SUMMER – 2022 EXAMINATION

Subject Name: Renewable Energy Technologies **Model Answer** Subject Code: 22661

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)	Classify Energy Sources **A.Primary energy sources** 1. Coal 2. Crude Oil 3. Natural gas 4. Biomass 5.Solar Energy 6.Hydropower energy 7.Wind Energy **B.Secondary energy sources** 1.Heat 2.Electricity 3.Petroleum 4.Biofuels **C.Tertiary Energy Sources** 1.Tidal Energy 2.Nuclear Energy	½ mark each (any four)
	(b)	**State application of biofuels** 1. Transportation 2. Energy generation 3. Cooking 4. Solvent 5. Germicide 6. Alcoholic beverage 7. Fuel 8. Depresent & as chemical intermediate 9. Fuel for Automobiles, use as additive to petrol	½ mark each (any four)

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Q. No.	Sub Q. N.	Answer	Marking Scheme
	(c)	**Types of Solar Panels** 1. First Generation Solar PV panels e.g. mono crystalline and polycrystalline 2. Second Generation Solar PV panels e.g. Thin film, Amorphous silicon 3. Third Generation Solar PV panels e.g. Cadmium Teluride, Copper, Indium, Galium, Selenide	02 marks
	D	**Specifications of HAWT** Note :- any other specifications of such type may be considered.	02 marks
	e	**Components of micro hydro power system** 1. Diversion structure 2. Desalting Tank 3. Water channel 4. Forebay Tank 5. Penstock 6. Turbine 7. Generator 8. Power house 9. Tail race	02 marks
	f	**Merits of PV cells** 1. Very long life 2. No moving parts 3. No noise 4. No pollution 5. High reliability 6. Easy operation and maintenance 7. System Fabrication is easy 8. Threshold required power is less 9. Unlimited renewable source 10. May be installed in remote areas.	02 marks

Sr.no	Name of specification	Details
01	Rated power	2.7 MW
02	Rated wind speed	9.5 m/s
03	Cut-in wind speed	3 m/s
04	Cut-out wind speed	30 m/s
05	Rotor diameter	129 m
06	Generator	50 Hz/ 60 Hz
07	Tower	140 m

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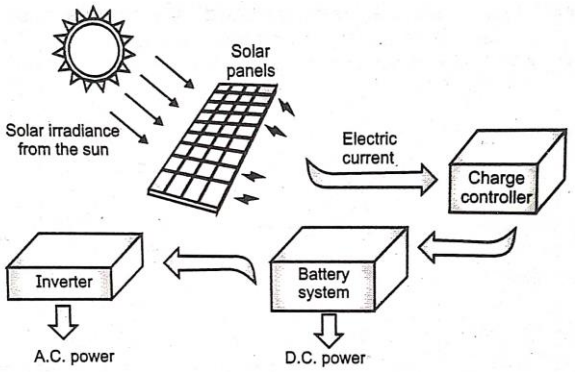
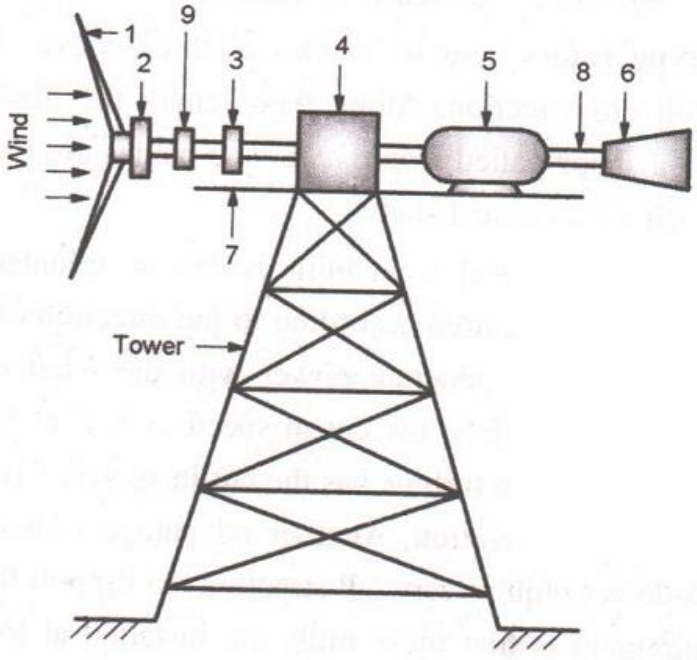
Q. No.	Sub Q. N.	Answer	Marking Scheme
1	g	**Hybrid systems** 1. Wind solar photovoltaic hybrid system 2. Wind biomass hybrid system 3. Solar biomass hybrid system 4. Solar diesel hybrid system 5. Solar gas turbine hybrid system 6. Combination of any two power generation plants	02 marks
2	a	**Distinguish between renewable and nonrenewable energy sources**	04 marks
	b	**Types of Solar Photovoltaic Systems** 1. Grid connected Solar PV Systems 2. Off grid / stand alone Solar PV Systems 3. Hybrid – connected Solar PV Systems	04 marks

