



SUMMER– 14 EXAMINATION

Subject Code: **17611**

Model Answer

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.1. (A) (a) (Two marks for advantages and limitations each)

Advantages of renewable Energy sources

1. These energy sources are sustainable and will never exhaust
2. It is available in abundance.
3. It has low operating and maintenance cost.
4. No fossil fuels are needed. No elaborated arrangements are required for transportation, handling and storage of fuels as needed in conventional power plants.
5. It can directly be converted into electrical energy using photovoltaic cells.
6. These energy sources produce no waste products, so it has no impact on environment. It is pollution free.

Limitations of renewable Energy sources

1. It is dilute source of energy.
2. Availability varies widely with time of the day, month and during the year.
3. It involves high cost of storage of energy during non availability of sun shine hours.
4. Needs very large collector area to harness solar energy involving high capital cost



SUMMER– 14 EXAMINATION

Subject Code: **17611**

Model Answer

Q.1. (A) (b) (One mark for each definition)

- i. **Solar altitude (α)**: It is defined as the angle between the central ray from the sun, and a horizontal plane containing the observer is the Solar altitude angle. At the Sunrise and Sunset the solar altitude angle (α) is zero
- ii. **Solar Azimuth angle (γ)**: It is the angle of deviation of the normal to the surface from the local meridian, the zero point being south, east positive and west negative.
- iii. **Day length (t_d)**: It is the time elapsed between sunrises to sunset. By knowing the values of sunrise and sunset hour angle, we can calculate the day length.
- iv. **Local solar time (LST)** : This is also called as Local Apparent time(LAT) . The time so calculated is (LST).
(LST)= IST+/- (Standard time longitude – longitude of location) + Equation of time correction

Q.1. (A) (c) (One mark for each type)

Following turbines are used for small hydroelectric plant:

- i. Francis turbine
- ii. Kaplan turbine
- iii. Propeller turbine
- iv. Axial flow bulb turbine

Q.1. (A) (d) (One mark for each use)

Following are the uses of the instruments:

- i. Fyrite : To measure the volume of O_2 , CO_2 and other gases
- ii. Pitot tube : To measure the pressure
- iii. Infrared thermometer : To measure temperature of heat source without coming In contact with other surface
- iv. Sunshine recorder : To measure Hours of bright sunshine in a day

Q.1. (B) (a) (Three marks for need, three marks for methods)

Need of orientation in concentrating type collectors: In flat plate collectors solar direct and diffuse radiations without sun tracking are collected for heating. It causes the loss of energy

SUMMER- 14 EXAMINATION

Subject Code: **17611**

Model Answer

during sunshine period since the solar radiations will not be normal to the surface and the temperature achieved are only 100 O C . For temperatures above these concentrating type collectors are needed.

