Set-B 156

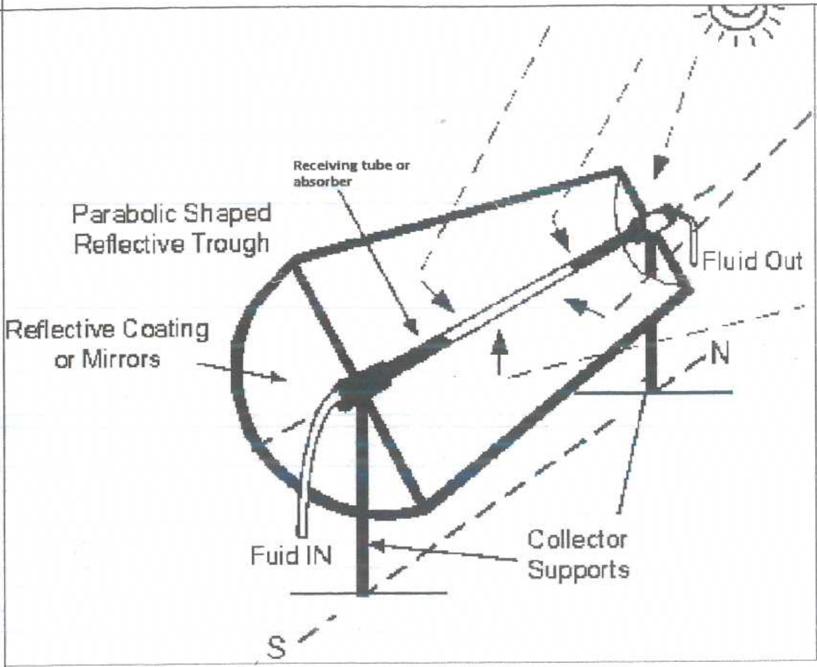
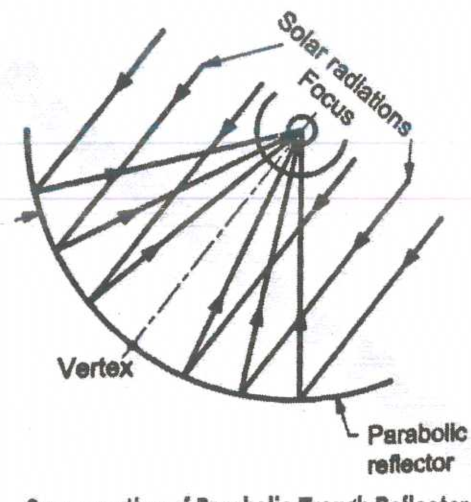
April-24
Pageno-16