Sr No.	Renewable energy sources	Non renewable energy sources
1	Renewable energy sources are essentially inexhaustible	Non Renewable energy sources are exhaustible and likely to be depleted with passage of time.
2	Can be harnessed without the release of harmful pollutants	Produce pollution
3	More capital cost	Less capital cost
4	Ex. Solar , wind power, geothermal , tidal etc	Ex: coal , oil , gas etc



2	c	A solar PV cells are used to supply power to a house where DC power is converted to AC power supply to house hold appliances. The solar PV cells converts the solar energy to electricity by using Photovoltaic effect as shown in figure. **Structure of horizontal axis wind mill**  Components:- 1. Rotor with blades 2. Electromagnetic brakes 3. Mechanical brakes 4. Gear box 5. Generator 6. Flap or tail vane 7. Tower top 8. Shaft 9. Controller	04 marks

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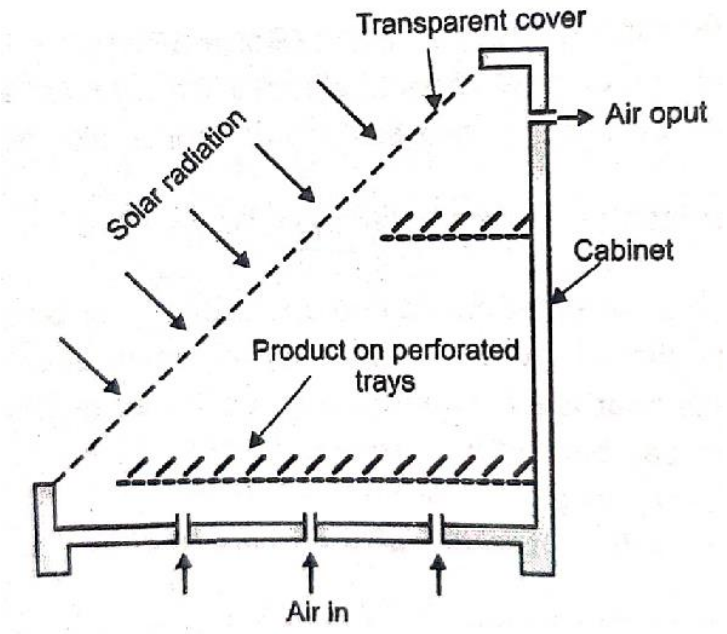
Subject Name: Renewable Energy Sources **Model Answer** Subject Code: 22661

Q. No.	Sub Q. N.	Answer	Marking Scheme
2	d	Micro hydel power plant is a type of hydroelectric power that typically produces from 5 kW to 100 kW of electricity using the natural flow of water. These installations can provide power to an isolated home or small community, or are sometimes connected to electric power networks, particularly where net metering is offered. There are many of these installations around the world, particularly in developing nations as they can provide an economical source of energy without the purchase of fuel. Micro hydro is frequently accomplished with a **Pelton** wheel for high head, low flow water supply. The installation is often just a small dammed pool, at the top of a waterfall, with several hundred feet of pipe leading to a small generator housing.	04 marks
3	a	**Working of Solar Dryer**  Solar radiations enters the enclosure and it is absorbed by the products as well as surrounding internal surfaces the products are directly heated by solar radiations., moisture from the products as the air inside is heated which follows decrease in density and rise in temperature , therefore low dense air moves up word and leaves through the openings provided at top of cabinet dryer and at the same time fresh air enters. The temp. inside the cabinet ranges from 50^0 c to 75^0 c the drying time for products varies from 2 to 4 days.	04 marks

