



MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
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MODEL ANSWER

SUMMER – 2018 EXAMINATION

Subject: Renewable Energy Sources

Subject Code: 17645

Important Instructions to examiners:

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

Q. No	Sub Q.N.	Answer	Marking Scheme
1.	A) a) Ans.	<p>Attempt any three of the following:</p> <p>Define primary energy sources, secondary sources and supplementary sources with its examples.</p> <p>Primary energy sources: Primary energy sources are those which are found or stored in nature. <i>Examples:</i> Coal, oil, Natural gas, Biogas, Nuclear energy in radioactive substances, thermal energy stored in earth's interior, potential energy due to earth's gravity etc.</p> <p>Secondary energy sources: Secondary energy sources are those which are obtained after the conversion from primary sources for industrial utilization. <i>Examples:</i> Coal, oil, Gas are converted into electricity or steam for industrial utility.</p> <p>Supplementary energy sources: Supplementary energy sources are those additional to the conventional energy sources can be used to supply energy to the grid.</p>	<p>12 4M</p> <p><i>Each definition 1M</i></p> <p><i>Example 1M</i></p>

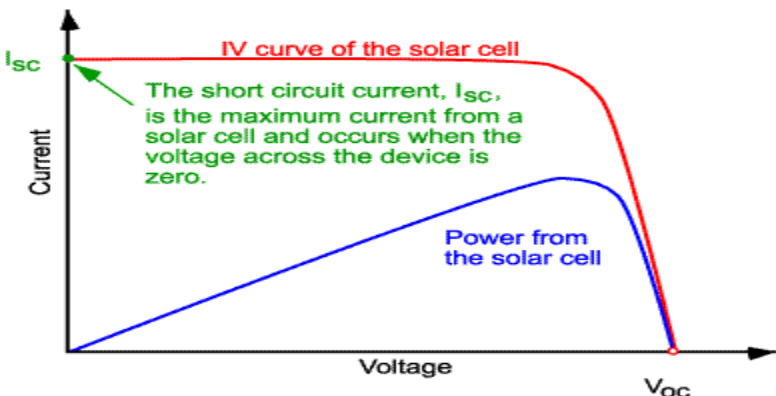


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		<i>Examples:</i> Solar thermal, Biogas, Tidal and wind power.	
b)	Define tilt factor for beam radiation. State the factor on which the value of tilt factor depends.	4M	
Ans.	Definition of tilt factor: Tilt factor is a measure of total solar radiations on a tilted (inclined) surface. Value of Tilt factor depends on: <ol style="list-style-type: none"> 1. Tilt angle 2. Latitude of the location 3. Solar declination angle 4. Sunrise and sunset hour angles on tilted surface. 	Definition 1M Any 3 factors 1M each	
c)	Draw the VI characteristics of solar cell. Also define efficiency of solar PV cell.	4M	
Ans.	 <p>Efficiency of a solar PV cell: This may be defined as the portion of the energy in the form of sunlight that can be converted via photovoltaic cells into electricity.</p>	Diagram 3M Definition 1M	
d)	Describe the meaning of terms:	4M	
Ans.	<ol style="list-style-type: none"> Power coefficient Thrust on turbine related to wind energy. <ol style="list-style-type: none"> Power coefficient: Power coefficient is a measure of wind turbine efficiency. It is the ratio of actual electric power produced by a wind turbine divided by total wind power flowing into the turbine blades at specific wind speed. Thrust on turbine related to wind energy: Thrust on turbine is 	Each term 2M	