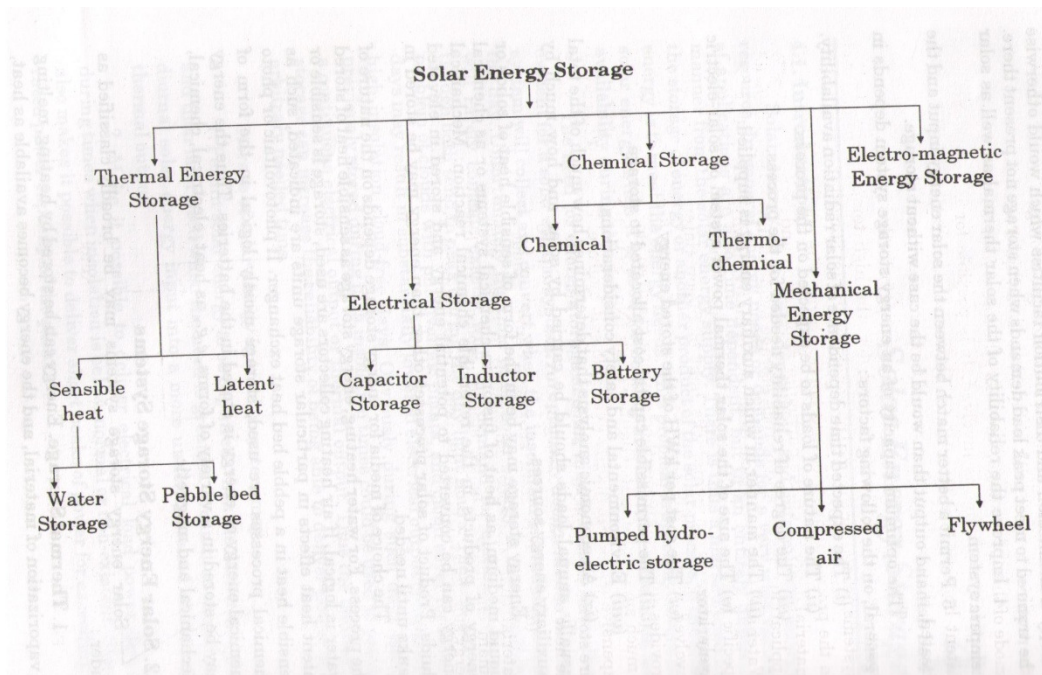
A cylindrical parabolic collector is oriented with its focal axis pointed either in the east-west or the north-south direction. In the east-west orientation the focal axis is horizontal while in the north-south orientation, the focal axis may be horizontal or inclined.

Different methods for sun tracking :

- i. The focal axis is east-west and horizontal
- ii. The focal axis is north-south and horizontal
- iii. The focal axis is north-south and inclined at a fixed angle equal to the latitude.

Q.1. (B) (b) (Three marks for classification, three marks for applications)

Classification of solar energy storage system:



Applications of thermal storage

- 1) Solar water heater
- 2) Solar space heating

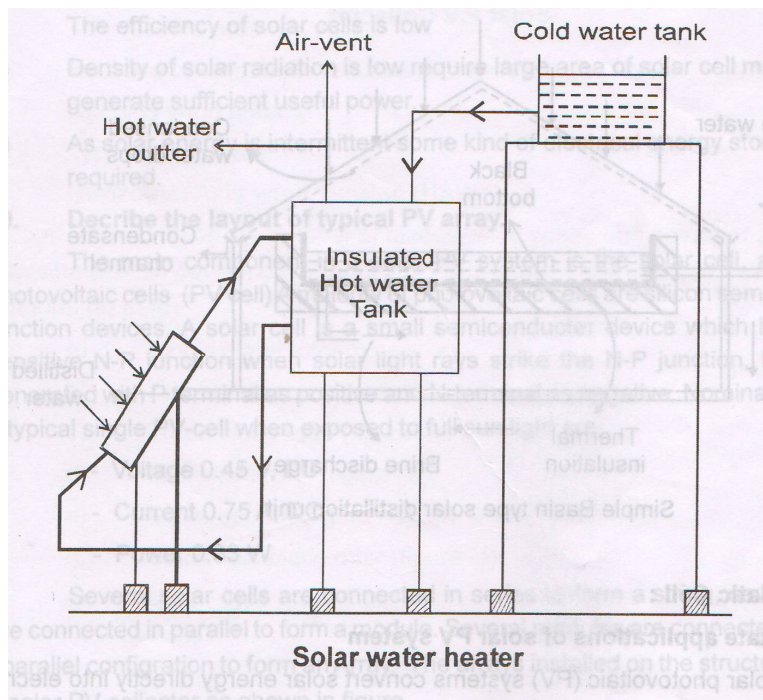
SUMMER- 14 EXAMINATION

Subject Code: **17611**

Model Answer

Q.2. (a) (Four marks for sketch, two marks for explanation and two for advantages)

Flat Plate Solar water heater: A tilted flat plate solar collector with water as heat transfer fluid is used in solar water heater system. A thermally insulated hot water storage tank is mounted above the collector. The heated water of the collector rises up to the hot water tank and equal quantity of cold water enters the collector. The cycle repeats, resulting in all the water of the hot water tank getting heated up. When water is taken out from hot water outlet, the same is replaced by cold water from cold water tank, fixed above the hot water tank.