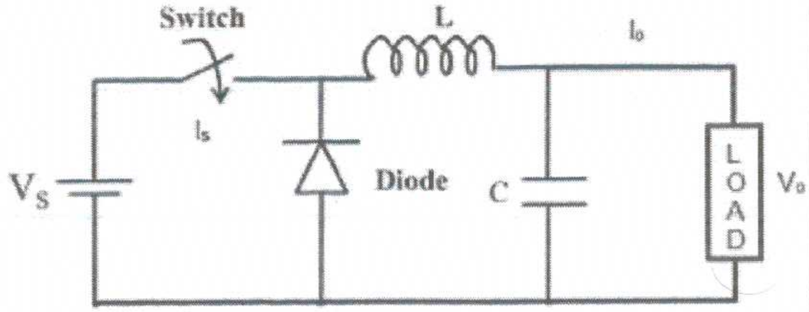
Scoring Indicators

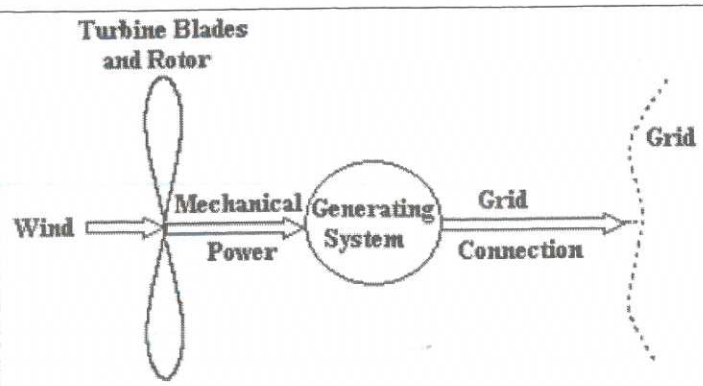
COURSE NAME : RENEWABLE ENERGY POWER PLANTS

COURSE CODE : 5033A. **QID :**

Q No	Scoring Indicators	Split score	Sub Total	Total score
	PART A			**9**
I. 1	Coal, Oil , Natural Gas etc *(Any 2)*	2*0.5	1	
I. 2	(i)Pelton wheel – (c)High Head (ii) Francis turbine – (b)Medium head (iii)Kaplan turbine – (c)Low Head	1	1	
I. 3	Parabolic trough type, mirror strip ,Fresnel type *(Any 2)*	2*0.5	1	
I. 4	factors considered while installing solar panel are • direction, • tilt, • shading, • temperature *(Any 2)*	2*0.5	1	
I. 5	Electricity generation, Pumping, etc	2* 0.5	1	
I. 6	Cut in speed	1	1	
I. 7	Horizontal axis Vertical axis *(Any 2)*	2* 0.5	1	
I. 8	Tidal range	1	1	
I. 9	• Fuel cells are highly efficient, • Clean Energy, • Fuel cells are highly reliable, • Fuel cells have a long lifespan, • Minimal Sound Pollution *(Any 2)*	2* 0.5	1	
	PART B			24
II. 1	• Biomass gasification is a process of converting solid biomass fuel into a gaseous combustible gas through a sequence of thermo-chemical reactions. • Biomass gasification involves burning of biomass in a limited supply of air to give a combustible gas • The basic gasification process involves de-volatization, combustion and reduction. • After gasification process resulting gas will be a mixture of	3	3	

	carbon monoxide, carbon dioxide, hydrogen, methane, water, nitrogen, along with contaminants like small char particles, ash and tars. The gas is cleaned to make it suitable for use in boilers, engines and turbines to produce heat and power(CHP).			
II. 2	 *(Any one diagram)*  **Cross section of Parabolic Trough Reflector** *(similar diagram can also be accepted)*	3	3	

II. 3	 A buck converter is a type of DC-DC voltage converter that reduces a higher input voltage to a lower output voltage efficiently. It consists of a semiconductor switch (usually a MOSFET,IGBT), an inductor, a diode, and an output capacitor. <u>Working</u> On-State: Initially, the MOSFET is on, connecting the input voltage to the inductor, allowing current to flow and storing energy in the inductor. Off-State: The MOSFET is then turned off. The inductor current tries to keep flowing, and the diode provides a path for it, delivering energy to the load. By controlling the duty cycle of the MOSFET, the buck converter can efficiently provide a regulated output voltage that is lower than the input voltage	3	3	
II. 4	Principle of wind energy conversion *Fig -1.5* *Explanation-1.5*	3	3	
	Kinetic Energy→Mechanical Energy→Electrical Energy Wind energy is the kinetic energy of air in motion. Wind is caused by uneven heating of the atmosphere by the Sun, irregularities of the Earth's surface, and rotation of the Earth. This wind energy is harvested by using wind turbines			