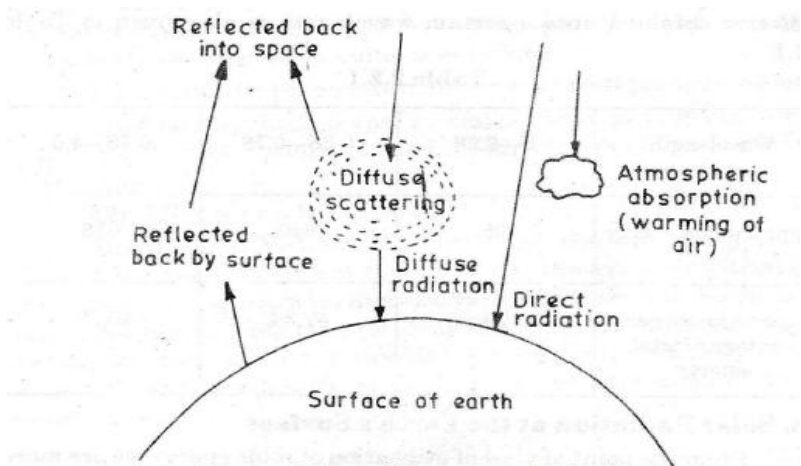
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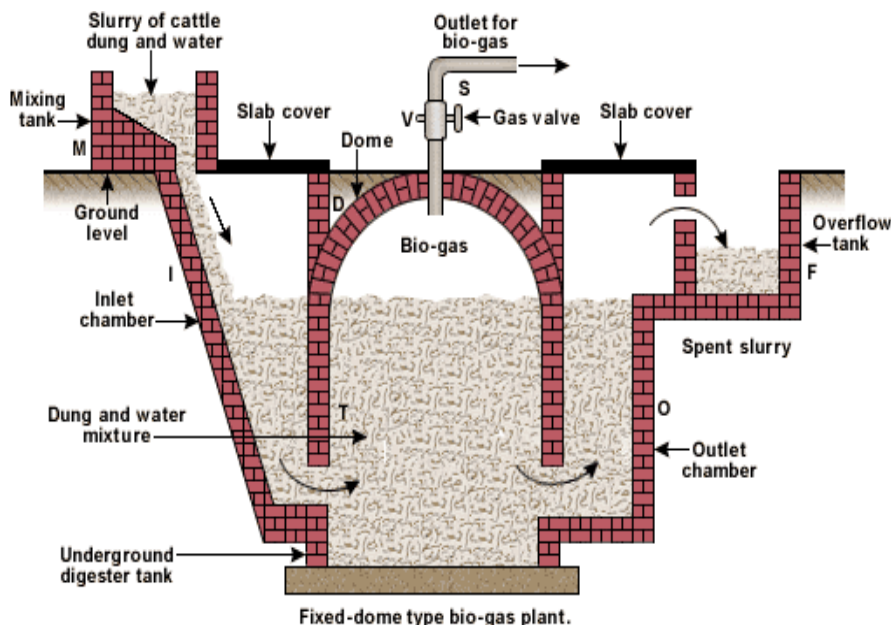
		the axial force applied by steam or wind on the rotor of steam or wind turbine.	
1.	<p>B) i) Ans.</p>	<p>Attempt any one of the following: Describe the distribution of solar energy as direct, diffused and total radiation with the help diagram.</p> <p>The solar radiation striking a surface generally consists of three components, direct, diffuse and reflected. The direct, or beam, solar radiation is that received from the sun without having been scattered by the atmosphere.</p> <p>The diffuse solar radiation is that received from the sun after its direction has been changed by scattering by the atmosphere.</p> <p>The reflected solar radiation is that which strikes a surface after the radiation is reflected from surrounding surfaces.</p> <p>The total radiation is the sum of direct, diffused and reflected radiations</p> 	<p>6 6M</p> <p><i>Description 3M</i></p> <p><i>Diagram 3M</i></p>
	<p>ii) Ans.</p>	<p>Describe with neat diagram the working of fixed dome type biogas plant.</p>	<p>6M</p>

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**Diagram
3M**

A fixed-dome plant consists of a digester with a fixed, non-movable gas holder, which sits on top of the digester. When gas production starts, the slurry is displaced into the compensation tank. Gas pressure increases with the volume of gas stored and the height difference between the slurry level in the digester and the slurry level in the compensation tank. The costs of a fixed-dome biogas plant are relatively low. It is simple as no moving parts exist. There are also no rusting steel parts and hence a long life of the plant (20 years or more) can be expected. The plant is constructed underground, protecting it from physical damage and saving space. While the underground digester is protected from low temperatures at night and during cold seasons, sunshine and warm seasons take longer to heat up the digester. No day/night fluctuations of temperature in the digester positively influence the bacteriological processes. The construction of fixed dome plants is labor-intensive, thus creating local employment. Fixed-dome plants are not easy to build. They should only be built where construction can be supervised by experienced biogas technicians. Otherwise plants may not be gas-tight (porosity and cracks).

**Descript
ion 3M**



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2.	a) Ans.	Attempt any four of the following: Describe the environmental aspects of energy and sustainable development. Development of clean energy for sustainable development is associated with a lot of environmental aspects, such as: 1. Removal of biomass from land and water for energy production increases soil and water degradation, flooding and removal of nutrients. It also affects wildlife and biota 2. Centralised systems for large solar power generation make permanent use of large land area. Generate lot of non recyclables during decommissioning such as fiberglass, glass, coolant, insulations, causing additional disposal problems. Accidental release of heat transfer fluids is highly toxic. These are hazard to eyesight from reflectors. Causes soil erosion, wind diversion, potential decrease in evaporation rate from soil. 3. Wind turbines pose a threat to birds. Movement of wind turbines causes noise pollution. 4. Hydroelectric power plant, ocean thermal energy, Geothermal energy releases greenhouse gases.	16 4M <i>Any four following or similar points 4M</i>
	b) Ans.	State any four advantages of solar water pumping system. Advantages of solar water pumping system: 1. As energy comes straight from the sun, lower operating cost. 2. Low maintenance cost 3. Easy installation 4. No fuel spill or extra cost. 5. Unattended operation	4M <i>Any four advantages 1M each</i>
	c) Ans.	State the main consideration in selecting site for wind energy conversion system. 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.($< 10\text{km}$). 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 <i>Any four points 1M each</i>