Advantages:

- i. Absorbs direct, diffused and reflected radiations
- ii. No tracking required
- iii. Low cost
- iv. Almost maintenance free

Q.2. (b) i) (Any Four, one marks for each)

Main considerations in selection of site for wind power generating station are :

- a) Availability of higher and constant wind speed with 7 to 8 m/sec

SUMMER- 14 EXAMINATION

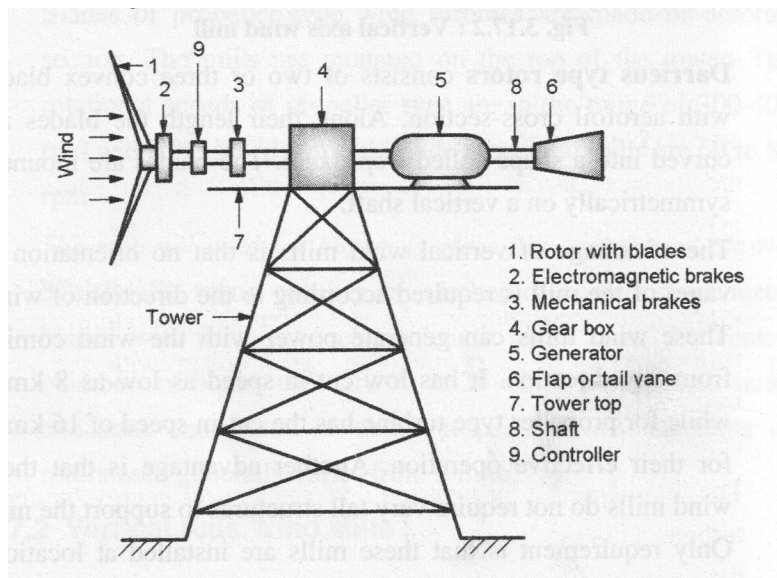
Subject Code: **17611**

Model Answer

- b) Availability of wind throughout the year.
- c) Proper altitude of site.
- d) Availability of sufficient land for installing wind mills.
- e) Connectivity to electric grid.
- f) Connectivity of site by road and other modes of transport.
- g) Easy and proper access to locality.
- h) Ecology considerations

Q.2. (b) ii) (Three marks for figure and one for labeling)

Components of Wind Electric system.



Q.2. (c)

i. (Two marks for definition and two for advantages)

Energy plantation: There are certain plants which can be planted and harvested over regular period of time to have high yield per unit area. Thus the method of tapping maximum solar energy by growing plants on large scale is called energy plantation.

Advantages

- a) Virtually there is no maintenance



SUMMER– 14 EXAMINATION

Subject Code: **17611**

Model Answer

- b) It is economical
- c) It is non polluting
- d) It acts as a best solar collector

ii. (one mark for each plant)

Main plants proposed for energy plantation: Following plants are suitable for large scale plantation in Indian conditions having high yield

- a) **Casuarina** : These are suitable for plantation in coastal areas
- b) **Eucalyptus** : Thjese are very fast growing trees. It grows to about 15m in three years
- c) **Sorghums** : These energy crop is suitable for alcohol production
- d) **Other suitable trees** : These are babool, Leucaena, Jajoba etc

Q.3. (a) (Two marks for principles and two for components)

Principles of photovoltaic power generation :

Photovoltaic electric conversion: When photon is absorbed, its energy is given to an electron in the crystal lattice. The energy given to this valence bond excites it into the conduction band.