$$P = \frac{1}{2}\rho A V^3$$

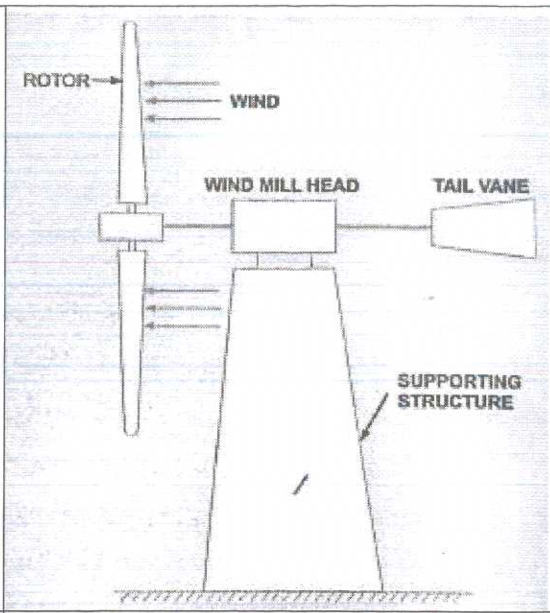
where A= area swept by the wind

V= velocity of wind

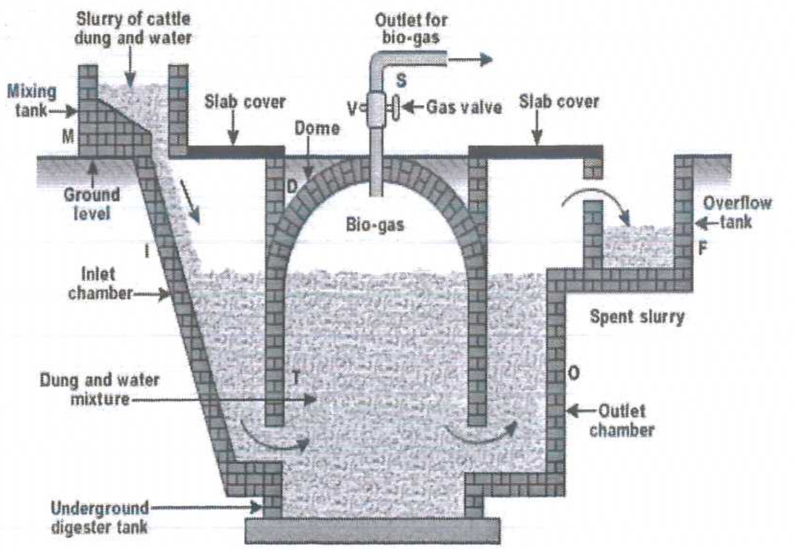
Power generated from wind(P) is proportional to the third power of the wind velocity(V). The available power increases eight times when the speed doubles. Wind turbines connected to grid are efficient at greater wind speeds.

II. 5	Compare Horizontal and vertical axis windmill. **(Any 3 comparisons)**	1*3	3

HORIZONTAL-AXIS WIND MACHINE	**VERTICAL-AXIS WIND MACHINE**
Axis of rotation is parallel to the ground.	Rotation is perpendicular to the ground.
All the blades work at a time.	Only one blade works at a time.
Wind turbine works only for specific wind direction.	Wind turbine works in all wind directions.
More efficiency (Since all blades works at a time).	Efficiency is less
More ground area is needed.	Less area is needed , (compared to horizontal axis)

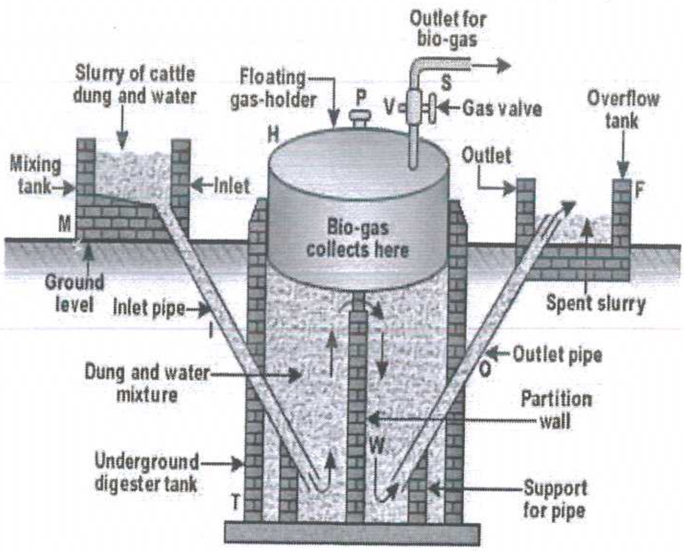
II. 6		Fig-1.5 Label-1.5	3	
II. 7	Power developed by a wind turbine Wind speed V = 20 m/s, Blade length l = r=80 m, Air density ρ = 1.23 kg/m3. The area is given by, $A = \pi r^2$ A = π × 80 x 80 = 20106.2 m2 The wind power=, $P = \frac{1}{2}\rho A V^3$ $P = \frac{1}{2}(1.23)(20106.2)20^3$ **P =98922504 W**	3	3	
II. 8	Single basin system Figure 1.5 Marks Explanation 1.5 Marks ● Single-basin		3	

