Flat Plate Collector • Compound Parabolic Collector • Evacuated tube collector **2. Sun tracking** concentrated collectors are again classified as: • Parabolic trough Collector			***2M types***

		• Linear Fresenel Reflector • Parabolic dish Reflector • Heliostat field Reflector **Components of Flat Plate Collector and their function:** 1. **Glazing**: One or more sheets of glass or other diathermanous (Radiation transmitting) material. The function of Glazing is to admit as much of solar radiation as possible and reduce upward loss of heat as much as possible. 2. **Tubes, fins or passages**: The function of this is to conduct or direct the heat transfer fluid from the inlet to the outlet. 3. **Absorber Plates**: Flat, corrugated, or grooved plates to which the tubes, fins or passages attached. The plate may be integral part of the tubes. The function of these plates is to absorb as much of radiation as possible through the glazing while losing as little heat to the atmosphere and downward to the back of casing. The collector plates transfer the retained heat to the transport fluid. 4. **Headers or manifolds**: Their function is to admit and discharge the fluid. 5. **Insulation:** Their function is to minimize the heat loss from the back and sides of the collector.	***2M components, 4M explanation***
	b) Ans.	**State the three main designs of fixed bed gasifiers. Describe the construction and working of any one type of fixed bed gasifier.** The three major designs of fixed bed gasifies are: 1. Up draft reactor 2. Down draft reactor 3. Cross draft reactor. **Construction of any one of the following:** **Up draft reactor:** This reactor is the oldest and simplest reactor design known. In this reactor, the gasifying medium is fed from the bottom and travels upward while the feedstock introduced from the top moves downwards on a bed in a counter-current direction to the gasifying agent. The produced gases leave the reactor from the top of the reactor. The feedstock descends through the drying, pyrolysis and oxidation zones of progressively increasing temperatures. The oxidation zone, which has the highest temperature, lies at the bottom of the reactor and the gasifying agent passes through this zone reacting with the	***8M*** ***State the designs 2M*** ***Construction of any one 2M*** ***Explanation 4M***

char, thereby releasing the heat requirement for the process. The produced gases, tar and other volatiles leave from the top while the ashes are removed at the bottom of the reactor. The produced gases usually exit the updraft reactor at low temperatures and hence contain high hydrocarbons and tar content. Hence, thorough cleaning is required before the gases can be utilized in applications other than direct heating. However, updraft reactors have the advantages of simple design and construction, low gas exit temperature, high burnout and thermal efficiency.

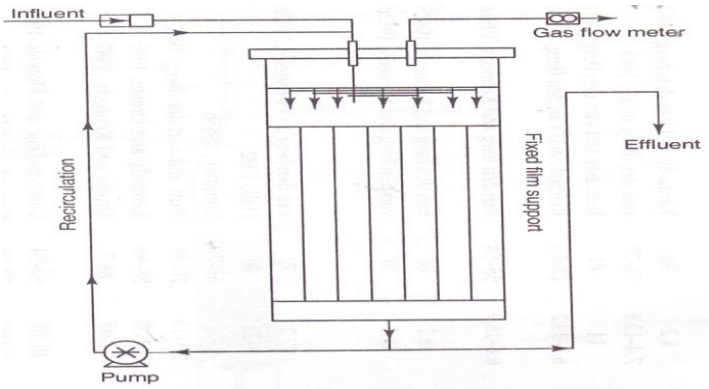


Down draft reactor:

A downdraft reactor is a co-current reactor in which the feedstock is introduced from the top and the gasifying medium is fed from the sides of the reactor. The reaction zones in this reactor are similar to those in the updraft reactor, but the locations of the oxidation and reduction zones are interchanged.

In downdraft reactor the pyrolysis products pass through the high temperature oxidation zone, and therefore undergo further decomposition. The final product gas leaves the reactor from the bottom at high temperature and contains lesser tar than the updraft reactor.

Downdraft reactor produces gases with low oil and tar contents, which means less cleaning and filtering are required before using the gas in applications like internal combustion engines. However, due to slag formation problems, this type of reactor is found unsuitable for feedstock with high ash contents and low ash fusion temperatures

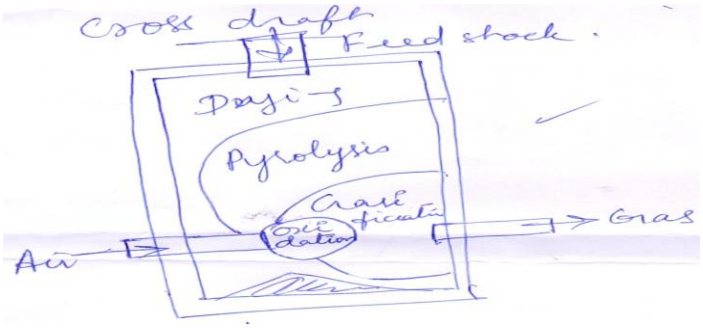


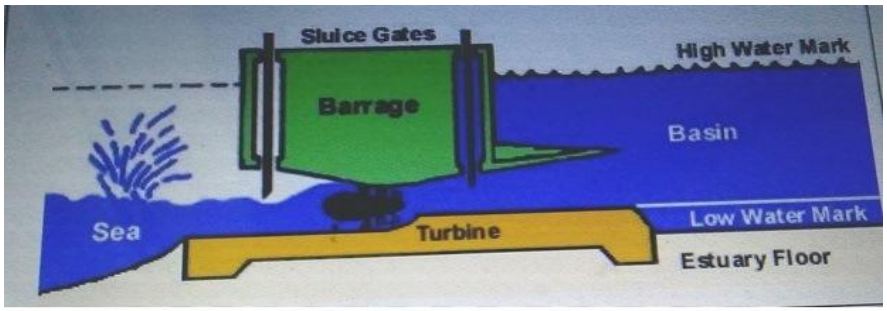
Cross draft reactor:

This is a co-current reactor in which the feedstock is introduced from the top and the gasifying medium is fed in from the side of the reactor near the bottom while the product gas exit from the opposite side. Normally, an inlet air nozzle is used to bring the air into the center of the combustion zone as shown in the figure below

The air velocity is considerably higher in crossdraftreactor, consequently have a hotter combustion zone than updraft and downdraft reactors. The oxidation and reduction zones are both concentrated to a small volume around the sides of the reactor

Cross draft reactor responds rapidly to local changes. They are normally simpler to construct and more suitable for running engines than the other types of fixed bed reactors due to very low tar production. However, they are sensitive to changes in biomass composition and moisture content.



	c) Ans.	**Describe with neat diagram, the construction of tidal power plant. State its main components and their functions**.  **The components of a tidal power station are:** 1.**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. **2. 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. There are many types of turbines used in tidal power stations: • Bulb turbines: these are difficult to maintain as water flows around them and the generator is in water. • Rim turbines: these are better maintained than thebulb turbines but are hard to regulate as generator is fixed in barrage. • Tabular turbines: these turbines are fixed to longshafts and thus solve both problems that bulb and rim turbines have as they are easier to maintain and control. **3.Sluices**: sluice gates are the ones responsible for the flow of water through the barrage. **4.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.	***8M*** ***Labeled diagram 4M*** ***List of components 2M, Function of components 2M***