SOLUTION FOR SECOND INTERNAL TEST

RENEWABLE ENERGY SOURCES - 8TH SEMESTER

Each Question carries 10 Marks

1. **Flat Plate Solar Collector**

A flat-plate collector is placed at a location in a position such that its length aligns with the line of longitude and is suitably tilted towards South to have maximum collection.

Basic Elements in Collectors

(a)Transparentcover(one or two sheets) of glass or plastic.

(b)Blackened absorber plate usually of copper, aluminium or steel.

(c)Tubes, channels or passages in thermal contact with the absorber plate.

(d)Weather tight, insulated container to enclose the above components.

- 4Marks

A solar air heating collectoris similar to a liquid flat plate collectorwith a change in the configuration of the absorber and tube(riser).The value of the heat transfer coefficientbetween the absorber plate and the air is low. Therefore sometimes the surfaces become roughened.Corrugated, V – shaped , matrixare some of the other variations of shapes of the absorber plate. – 2 Marks

Diagram – 4 Marks

2. **A greenhouse**(also called a glasshouse) is a structure with walls and roof made chiefly of transparent material, such as glass in which plants requiring regulated climatic conditionsare grown. These structures range in size from small sheds to industrial sized buildings. A green house is an enclosure where proper environment is provided for growth and production of crops, vegetables and flower plantsunder adverse climatic conditions.

-2Marks

Types of Greenhouse - Winter Greenhouse and Summer Greenhouse

Winter Greenhouse :A south facing wall and roof is provided with double glazing.A north facing roof is made of insulating material with reflecting inner lining toreflect solar radiation on the plant canopy.The frame of the entire green house is made up of wood.The east and west facing walls are provided with a single layer of rigid transparent fibre glass sheets. -2 Marks

Diagram – 2 Marks

Summer Greenhouse :In a summer green house, the most important Requirementsare maintaining moderate temperature by reducing cooling loadsand also to provide adequate solar radiation.A south facing wall is provided with double glazing, covered with white thick movable insulating blocks.A part of the greenhouse is also sunken in the ground to take advantage of the low and constant ground temperature. - 2 Marks

Diagram – 2 Marks

3. Solar Cooker

Solar energy is considered a suitable alternative for a variety of applications.

Solar cookingoffers an effective method of utilizing solar energy for meeting a considerable demand for cooking energy and hence protecting the environment.Cooking with solar cookers is anenergy efficient, pollution free wayto help fight global warming and take advantage of nature's free inexhaustiblesupply of energy. Solar cookeris a device that cooks food using only solar radiation and can save the conventional fuels to a significant amount.It is the simplest, safest, most convenientway to cook without consuming fuelsor heating up the kitchen.It supplements the cooking fuel but cannot replace it in total. – 6 Marks

Diagram - 4 Marks

4. **Solar Still -**It is a process of removing undesirable chemicals, biological contaminants, suspended solids and gases from contaminated water.

Solar still is called as "still" as they distill or purify the contaminated water.

It works on the same principle as rain water: evaporation and condensation. The water from the ocean evaporates, only to cool, condense and return to earth as rain.When the water evaporates it removes only pure water and leaves all the impurities. Solar stills mimic this natural process. – 3 Marks

The raw water supply is distributed through the jet tube and wicks in the soakage shield.In the distillation reservoir the raw water is led through a soakage filter and is heated up to 100˚C.About 50-70% is evaporated and will be condensedagain. 30-50% remain as sewage water.The condensation is pure water. All the harmful agents and mineralsstay in the unevaporized water andwill be flushed out of the collector along with the sewage water.

The condensate runs into the collecting channel. It drips from a trickling filter into the lower condensate channel. The product is now pure water which can be used for drinking and other industrial purposes.The sewage water can be used for plantirrigation with higher tolerance for salt. – 4 Marks
Diagram - 3 Marks

5. **Concentrating type collectors** - These are devices that optically reflect and focus incident solar energy onto a small receiving area.As a result of this concentration, the intensity of the solar energy is magnified, and the temperatures that can be achieved at the receiver (called the "target") can approach several hundred or even several thousand degrees Celsius.

Types of concentrating type collectors – parabolic trough system, parabolic dish, central tower collector and stationary concentrating collectors

(a)Parabolic trough system - Parabolic troughs are devices that are shaped like the letter “U”. The troughs concentrate sunlight onto a receiver tube that is positioned along the focal line of the trough. Sometimes a transparent glass tube envelops the receiver tube to reduce heat loss.