	• Digester tank: It is an underground tank made of bricks and cement. Its roof is made in the form of dome. The dome collects the biogas. It is provided with an outlet for biogas. • Slurry mixing tank: This is tank above the ground level. The bottom of this tank connects the digester through a brick-lined channel near the base. The fresh slurry is poured into the slurry mixing tank. •Spent slurry tank: The spent slurry tank is below the ground level. The base of this tank is in line with the lowest point of the dome of the digester. The base of this tank is connected to the base of the digester through a brick-lined channel. • Working of fixed dome type biogas plant: Animals-dung is mixed with water to make a slurry in the mixing tank. This slurry enters the digester through the inlet chamber. In the digester anaerobic fermentation starts with the release of biogas.The slurry in the digester is left for about two months for fermentation. The biogas formed is collected in the dome. When a sufficient amount of biogas is collected in the dome, it exerts a large pressure on the slurry and forced it to go into the overflow tank through the outlet chamber. The biogas is taken out from the dome through a pipe and used for cooking food or heating water whenever required. Once the biogas plant starts functioning, more and more slurry may be fed into the digester to get a continuous supply of biogas.			
IV	Flash steam geothermal power plant. *Figure - 4 marks* *Explanation - 3 marks*	4+3	7	7

II.10	A hydrogen-oxygen fuel cell is an electrochemical device that converts hydrogen and oxygen gases into electricity and water. Fuel Input: Hydrogen gas is supplied to the anode, while oxygen is directed to the cathode. A proton-exchange membrane separates the anode and cathode, allowing only protons to pass through. Anode: At the anode, hydrogen gas undergoes oxidation, splitting into protons (H+) and electrons (e^-). Electrons cannot pass through the membrane and so it flows through the external circuit. Cathode: Oxygen reacts with protons and electrons at the cathode to form water (H2O), releasing energy. The flow of electrons through an external circuit generates an electrical current that can power devices or charge batteries.	3	3	
	PART C			42
III	Fixed dome bio gas plant. *Figure - 4 marks* *Explanation - 3 marks*	4+3	7	7
	 Fixed-dome type bio-gas plant.			

They cause pollution	They cause little to no pollution
Conventional energy sources are comparatively expensive	Non-conventional energy sources are comparatively less expensive
Conventional energy sources requires long time for their formation	Non-Conventional energy sources requires short time for their formation
Conventional sources of energy are primarily used for commercial and industrial purposes.	The main use of non-conventional sources of energy is for domestic purposes.
These resources have been in use from many years.	These resources are relatively new sources of energy.

I	Floating-drum biogas plant *Figure 5 Marks* *Explanation 2 marks*		7	7



Floating gas-holder type bio-gas plant.