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	<p>d)</p> <p>Ans.</p>	<p>Define the following method of energy generation from bio-mass.</p> <p>i) Combustion ii) Anaerobic digestion ii) Pyrolysis iv) Gasification</p> <p>i) Combustion: This is a method of extraction of energy from biomass by direct combustion.</p> <p>ii) Anaerobic digestion: In this method biogas is produced when wet sewage, sludge, animal dung or green plants are allowed to decompose in a sealed tank under anaerobic (oxygen free) conditions.</p> <p>iii) Pyrolysis: In this method high energy rich fuels (produced by roasting dry woody matter) is pulverized and fed to reactor and heated in absence or little presence of air.</p> <p>iv) Gassification: This is a process in which wood produces a flammable gaseous mixture of hydrogen, carbon monoxide, methane, and other non flammable by-products. This is done by partially burning and partially heating the biomass in the presence of charcoal.</p>	<p>4M</p> <p><i>Each definition 1M</i></p>												
	<p>e)</p> <p>Ans.</p>	<table><tr><th>Differences</th><th>Drum Type Biomass Plant</th><th>Dome type Biomass Plant</th></tr><tr><td>Construction</td><td>A fixed-dome plant consists of a digester with a fixed, non-movable gas holder, which sits on top of the digester.</td><td>Floating-drum plants consist of an underground digester and a moving gas-holder. The gas-holder floats either directly on the fermentation slurry or in a water jacket of its own</td></tr><tr><td>Economy</td><td>The costs of a fixed-dome biogas plant are relatively low</td><td>The steel drum is relatively expensive and maintenance-intensive.</td></tr><tr><td>Maintenance</td><td>The plant is constructed underground, protecting it from physical damage and saving space and labour. Lesser</td><td>The susceptibility of steel parts to corrosion, regular maintenance costs for the painting of the drum.</td></tr></table>	Differences	Drum Type Biomass Plant	Dome type Biomass Plant	Construction	A fixed-dome plant consists of a digester with a fixed, non-movable gas holder, which sits on top of the digester.	Floating-drum plants consist of an underground digester and a moving gas-holder. The gas-holder floats either directly on the fermentation slurry or in a water jacket of its own	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	The susceptibility of steel parts to corrosion, regular maintenance costs for the painting of the drum.	<p>4M</p> <p><i>Any 4 points 1M each</i></p>
Differences	Drum Type Biomass Plant	Dome type Biomass Plant													
Construction	A fixed-dome plant consists of a digester with a fixed, non-movable gas holder, which sits on top of the digester.	Floating-drum plants consist of an underground digester and a moving gas-holder. The gas-holder floats either directly on the fermentation slurry or in a water jacket of its own													
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	The susceptibility of steel parts to corrosion, regular maintenance costs for the painting of the drum.													



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			maintenance cost.		
		Operation & Labor	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.	
	f) Ans.	<p>Describe the operation of single basin arrangement for tidal power generation with neat diagram.</p> <div style="text-align: center;"> <p>Figure: Single-basin single-effect tidal system-“Emptying only”</p> </div> <p>Single basin system: EBB generation: During flood tide basin is filled and sluice gates are closed, trapping water. Gates are kept closed until the tide has ebbed sufficiently and thus turbines start spinning and generating electricity. Flood generation: The basin is filled through the turbine which generate at flood tide. Two way generation: Sluice gates and turbines are closed until near the end of the flood tide when water is allowed to flow through the turbines into the basin creating electricity. At the point where the hydrostatic head is insufficient for power generation the sluice gates</p>			4M
					Diagram 2M
					Description 2M



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		are opened and kept open until high tide when they are closed. When the tide outside the barrage has dropped sufficiently water is allowed to flow out of the basin through the turbines again creating electricity.	
3.	a) Ans.	<p>Attempt any four of the following:</p> <p>State any two advantages and disadvantages of renewable energy sources.</p> <p>Advantages of renewable energy sources:</p> <ul style="list-style-type: none">i) These energy sources recur in nature and are inexhaustible.ii) The power plants using renewable sources of energy do not have any fuel cost and hence their running cost is negligible.iii) As renewable have low energy density there is more or less no pollution or ecological balance problem.iv) Save foreign exchange and generate local employment.v) More site specific and are employed for local processing and application, their economic and technological losses of transmission and distribution being nil.vi) Conversion technology tends to be flexible and modular. <p>Renewable energy can usually be rapidly deployed.</p> <p>Disadvantages of renewable energy sources:</p> <ul style="list-style-type: none">i) Large size plants are required due to this delivered energy cost is increased.ii) Energy sources are intermittent and also lack dependability.iii) The user of these sources of energy has to make huge additional investment before deriving any benefit from it.iv) These energy sources due to their low energy density have low operating temperatures leading to low efficiencies.v) Since the renewable energy plants have low operational efficiency, the heat rejections are large which cause thermal pollution.vi) These energy sources are energy intensive	<p>16 4M</p> <p><i>Any two advantages & disadvantages 2M each</i></p>
	b) Ans.	<p>Explain with neat sketch the construction and working of the flat plate collectors.</p>	<p>4M</p>