Diagram – 2 Marks

(b)Parabolic dish systems - A parabolic dish collector is similar in appearance to a large satellite dish, but has mirror-like reflectors and an absorber at the focalpoint. It uses a dual axis sun tracker. A parabolic dish system uses a computer to track the sun and concentrate the sun's rays onto a receiver located atthe focal point in front of the dish.A parabolic dish system uses a computerto track the sun and concentrate the sun's rays onto a receiver located at the focalpoint in front of the dish.

Diagram – 3 Marks

(c)Central Tower collector system - A heliostat uses a field of dual axis sun trackers that direct solar energy to a large absorber located on a tower. To

date theonly application for the heliostat collector is power generation in a system called the power tower.A power tower has a field of large mirrors that follow the sun's path across the sky.

Diagram –2 Marks

(d)Stationary concentrating solar collectors - Stationary concentrating solar collectors use compound parabolic reflectorsand flat reflectorsfor directing energy to an accompanying absorber or aperture through a wide acceptance angle. This class of collector includes parabolic trough flat plate collectors, flat platecollectors with parabolic boosting reflectors, and solar cooker.

Diagram –3 Marks

6. Central Receiver System

Central receivers (or power towers) use thousands of individual sun-tracking mirrors called "heliostats" to reflect solar energy onto a receiver located on top of tall tower.The receiver collects the sun's heat in a heat-transfer fluid (molten salt) that flows through the receiver. The salt's heat energy is then used to make steam to generate electricityin a conventional steam generator, located at the foot of the tower.In this system, molten-salt is pumped from a “cold” tank at 288 ˚C and cycled through the receiver where it isheated to 565 ˚C and returned to a “hot” tank.The hot salt can then be used to generate electricity when needed. Current designs allow storageranging from 3 to 13 hours . -5 Marks

Diagram - 5 Marks

7. **A solar pond** is simply a pool of saltwater which collects and stores solar thermal energy. The saltwater naturally forms a vertical salinity gradient also known as a "halocline", in which low-salinity water floats on

top of high-salinity water.

Working Principle:It is well-known that, when water or air is heated they become lighter and rise upward.Similarly, in an ordinary pond, the sun's rays heat the water and the heatedwater from within the pond rises and reaches the top but loses the heat into the atmosphere.The net result is that the pond water remains at the atmospheric temperature.The solar pond restricts this tendency by dissolving salt in the bottom layer of the pond making it too heavy to rise.An upper convective zoneof clear fresh water that acts as solar collector/receiver and which is relatively the most shallow in depth and is generally close to ambient temperature.A gradient which serves as the non-convective zonewhich is much thicker andoccupies more than half the depth of the pond. Salt concentration andtemperature increase with depth (Insulation zone).A lower convective zonewith the densest salt concentration, serving as the heatstorage zone. Almost as thick as the middle non-convective zone, salt concentration and temperatures are nearly constant in this zone. – 7 Marks

Diagram – 3 Marks

8. Principle of Solar Photovoltaic power generation - The best conductors (silver, copper and gold) have one valence electron, whereas the best insulators have eight valence electrons.A semiconductor has electrical conductivity due to electron flow (as opposed to ionic conductivity)intermediate in magnitude between that of a conductor and an insulator.Semiconducting materials are the foundation of modern electronics, and areused in transistors, solar cells, many

kinds of diodes including the light-emittingdiode, and digital and analog integrated circuits. Semiconductor PV cells directly convert light energy into electrical energy.In metals, current is carried by the flow of electrons. In semiconductors, current is often schematized asbeing carried either by the flow of electrons or by the flow of positively chargedholes in the electron structure of the material (in both cases only electronmovements are actually involved).

3 Marks

Solar PV System Components :

- Modules – solar electric collectors. 3 basic types in the marketplace: Mono crystalline, poly crystalline, thin film.
- Array– modules connected together into a system.
- Inverter – converts the DC power produced by the modules to A/C.
- Grid Tie Inverter– converts DC to AC and feeds the utility grid with the A/C power.
- Charge Controller– regulates the power going to the batteries.
- Batteries – stores DC power. – 4 Marks

Diagram - 3 Marks

9.

(a)

(b)

- In this system, molten-salt is pumped from a “cold” tank at 288 ˚C and cycled through the receiver where it is heated to 565 ˚C and returned to a “hot” tank.
- The hot salt can then be used to generate electricity when needed. Current designs allow storage ranging from 3 to 13 hours .

1.
2.
3. contaminants behind.

These blocks can be selectively moved to admit only absolutely essential solar radiation whenever needed.

Sunlight is allowed to enter only in the morning and evening hours.