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.
The gas is collected in the gas drum, which rises or moves down,

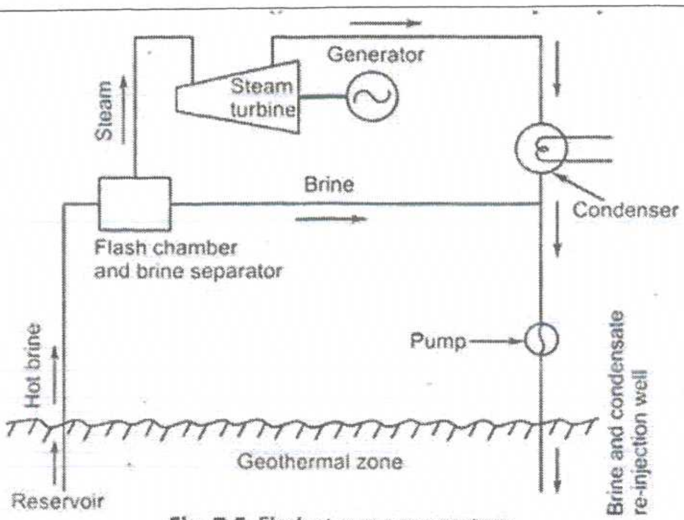


Fig. 7.5. Flash steam open system.

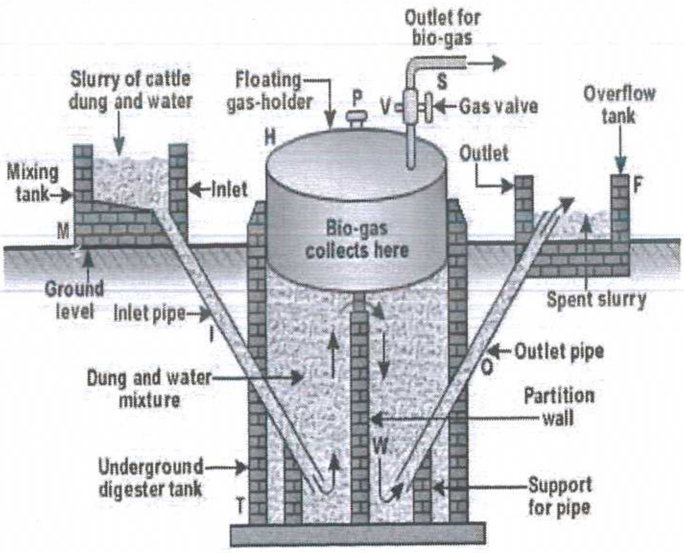
Most common type of geothermal power generation plants
Fluid at temperatures greater than 360°F (182°C) is pumped under high pressure into a tank at the surface held at a much lower pressure,
some of the fluid vaporize, or "flash."rapidly
This vapour travels to a turbine, which drives a generator to produce electricity.

V	Comaparison between Conventional and Non Conventional Sources of energy *(Any 7 comparison)*	7*1	7	7

Conventional Sources of Energy	Non Conventional Sources of energy
These are the traditional sources of energy which are generally bought and sold in market	These are modern sources of energy
Consumer have to pay a price for energy generated through these sources	Consumer do not have to pay a price for energy generated through these sources
These sources of energy are exhaustible	These sources of energy are renewable
Coal petroleum etc example of conventional energy sources	Solar power, wind power etc are some of the examples of non conventional sources of energy