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		<div data-bbox="454 483 1218 871" data-label="Diagram"> </div> <p style="text-align: center;">Solar water heater using a flat plate collector</p> <p>Construction: It consists of solar radiation collector or absorber, glass cover, insulating material and water pipe. The most important part is its solar radiation absorber which derives heat energy from sunrays. The absorbing material is typically a flat metal sheet. Water carrying pipe is attached to this sheet. The absorber plate is insulated at the back and at the side to insulate it from ambience for minimizing the heat losses. At the front side, transparent glass is kept which allows solar radiation to fall on the absorber metal sheet & prevents upward thermal losses. Eventually the insulated absorber plate and pipe / channel assembly is connected to the water tank through pipes as shown in figure.</p> <p>Working: The absorber plate receives the solar radiation and gets heated. The heat is then transferred to the water channel and water therein. Hot water has low density as compared to the cold water. Due to this density difference, cold water at inlet pushes the hot water in the water channel, sending it up all the way to outlet and to the water tank. This water circulation pattern gets set automatically due to density difference.</p>	<p style="text-align: center;">2M for labeled Diagram</p> <p style="text-align: center;">1M for Constru ction</p> <p style="text-align: center;">1M for working</p>
	<p>c) Ans.</p>	<p>State advantages and limitations of box type solar cooker.</p> <p>Advantages of box type solar cooker:</p> <ol style="list-style-type: none"> 1. No attention is needed during cooking as in other devices. 2. No fuel is required 3. Negligible maintenance cost 4. No pollution 	<p style="text-align: center;">4M</p> <p style="text-align: center;">Any 4 advanta ges ½ M each</p>



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		<p>5. No problem of charring of food and no over flowing</p> <p>6.Vitamins of the food are not destroyed and food cooked is nutritive and delicious with natural taste</p> <p>Limitations of box type solar cooker:</p> <p>1. One has to cook according to the sun shine , the menu has to be preplanned</p> <p>2. One can cook at short notice but food cannot be cooked in the night or during cloudy days</p> <p>3. It takes comparatively more time</p> <p>4. Chapaties are not cooked because high temperature for baking is Required.</p>	<p><i>Any 2 limitations 1M each</i></p>														
	<p>d)</p> <p>Ans.</p>	<p>Compare horizontal axis wind mills to vertical axis wind mills (any four).</p> <table><tr><th>Horizontal axis wind mills</th><th>Vertical axis wind mills</th></tr><tr><td>More power capture (for same tower height)</td><td>Less power capture (for same tower height)</td></tr><tr><td>No effect of fatigue in such structure</td><td>The structure suffers from fatigue effect.</td></tr><tr><td>No appearance of the unwanted power periodicity</td><td>appearance of the unwanted power periodicity</td></tr><tr><td>Less noise problem</td><td>More noise problem</td></tr><tr><td>There exists complexity of yaw mechanism</td><td>No such problem of complexity in yaw mechanism</td></tr><tr><td>More complex design</td><td>Less complex design</td></tr></table>	Horizontal axis wind mills	Vertical axis wind mills	More power capture (for same tower height)	Less power capture (for same tower height)	No effect of fatigue in such structure	The structure suffers from fatigue effect.	No appearance of the unwanted power periodicity	appearance of the unwanted power periodicity	Less noise problem	More noise problem	There exists complexity of yaw mechanism	No such problem of complexity in yaw mechanism	More complex design	Less complex design	<p>4M</p> <p><i>Any 4 points 1M each</i></p>
Horizontal axis wind mills	Vertical axis wind mills																
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	<p>e)</p> <p>Ans.</p>	<p>Explain how the energy can be obtained from biomass using fermentation method.</p> <p><i>(Note: Any relevant explanation shall be considered)</i></p> <p>The biomass resource can be considered as organic matter, in which the energy of sunlight is stored in chemical bonds. When the bonds between adjacent carbon, hydrogen and oxygen molecules are broken by digestion, combustion, or decomposition, these substances release their stored, chemical energy. This method is a biochemical process. The fermentation that follows produces alcohol which is a very high energy fuel that makes it very practical for use in cars. Fermentation is an anaerobic process (occurs in the absence of oxygen) that breaks</p>	<p>4M</p> <p><i>Explanation 4M</i></p>														



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		<p>down the glucose within organic materials. It is a series of chemical reactions that convert sugars to ethanol.</p> <p>The basic fermentation process involves the conversion of a plant's glucose (or carbohydrate) into an alcohol or acid. Yeast or bacteria are added to the biomass material, which feed on the sugars to produce ethanol (an alcohol) and carbon dioxide. The ethanol is distilled and dehydrated to obtain a higher concentration of alcohol to achieve the required purity for the use as automotive fuel. The solid residue from the fermentation process can be used as cattle-feed and in the case of sugar cane; the biogases can be used as a fuel for boilers or for subsequent gasification. The most common forms of biomass that are used in the production of bio-ethanol are high in sugar and include sugarcane, corn and sweet potatoes. Other forms of biomass that are used in fermentation processes are starchy materials such as wheat, barley, oat and rice along with lignocelluloses materials such as agricultural wastes and woody materials.</p>	
	<p>f) Ans.</p>	<p>List advantages and disadvantages of Hydrogen Energy.</p> <p>Advantages of hydrogen energy:</p> <ol style="list-style-type: none"> 1. Very high energy content 2. Burning is non polluting 3. Hydrogen produced from biomass and supplied to consumers in the transport sector 4. Fuel cell operated bus; hydrogen produced from biomass can compete well with gasoline operated vehicles. 5. It is a superior fuel for turbojet aircraft due to greater economy or lower noise level and little pollution 6. Hydrogen as a vehicular fuel can reduce dependence on fossil fuel which is increasing in cost every year. 7. Hydrogen can easily be transported and distributed through pipeline 8. Hydrogen being a high density fuel. Its low transport cost high product cost to make it can economically viable fuel <p>Disadvantages of hydrogen energy:</p> <ol style="list-style-type: none"> 1. Commercial production of hydrogen at cheap cost. 2. Effective energy utilization 3. Difficulty in storage since it is highly explosive 4. Lack of safety and management 	<p>4M</p> <p><i>Any 4 advantages ½M each</i></p> <p><i>Any 2 disadvantages 1M each</i></p>