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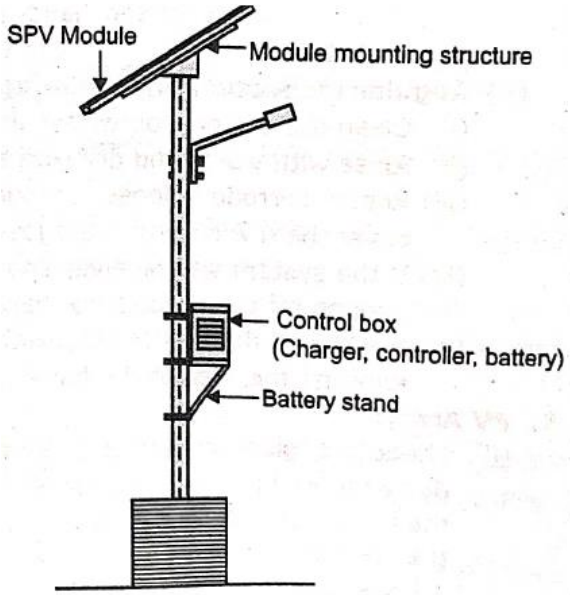
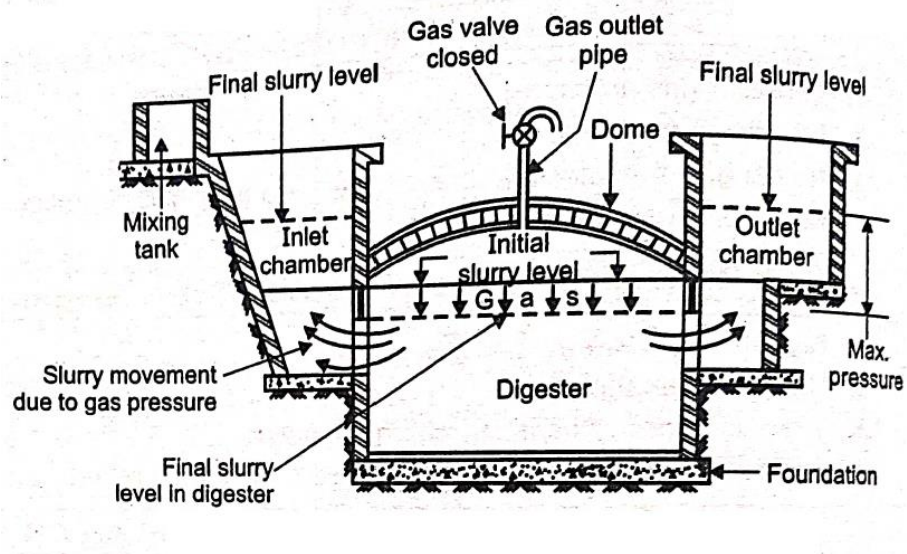
Q. No.	Sub Q. N.	Answer	Marking Scheme
3	b	**Stand alone street light system**  A stand-alone solar photovoltaic street lighting system comprises following compo-nents: 1. Foundation, 2. Solar panel with frame, 3. LED lamps, or compact fluorescent (CFL) lamp, 4. Light pole, 5. Control box (charger, controller, battery, wires etc.).	04 marks
	C	**Fixed dome biogasplant**  The cattle dung and water are mixed properly in the ratio 1:1 to form slurry, which is then filled in the digester up to height of its cylindrical portion. The fermentation fixed up and gas is generated this gas is collected through the pipe line provided at the top and slurry is released through outlet chamber.	04 marks