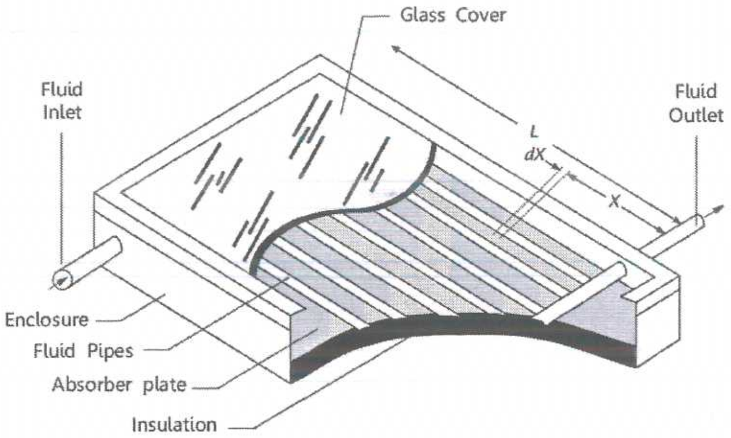
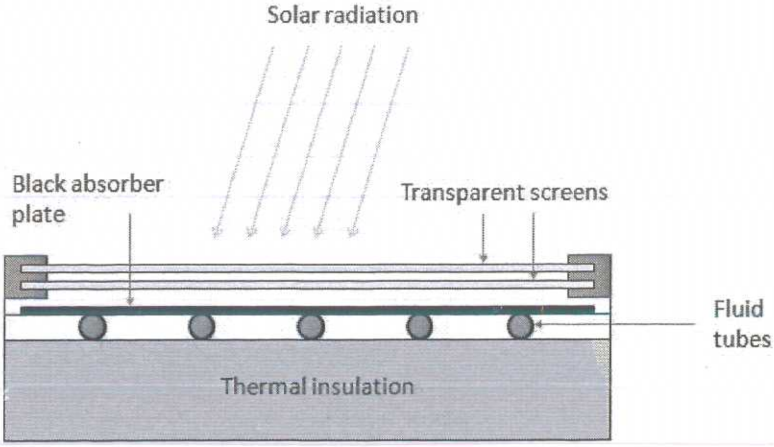
They cause pollution	They cause little to no pollution
Conventional energy sources are comparatively expensive	Non-conventional energy sources are comparatively less expensive
Conventional energy sources requires long time for their formation	Non-Conventional energy sources requires short time for their formation
Conventional sources of energy are primarily used for commercial and industrial purposes.	The main use of non-conventional sources of energy is for domestic purposes.
These resources have been in use from many years.	These resources are relatively new sources of energy.

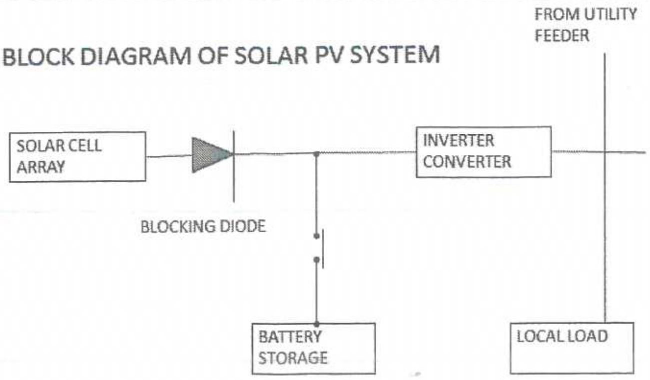
VI	Floating-drum biogas plant *Figure 5 Marks* *Explanation 2 marks*		7	7



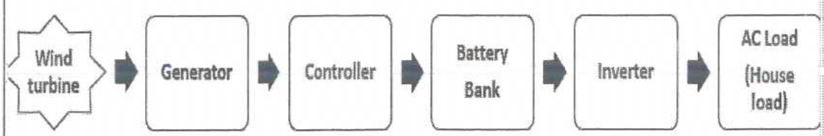
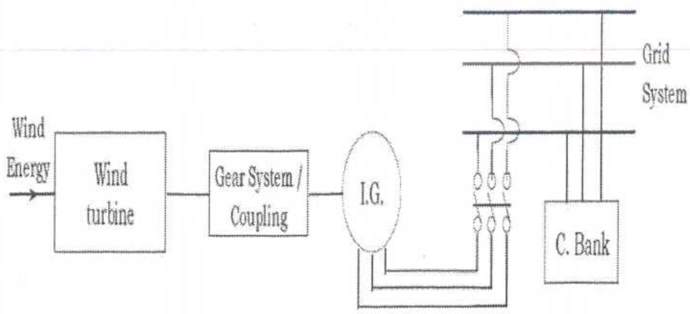
Floating gas-holder type bio-gas plant.