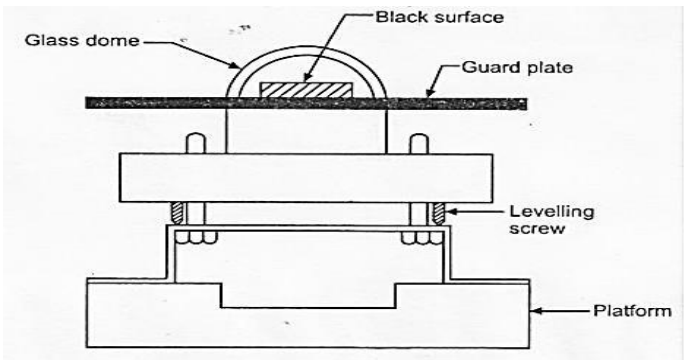
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4.	A) i) Ans.	<p>Attempt any three of the following:</p> <p>Describe the necessity of alternative energy sources.</p> <ol style="list-style-type: none"> 1. Conventional sources of energy are depleting oil is likely to last upto 2025 and coal another 200 year. 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. <p>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.</p>	<p>12 4M</p> <p><i>Any 4 necessity 1M each</i></p>
	ii) Ans.	<p>Describe the working of pyrano-meter for measurement of total radiation. (Note: Any other relevant diagram shall be considered)</p> <div style="text-align: center;">  </div> <p>Construction: A pyrano-meter is an instrument which measures total or global radiation over a hemispherical field of view. It consists of a “black surface” which receives the beam as well as diffuse radiations which produces heat. A “glass dome” prevents the loss of radiation received by the black surface. A “thermopile” is a temperature sensor and consists of a number of thermocouples connected in series to increase the sensitivity. The “supporting stand” keeps the black surface in a proper position. The sun’s radiation is allowed to fall on a</p>	<p>4M</p> <p><i>2M for labeled diagram</i></p> <p><i>2M for working</i></p>



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		black surface to which the hot junctions of a thermopile are attached. The cold junctions of the thermopile are located in such a way that they do not receive the radiation. As a result, an emf proportional to the solar radiation is generated.													
	<div>iii)</div> <div>Ans.</div>	<div>State any two advantages and disadvantages each of photo-volatic power generating station.</div> <div>Advantages of photo-volatic power generating station :</div> <div><div>1. System is durable.</div><div>2. No Operation cost</div><div>3. Low maintenance.</div><div>4. More flexibility available.</div><div>5. Systems are eco friendly.</div><div>6. Highly reliable.</div><div>7. Long effective life.</div><div>8. Absence of moving facts.</div><div>9. Can function unattended for long period.</div><div>10. High power to weight ratio.</div><div>11. Natural sunlight is used as Input energy.</div><div>12. Pollution free system.</div></div> <div>Disadvantages of photo-volatic power generating station:</div> <div><div>1. Weather dependant.</div><div>2. Low efficiency.</div><div>3. High Installation cost.</div><div>4. Storage is required</div></div>	<div>4M</div> <div>Any 2 advantages 1M each</div> <div>Any 2 disadvantages 1M each</div>												
	<div>iv)</div> <div>Ans.</div>	<div>State the difference between 'Fixed bed gasifier' and 'fluidized bed gasifier'.</div> <div>(Note: Any four differences shall be considered)</div> <table><tr><th>Differences</th><th>Fixed bed gasifier</th><th>Fluidized bed gasifier</th></tr><tr><td>Technology</td><td>There is necessity of a safety valve to prevent development of excessive pressure.</td><td>There is no need to provide any safety valve as the holder is free to rise.</td></tr><tr><td>Use of material</td><td>High carbon conversion.</td><td>lower carbon conversion</td></tr><tr><td>Efficiency</td><td>High cold gas</td><td>Lesser cold gas</td></tr></table>	Differences	Fixed bed gasifier	Fluidized bed gasifier	Technology	There is necessity of a safety valve to prevent development of excessive pressure.	There is no need to provide any safety valve as the holder is free to rise.	Use of material	High carbon conversion.	lower carbon conversion	Efficiency	High cold gas	Lesser cold gas	<div>4M</div> <div>Any 4 differences 1M each</div>
Differences	Fixed bed gasifier	Fluidized bed gasifier													
Technology	There is necessity of a safety valve to prevent development of excessive pressure.	There is no need to provide any safety valve as the holder is free to rise.													
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Efficiency	High cold gas	Lesser cold gas													