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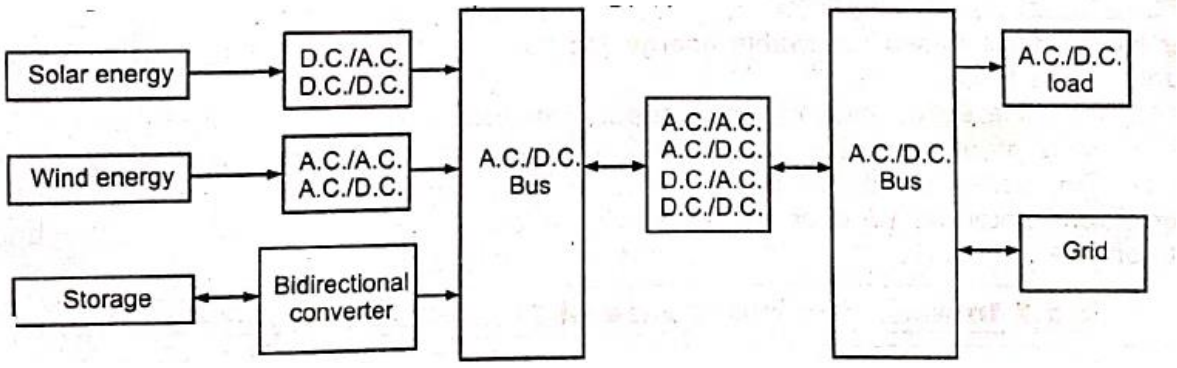
Q. No	Sub Q. N	Answer	Marking Scheme
3	d	**Biomass** Biomass is defined as all plant and animal matter on the earth surface. **Biomass energy** Energy obtained from Biomass is called Biomass energy**.** Biomass Resources: 1. Wood 2. Energy crops 3. Agricultural residues a) Grass b) Tree leaves c) Wheat straw d) Rice husk e) Sugarcase bagasse 4. Food waste 5. Industrial waste and co-products etc.	04 marks
4	a	**Wind solar hybrid system**  Wind solar hybrid system work in stand alone or grid connected mode in which AC power output is directly connected to the utility grid through transformer. In this system solar energy and wind energy are key resource used to generate electricity.	04 marks

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Subject Name: Renewable Energy Sources **Model Answer** Subject Code: 22661

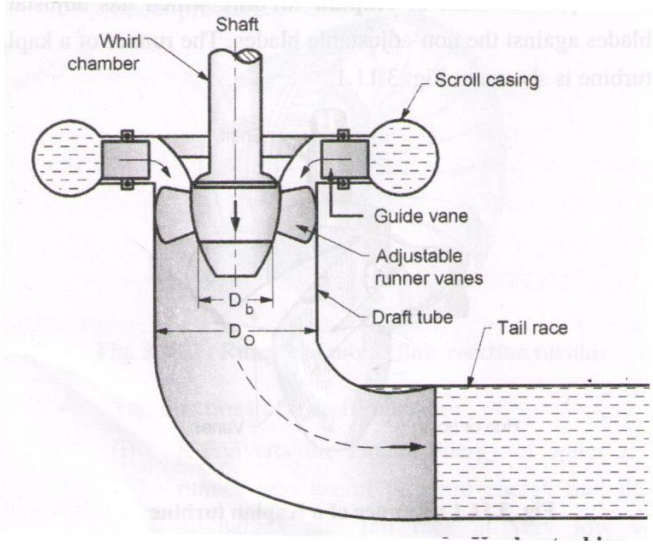
Q. No.	Sub Q. N.	Answer	Marking Scheme
4	b		04 marks

Sr. No.	Comparative Point	Horizontal Axis Wind Turbine	Vertical Axis Wind Turbine
1.	**Axis of rotation**	Horizontal.	Vertical.
2.	**Space required**	HAWTs needs to be placed appropriately on large distances.	VAWTs occupy a smaller footprint. Therefore, they can be used in confined physical locations or can be positioned close together.
3.	**Need of yaw control**	Required.	Not required.
4.	**Cut in speed**	High (>10 m/s).	Low (2 m/s).
5.	**Tip to speed ratio**	High (> 5)	Low (≈ 1 for Savonius)
6.	**Installation of generator**	Generator is placed at top.	Generator is placed at ground.
7.	**Maintenance cost**	Very high.	Relatively less.
8.	**Need of guy wires**	Does not required to be supported by guy-wires, tower foundation is sufficient.	A very large bending moment is created in the rotor shaft, if it is not supported at the top.

c

Propeller type reaction turbine:

IT is a axial flow reaction turbine in which water flows parallel to the axis of shaft. It has a vertical hollow shaft which is enlarged at the bottom in the shape of propeller called hub or boss. The vanes are fixed on the hub which acts as the runner. It has scroll casing guide mechanism and draft tube .