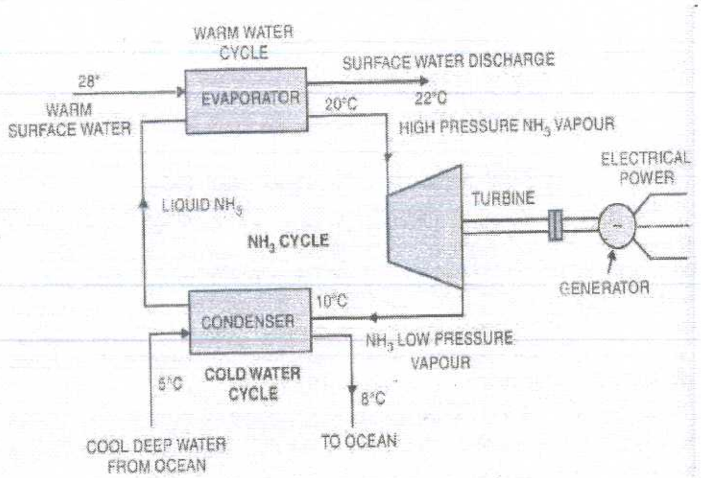
Floating-drum plants consist of an underground digester and a moving gas-holder.
The gas holder floats either directly on the fermentation slurry or in a water jacket of its own.
The gas is collected in the gas drum, which rises or moves down,

	according to the amount of gas stored			
VII	Flat plate solar collector *Figure- 4 Marks* *Explanation - 3 Marks*		7	7
	 ***(Any one diagram)***  ***(Similar block diagrams can also be accepted)*** A solar flat plate collector typically consists of a large heat absorbing plate, usually a large sheet of copper or aluminum which is painted black to absorb as much solar radiation. This blackened heat absorbing surface has several parallel copper tubes running length ways across the plate which contain the heat transfer fluid, typically water. These pipes are soldered directly to the absorber plate to ensure maximum surface contact and heat transfer. Sunlight heats the absorbing surface which increases the temperature. As the plate gets hotter this heat is conducted through the tubes heating the water inside it.	4 3		
VIII	Grid connected photovoltaic system.		7	7

	BLOCK DIAGRAM OF SOLAR PV SYSTEM  *(Similar block diagrams can also be accepted)*	4		
	Grid connected PV system consists of a matrix of PV arrays, which converts the sunlight to DC power, a power conditioning unit (PCU) that converts the DC power to an AC power. The generated AC power is injected into the UG or utilized by the local loads. In a grid-connected system, the grid acts as a backup and there is no need for battery storage unless there is a power outage problem. The grid-connected system is connected to the utility grid with two metering system. It may be a small roof top system owned and operated by the house owner or a relatively bigger system, meant for the whole village. It meets day time requirements without any battery and surplus power is fed to the grid. During peak hours and during nights, the energy shortage may be met from grid	3		
IX	A house has the following electrical appliance usage: Three 18 Watt fluorescent lamp with electronic ballast used 4 hours per day. One 60 Watt fan used for 6 hours per day. One 75 Watt LED TV that runs 5 hours per day. The system will be powered by 12Vdc, 110 Wp PV module. Determine the following: - 1.Power consumption demands 2.Size of the PV panel 3.Rating of Inverter (Assume panel generation factor=3.4 and a 30 % loss)		7	7.