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			efficiency	efficiency	
		Use of energy	Low oxygen is required.	Moderate oxygen is required	
		Economy	Gas is produced at relatively low temperature. No need for expensive heat recovery equipment.	Gas is produced at moderately high temperature, heat recovery equipment is required.	
		Environment	Environmentally most gentle, produces syngas H ₂ , CO, CO ₂	Environmentally more harsh.	
4.	B) i) Ans.	<p>Attempt any one of the following :</p> <p>Define following terms :</p> <p style="text-align: center;"> i) Altitude angle ii) Incident angle iii) Zenith angle iv) Solar azimuth angle v) Declination angle vi) Hour angle </p> <p>i) Altitude angle: It is the vertical angle between the projection of the sun's rays on the horizontal plane and the direction of sun's rays (passing through the point)</p> <p>ii) Incident Angle: It is the angle being measured between the beam of rays and normal to the plane.</p> <p>iii) Zenith angle: It is the vertical angle between the sun's ray and the line perpendicular the horizontal plane through the point. It is the complimentary angle of the sun's altitude angle.</p> <p>iv) Solar azimuth angle: It is the angle subtended in the horizontal plane of the normal to the surface of the horizontal plane. The angle is taken positive if the normal is west of earth and negative when east of earth in Northern hemisphere.</p> <p>v) Declination angle: The declination is the angular distance of the sun's rays north (or south) of the equator. It is the angle between a line extending from the centre of the sun to the centre of the earth and the projection of this line up to the earth's equatorial plane.</p>			<p style="text-align: center;">6 6M</p> <p style="text-align: center;"><i>Each definition 1M</i></p>

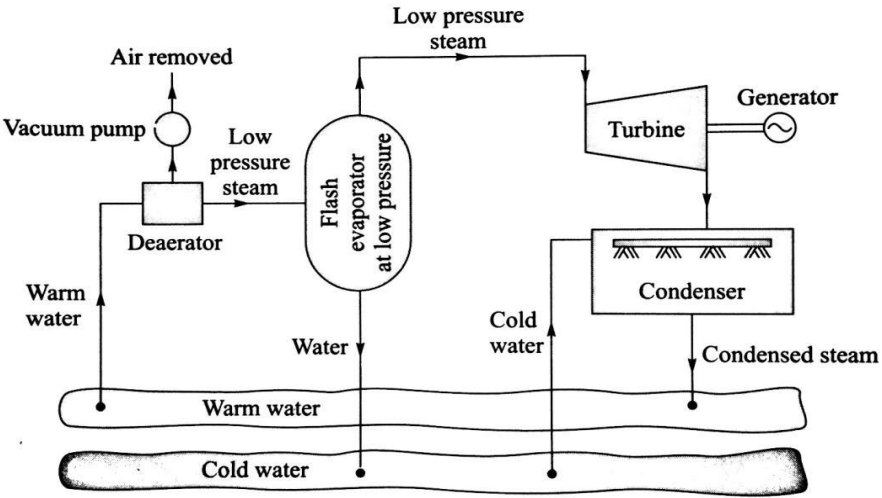


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		<p>vi) Hour angle: It is the angle through which earth must rotate to bring the meridian of point directly under sun, it is angular measure of time at the rate of 15 degree per hour. Hour angle is measured from noon based on local apparent time in the forenoon.</p>	
ii) Ans.	<p>Describe with schematic diagram construction and operation of open cycle OTEC plant.</p>  <p style="text-align: center;">Open cycle OTEC plant.</p> <p>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 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</p>	4M <i>3M for labeled diagram</i> <i>3M for construction and working</i>	



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		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.	
5.	a) Ans.	<p>Attempt any four of the following: State the limitations of pyrheliometer for measurement of beam radiation. Limitation of pyrheliometer for measurement of beam radiation:</p> <ol style="list-style-type: none"> 1. Not possible to measure total radiation 2. Problem to measure aperture angle 3. Imprecision in tracking mechanism 4. Not possible to measure soircum solar contributions 	<p>16 4M</p> <p><i>Any 4 points 1M each</i></p>
	b) Ans.	<p>List the applications of solar space heating and cooling. Applications of solar space heating and cooling:</p> <ol style="list-style-type: none"> 1. Solar heating & cooling technologies collect the thermal energy from the sun and use this heat to provide hot water, 2. Space heating cooling and pool heating for residential, 3. Space heating cooling and pool heating commercial 4. Space heating cooling and pool heating industrial process application. 	<p>4M</p> <p><i>Applicat ion 1M each</i></p>
	c) Ans.	<p>Explain the construction and operation of solar green house. Solar Green House: Construction:</p> <div style="text-align: center;"> <p>Greenhouse for cold climate.</p> </div> <p>A green house is a shed or enclosure in which a proper environment is provided to enable the growth and production of vegetables and flowering plants even during adverse and severe climatic conditions prevailing outside. A typical green house is shown in figure. To ensure enough sunlight inside the green house, sufficient glass or transparent plastic sheet is provided in roof and walls in the greenhouse facing the sun. For roof, two layers of glass or plastic</p>	<p>4M</p> <p><i>Constru ction 2M</i></p> <p><i>Explana tion 2M</i></p>