04 marks

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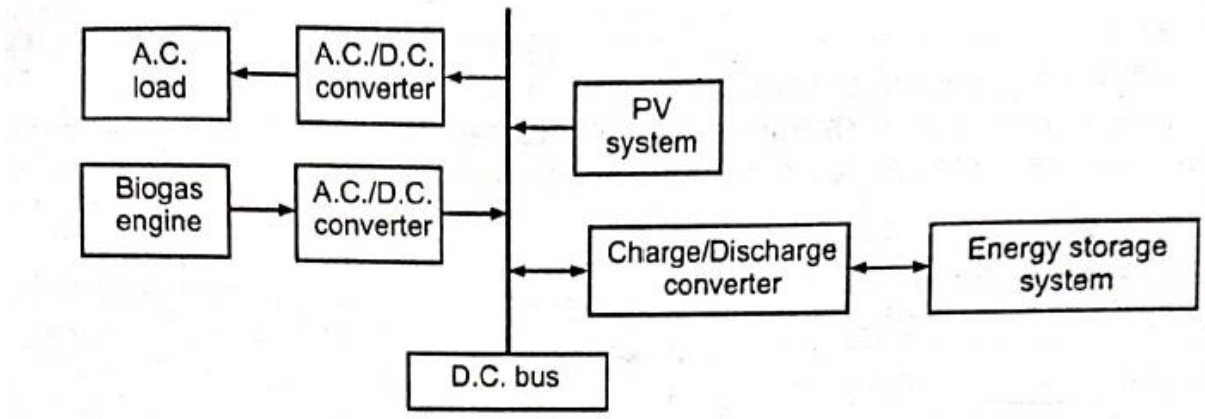
Subject Name: Renewable Energy Sources **Model Answer** Subject Code: 22661

Q. No.	Sub Q. N.	Answer	Marking Scheme
4	d	**Preventive Maintenance of Hydro Power Plant** Preventive maintenance is planned maintenance of plant and equipment. It is designed to improve equipment life and avoid unplanned maintenance activities. Preventive maintenance is the inspection, replacement, repair of any piece of equipment and set parameters. It includes painting, lubrication, cleaning, adjusting and minor component replacement to extend the life of equipment and facility. Its main purpose is to minimize break down deterioration. **Necessity** Good condition of Power plant for longer period To avoid the accidents with operator Water way facilities, electric equipment, transmission and distribution lines work properly.	04 marks
	e	 The biogas engine coupled with generator used for power generation from biogas. A.C./D.C. convertors rectify the generated A.C. voltage from the biogas engine generator to a D.C> voltage to be feed into the D.C. bus. D.C. power output from the solar PV system is also feed to the common D.C. bus shown in figure. A standard charge controller is used to charge the battery. A static frequency convertor converts the D.C. voltage from all sources into an A.C. voltage for consumer use.	04 marks

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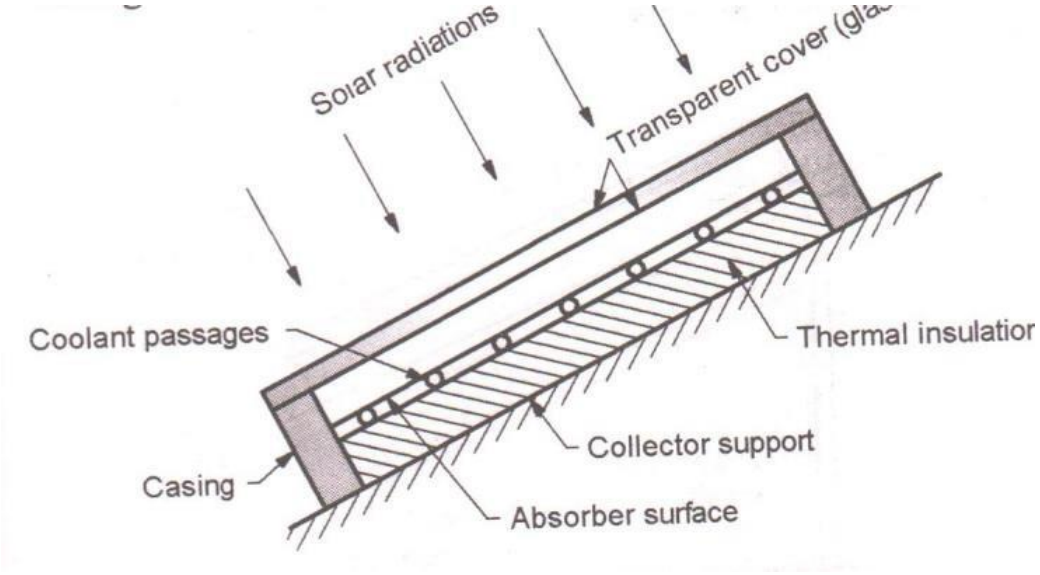
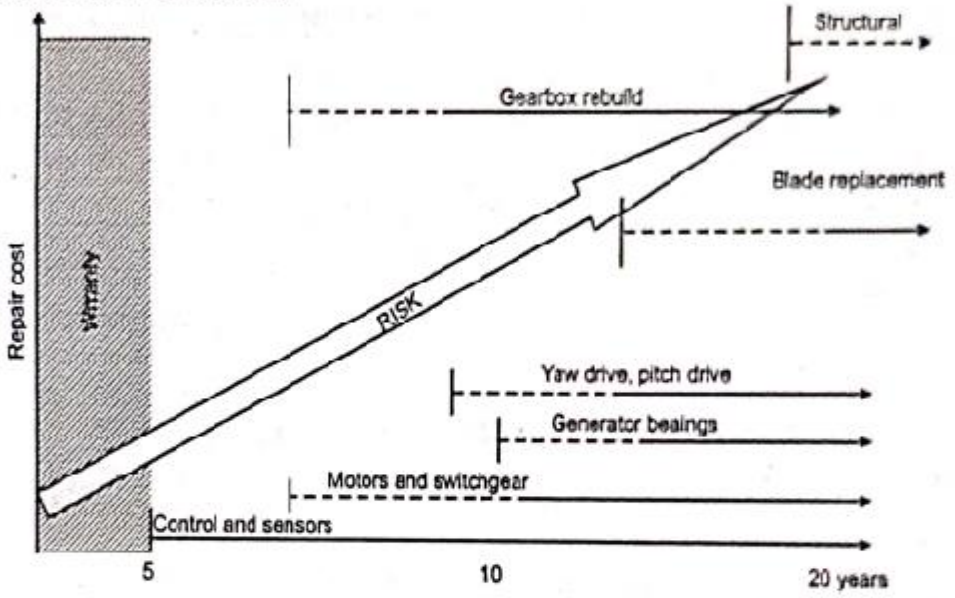
Subject Name: Renewable Energy Sources **Model Answer** Subject Code: 22661