	Solution Given data: PV module ratings, 12Vdc 110Wp 1. **Determine solar energy consumption in Whr/day** Total appliance use = (3 x 18 W x 4 hours) + (60 W x 6 hours) + (75 W x 5 hours) = 951 Wh/day Total PV panels energy needed = 951 x 1.3 = 1236.3 Wh/day. **2. Size of the PV panel** 2.1 Total Wp of PV panel capacity needed = 1236.3 / 3.4 = 363.61 Wp 2.2 Number of PV panels needed = 363.61 / 110 = 3.31 modules Actual requirement = 4 modules So this system should be powered by at least 4 modules of 110 Wp PV module. **3. Rating of Inverter** Total Watt of all appliances = (3 x 18) + (1 x 60) + (1 x 75) = 189 W For safety, the inverter should be considered 25-30% bigger size. The inverter size should be about 240 W or greater.	2 3 2		
X	4 Nos of 12 V, 100 Ah batteries connected in parallel are to be charged from a solar panel. Calculate the Number of 110 Wp solar panels required for this purpose .Assume charging current = 1/10 of ampere hour rating		7	7
	Battery Voltage = 12 V No of batteries = 4 Battery Ah rating = 100Ah Total Ampere hour rating = 4 x 100 =400 Ah Charging current = 400/10 = 40 A Total power output required from solar panel = 40 x 12			

	= 480 W Number of solar panels required = 480/110 = 4.36 = 5 We use even number of panels therefore instead of 5 we use six panels Therefore finally Number of solar panels = 6			
XI	block diagram of standalone wind power generation. Figure- 4 Marks Explanation - 3 Marks		7	7
	 *(Similar diagrams can also be accepted)*	3		
	The kinetic energy of wind is converted to mechanical energy by the turbine. The turbine is coupled to the generator which generate electricity. Charge controller adjust the voltage and charges the battery tank. The battery is connected to an inverter which converts the electricity to AC power. This can be used for powering up standalone systems	4		
XII	Explain the Constant Speed Constant Frequency Scheme for wind power generation.		7	7
	 	3		
	Constant speed drives are used for large generators that feed the generated power to the grid. Commonly synchronous generators (alternator) or squirrel cage induction generators (IG) are used for power generation.			

	If the stator of an induction machine is connected to the power grid and if the rotor is driven above Synchronous Speed Ns, the machine delivers a constant line frequency (f = PNs/120) power to the grid. The slip of the generators is between 0 and 0.05. The torque of the machine should not exceed max. Torque to prevent run away (speed continues to increase unchecked). Compared to synchronous generator, Induction generators are preferred because they are simpler, economical, easier to operate, control and maintain and have no synchronization problem. However, Capacitors (Capacitors bank) have to be used to avoid reactive volt ampere burden on the grid (Reactive power required by the Induction Generator can be supplied by installing the Capacitor)	4		
XIII	Block diagram of closed cycle ocean thermal energy conversion and summarize its operation *Figure- 4 Marks* *Explanation - 3 Marks*		7	7
	Ammonia or propane is used as working fluid. The warm ocean surface water is pumped into the evaporator to extract the heat from the ocean water. This heat is transferred into the working fluid and transferred to turbine	3		
		4		

<table>
<tr><td>XIV</td><td>MHD power generation.
Figure- 3 Marks
Explanation - 4 Marks</td><td></td><td>7</td><td>7</td></tr>
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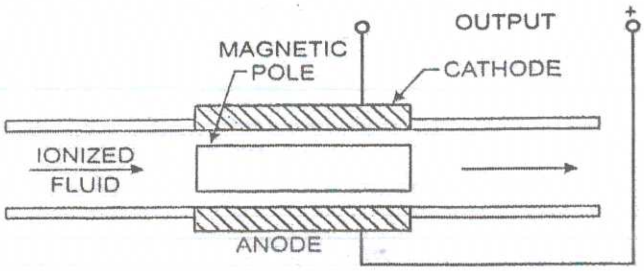

Fig. 1 : General operating principle

Basic principle - Faradays law of electromagnetic induction

In MHD generator electrical energy is directly generated from hot combustion gases produced by the combustion of the fuel without moving parts.

Instead of making charges move in a magnetic field via a rotating armature, a plasma of electrons and positive ions expands through a nozzle and moves at supersonic speed through a magnetic field.

This flow (motion) of the conducting plasma through the magnetic field causes a voltage to be generated (and an associated current to flow)

Direction of induced emf is perpendicular to both the plasma flow and the magnetic field according to Fleming`s Right Hand Rule.
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