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		<p>sheets are provided with small air gap in between to obtain proper thermal insulation. The air gap helps in entrapping the solar radiation inside the green house. Adequate presence of carbon dioxide is ensured by (i) supplying outside air (ii) Using organic manure (iii) combustion of sulphur free fossil fuels and (iv) carbon dioxide gas.</p>	
	<p>d)</p> <p>Ans.</p>	<p>Describe with diagram working of variable speed frequency wind electric generating system. (Note: Any one method shall be considered)</p> <div style="text-align: center;"> <p>Variable speed variable frequency scheme</p> </div> <p>Variable speed variable frequency scheme: 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.</p> <p style="text-align: center;">OR</p> <p>Variable speed constant frequency scheme: Variable-speed drive is typical for most small wind generators used in autonomous applications, generally producing variable frequency and variable voltage output. The variable speed operation of wind-electric system yield higher outputs for both low and high wind speeds. This results in higher annual energy yields per rated installed kW capacity.</p>	<p>4M</p> <p style="text-align: right;"><i>Diagram 2M</i></p> <p style="text-align: right;"><i>Description 2M</i></p>

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Both horizontal axis and vertical axis turbines will exhibit this gain under variable speed operation. The popular schemes to obtain constant frequency output are as follows:

(a) AC-DC-AC link: With the advent of high powered thyristors and high voltage d.e. transmission systems, a.c. output of the 3-phase alternator is rectified using a bridge rectifier and then converted back to a.c. using line commutated inverters. They utilize an a.c. source (power lines) which periodically reverses polarity and causes the commutation to occur naturally. Since frequency is automatically fixed by the power line, they are also known as synchronous inverters. The block diagram of the system is shown in figure.

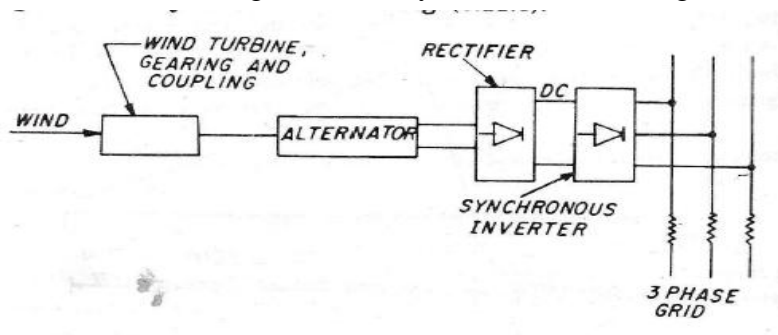
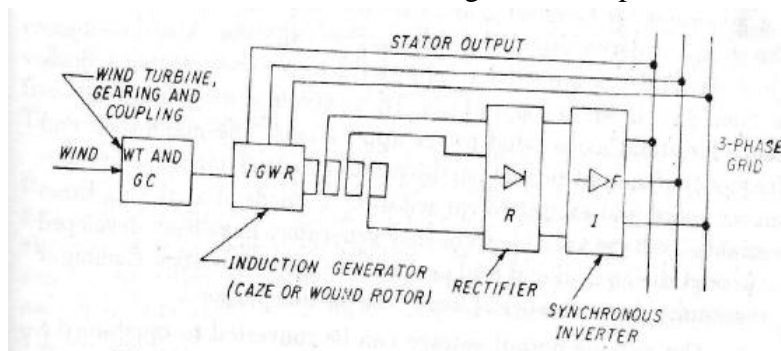


Figure: Block diagram of Wind Electric Scheme

(b) Double Output Induction Generator: In this system a slip-ring induction motor is used as shown in Figure. Rotor power



Block diagram of double output wind driven Wound Rotor Induction Generator (IGWR)

Output at slip frequency is converted to line frequency power by



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		<p>rectification and inversion output power is obtained both from stator and rotor and hence this device is called double output induction generator. Rotor output power has the electrical equivalence of an additional impedance in the rotor circuit. Therefore, increasing rotor outputs lead to increasing slips and higher speeds. Such an operation increases the operating speed range from N_8 to $2N_8$, i.e. slip varying from 0 to 1.0.</p> <p>(c) A.C. commutation generator: This system is also known as scherbius system employs two polyphase windings in the stator and a commutator winding on the rotor. Basic problems in employing this device for wind energy conversion are the cost and the additional maintenance and the care required by the commutator and the brush gear.</p>	
	<p>e) Ans.</p>	<p>State the advantages and disadvantages of floating drum type biomass plant.</p> <p>Advantages of floating point drum type biomass plant:</p> <ol style="list-style-type: none">1. Floating-drum plants are easy to understand and operate.2. They provide gas at a constant pressure, and the stored gas-volume is immediately recognizable by the position of the drum.3. Gas-tightness is no problem, provided the gasholder is de-rusted and painted regularly. <p>Disadvantages of floating point drum type biomass plant:</p> <ol style="list-style-type: none">1. The steel drum is relatively expensive and maintenance-intensive.2. Removing rust and painting has to be carried out regularly.3. The life-time of the drum is short (up to 15 years; in tropical coastal regions about five years).4. If fibrous substrates are used, the gas-holder shows a tendency to get "stuck" in the resultant floating scum.	<p>4M</p> <p><i>Any 2 advantages 1M each</i></p> <p><i>Any 2 disadvantages 1M each</i></p>
	<p>f) Ans.</p>	<p>Describe with block diagram fuel cell based electrical power generating scheme.</p>	<p>4M</p>