Q. No.	Sub Q. N.	Answer	Marking Scheme
5	a	**Flat plate collector** Important parts of liquid flat plate collector are shown 1. Transparent cover 2. Absorber plates 3. Tubes fixed to absorber plate to form coolant passages 4. Thermal insulation 5. Casing or container. 6. It is a box like structure. It consists of an absorber plate which receives beam as well the diffuse solar radiations through transparent glass covers. The absorbed radiations are partly transferred to the liquid flowing through tube which is either fixed to the absorber plate or they form an integral part of it. Remainder part of the radiation solar energy absorbed by the absorber plate is either re radiated to the surroundings through the top surface or lost by convections.  	06 marks

5	b	**Solar Roof top Installation Process** **1. Laying Out the Framework:** This phase of the array installation consists of three stages: (i) **Completing the basic layout of footers and rails:** Mapping the location of the racking and PV modules on paper. (ii) **Locating rafters (or trusses) for footers:** Measuring for the precise locations of the roof framing members that you will anchor into. (iii) **Snapping chalk lines and marking pilot holes:** Creating reference lines on the rooftop and marking pilot holes for installing the footers. **2.** Installing footers and rails, which will act as a mounting base for the modules. **3.** Once the footers and rails are in place, aligned and secured, the process of assembling the pre-fabricated parts of PV module is initiated. **4. Installing the microinverters and ground wire:** This includes following steps: (i) Mount all microinverters to the rails. (ii) Connect the microinverters together and cap-off the last microinverter lead. (iii) Connect the ground wire to each microinverter case or mounting bracket, as directed. (iv) Run the wire to the junction/combiner box location, leaving enough loose or flexible, for wiring into the box later. **5. Install the junction box:** Mount the electrical box of a suitable size to the mounting frame. With microinverters, junction box will be used with A.C. as an input, while with string inverters, disconnecting D.C. junction/combiner box will be installed. **6. Installing the modules:** Set the first module onto the rails at one end of the row (if the array has multiple rows, start at the bottom row). Make sure that, the module is centered top-to-bottom and it is square to the rails. Connect the module leads to the rail-mounted microinverter or D.C. optimizer, and in case of the frame-mounted microinverters, connect the microinverter to the A.C. trunk cable. **7.** Similarly, set all remaining modules and connect its leads to microinverter. **8.** Installing conduit and wiring between the combiner or junction box at the array and the system components at ground level (i.e. inside house). **9. Installing the ground-level components:** (i) Install D.C.-A.C. inverter and Rapid-shutdown control, if string inverter system is used. (This step could be skipped in the case, where microinverters have already been spaced as stated in previous steps). (ii) Installing A.C. disconnect, PV production meter, A.C. breaker(s) and utility meter.	06 marks

Q. No.	Sub Q. N.	Answer	Marking Scheme
5	c	The operation and maintenance procedure should be based on guidelines specified by the wind turbine supplier and any other suppliers. This is necessary for the effective performance of the wind energy conversion system. However, in general, the maintenance includes the following elements: 1. Routine checks 2. Periodic maintenance 3. Periodic testing 4. Blade cleaning 5. Electrical equipment maintenance 6. Unscheduled maintenance.  **Fig. 3.14: Repair cost and failure events of typical small/large size wind machine** Generally, maintenance is divided into three categories. **Corrective maintenance:** ○ Corrective maintenance is carried out after a failure has occurred. ○ This means that, the working of wind mill has to be stopped, until the failed component is either repaired or replaced by a new one. **Preventive maintenance:** ○ Preventive maintenance activity is carried out at predetermined schedule to reduce the probability of failure or the degradation of the functioning equipment. ○ Preventive maintenance activities are planned and periodical. ○ Preventive maintenance can be divided into two categories: (I) **Indirect preventive maintenance:** It includes activities, which can be executed during operation and that will not affect the object (component, equipment). This include inspecting various components of the wind energy system using condition-based monitoring (CBM). The condition monitoring could be used to get a constant monitoring of various subsystems (II) **Direct preventive maintenance.**	06 marks

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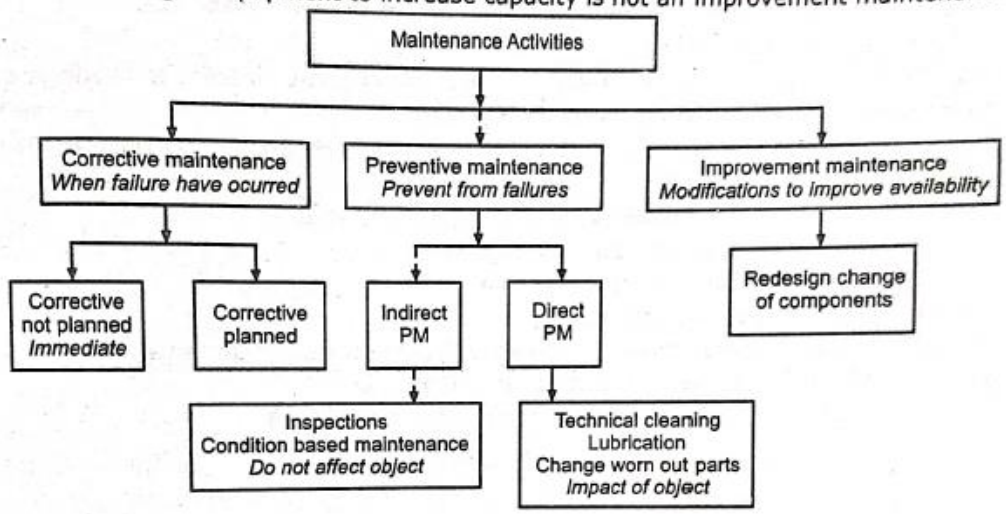
2. Improvement maintenance:

- Improvement maintenance is the program of initiatives taken to improve the operational reliability from a maintenance aspect.
- Reconditioning of equipment to increase capacity is not an improvement maintenance.



Wind turbine maintenance refers to the process of keeping wind turbines running smoothly. It includes routine inspections, cleaning, lubrication, and repairs. Wind turbine maintenance tasks include turbine inspection, turbine cleaning, turbine lubrication, and turbine repair.