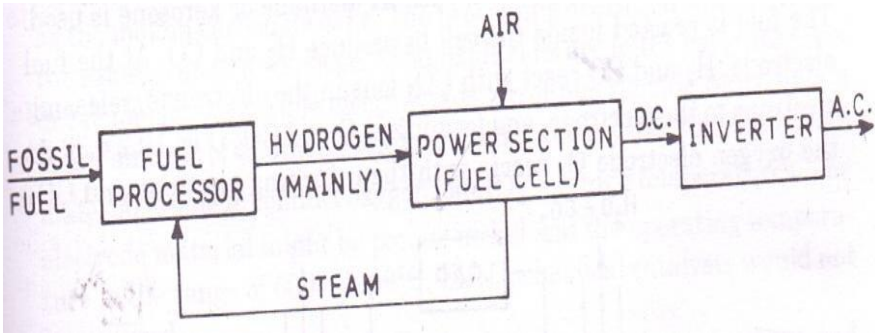
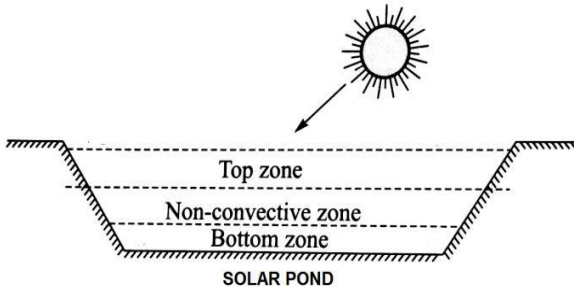
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		 <p>1. The fuel gas diffuses through the anode and is oxidized, this releasing electron to the external circuit.</p> <p>2. The oxidizer diffuses through the cathode and is reduced by the electrons that have come from anode by products out of the external circuits.</p> <p>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.</p> <p>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.</p>	<p>Diagram 2M</p> <p>Description 2M</p>
6.	<p>a) Ans.</p>	<p>Attempt any two of the following: Explain principle, working and advantages of solar pond. Principle: In general pond, when water is heated up by the sun rays the heated water rises to the top of the pond. The hot water loses heat to the atmosphere & so the net temperature at the top of the pond remains nearly at atmospheric temperature. The solar pond technology ensures that heated brine water remains at the bottom of the pond due to more brine concentration and density in it.</p>  <p style="text-align: center;">SOLAR POND</p>	<p>16 8M</p> <p>Principle 3M</p>



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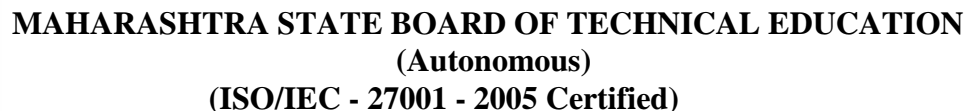
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		<p>Working: The solar pond consists of a large size brine pond (depth almost about 1 meter) which has salt concentration gradient in such a way that most concentrated and dense part of the brine solution is at the bottom of the pond & brine concentration gradually reduces from bottom to top of the pond based on the variation of brine solution density. A Solar pond has three zones as shown in figure. The top zone is surface zone which has the least salt content and its temperature is the atmospheric temperature. The bottom zone has the maximum salt content & it has a high temperature (700C to 850C). This is the zone that collects and stores the solar energy as heat energy. In between these two zones, there is the gradient non convective zone. Because of solar rays the brine solution from the bottom becomes hot which is taken out from the pond & used to evaporate an organic working fluid in a heat exchanger & then supplied back to the pond. The heated organic working fluid produces mechanical power in a rankine cycle which then drives the turbine & ultimately the generator.</p> <p>Advantages of solar pond:</p> <ol style="list-style-type: none"> Heating and cooling of building Production of power Industrial process heat Desalination Heating animal housing and drying crops on farms Heat for biomass conversion 	<p>Working 3M</p> <p>Any 2 advantages 1M each</p>
	<p>b) Ans.</p>	<p>Draw block diagram showing basic components of wind energy conversion system and state function of each block.</p> <p>The basic components of a wind energy conversion system are shown in figure:</p>	<p>8M</p> <p>Diagram 4M</p>



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		d) Crop drying (Seawood, grass etc.) e) Plastic manufacture f) Paper manufacture g) Heavy water production h) Timber seasoning i) Salt production from sea water j) Sewage heat treatment	
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