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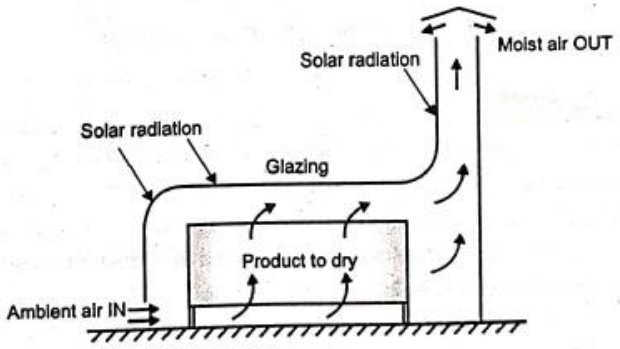
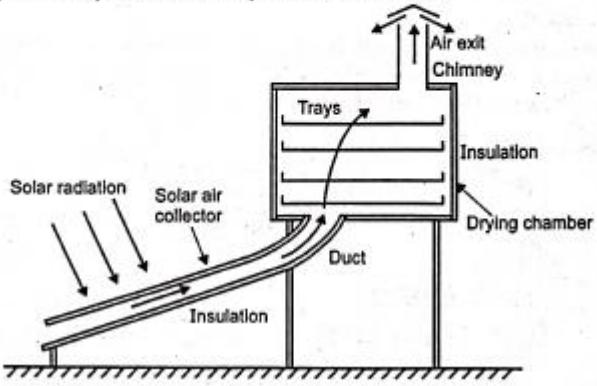
Q. No.	Sub Q. N.	Answer	Marking Scheme
6	a	**Solar dryer** 1. **Integrated solar dryer** 2. **Distributed solar dryer** **Integrated solar dryer** Integrated type solar energy dryer consists of a container insulated at its sides and covered with a single glazing or roof. The interior walls are blackened. Therefore, solar radiation transmitted though the cover is absorbed by the blackened interior surfaces as well as by the product, thus raising the internal temperature of the container. At the front, special openings provide ventilation, with warm air leaving via the upper opening under the action of buoyant forces.  **Distributed solar dryer** They can generally produce higher-quality products and are recommended for deep layer drying. Their disadvantages are that the fluctuation in the temperature of the air leaving the solar air collector makes constant operating conditions within the drying chamber difficult to maintain; they are relatively elaborate structures, requiring more capital investment in equipment; and they have higher running costs for maintenance than integral types. The efficiency of distributed type dryers can be easily increased, because the components of the unit can be designed for optimal efficiency of their functions.  	06 marks

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<table>
<tr><th>Q. No.</th><th>Sub Q. N.</th><th>Answer</th><th>Marking Scheme</th></tr>
<tr><td>6</td><td>b</td><td>
For environment friendly solution, the available energy renewable sources need to be examine on the basis of technical and economical aspects. Depending upon geographical location and availability of resources some solutions are possible. e.g. different combinations of renewable hybrid system includes solar, wind, diesel, battery etc.

Following procedure can be adapted for feasibility assessment,

1.Nature of load profile

First step is to prepare load profile and find maximum and average power consumption.

2.Choosing a suitable location(Site Selection)

<table>
<tr><td>Sr. No.</td><td>Graphical Feature</td><td>Type of plants</td></tr>
<tr><td>1</td><td>High altitude mountain valley</td><td>Solar-Biomass</td></tr>
<tr><td>2.</td><td>Plain Plateau, rural areas</td><td>Biomass-Wind</td></tr>
<tr><td>3.</td><td>Semi-dessert and Dessert, Costal regions</td><td>Solar-Wind</td></tr>
</table>

3.Exploring availability of that resources at that location: Information related to long term availability of all possible RES. e.g. wind speed, solar radiation, biomass availability should be gather

4.Modelling the hybrid system based on the resources and cost.

There are several commercial and free software available to analyze feasibility of power generation system e.g. RETscreen, HOMER, iHOGA and hybrid tool

5. Hybrid optimization model for electric renewable optimization tool of USA base is largely used.

6. The reliability impact on total cost function could be investigated. Socio –environmental benefits of various electricity generations could be estimated and taken in to consideration before coming into final conclusion.
</td><td>06 marks</td></tr>
</table>

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Q. No.	Sub Q. N.	Answer	Marking Scheme
	c	**Installation of Typical Biogas Plant** 1.Dimensions marking 2. Excavation works 3.Preparation of the digester's bottom 4.Building the Digester 5.Integrating the heating tubes 6.Building the gas holder 7.Technology Installation 8.Installing the insulation 9.Gas processing unit 10.Mixing technology 11.Solid feeder 12.Biogas storage 13.Cover membrane 14.Monitoring and controlling 15.Digested substrate storage **Maintenance procedure of Typical Biogas Plant** 1.Removal of sediments in the digester 2.Measures against foam layers 3. Clean and lubricate the primary gas valve. 4. Clean or repair gas lamp 5. Clean and repair water drain overflow. 6. Repair pipeline to stop leakages 7. Clean stoves. 8. Replace the rubber hose. 9.Any sealant, gasket or fastener used in tank construction needs to be properly evaluated to ensure long service life	06 marks