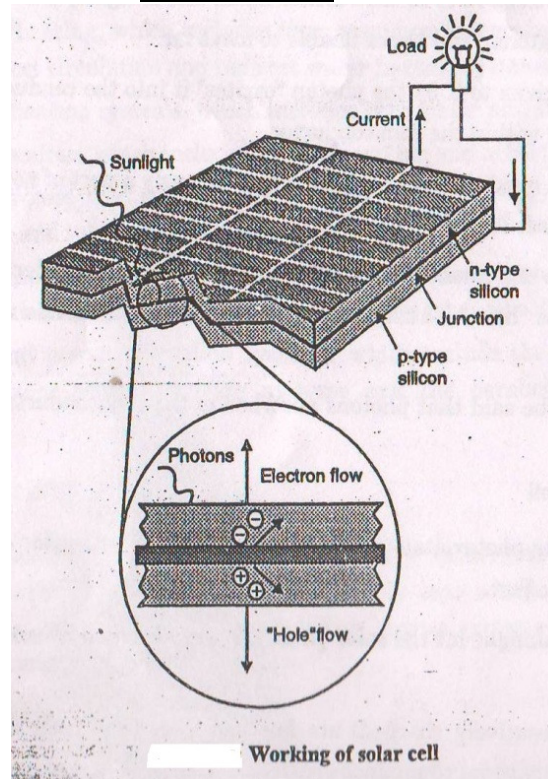
Photovoltaic cell: A solar cell or photovoltaic cell is a device that converts solar energy into electricity by the photovoltaic effect. Photons in sunlight hit the solar panel and are absorbed by semiconducting materials such as silicon.

Electricity can be produced by solar cells whose principal component consists of a semiconductor that is typically made of silicon. Solar cells are often electrically connected and encapsulated as a module often has a sheet of glass. To make practical use of solar generated energy the electricity is most often fed into electricity grid using inverters.

SUMMER- 14 EXAMINATION

Model Answer

Subject Code: **17611**



Main elements of SPV :

- 1) Photovoltaic array
- 2) Inverter
- 3) Energy storage
- 4) System charge control
- 5) Balance of system (BOS) components

Q.3. (b) (Two marks for sketch and two for components)

Solar pump system : Solar pumping consists of power generated by solar energy for water pumping useful for irrigation.

The basic system consists of following components:

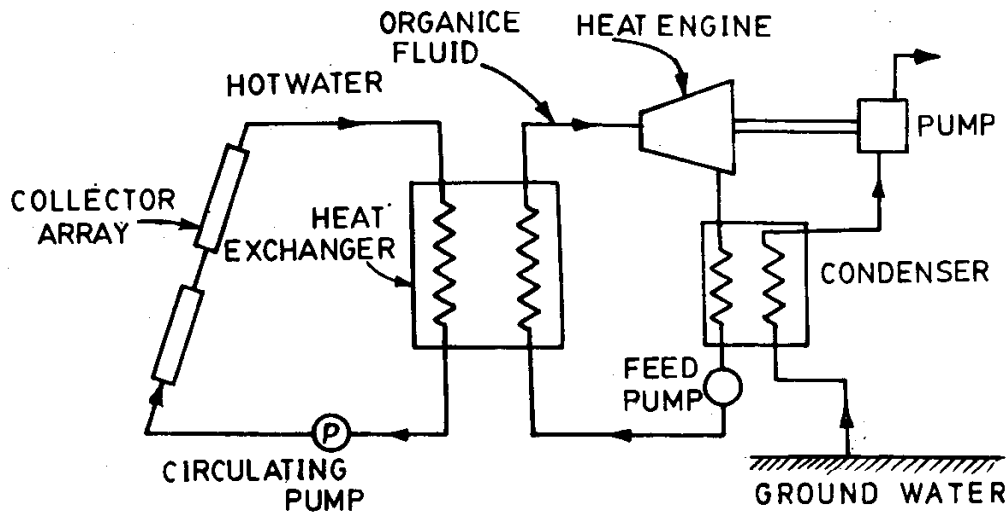
1. Solar collectors may be Flat plate or sun tracking concentrators

SUMMER- 14 EXAMINATION

Subject Code: **17611**

Model Answer

2. The heat transport system
3. Boiler or heat exchangers
4. Heat Engine : Rankine/ Stirling hot gas, rotary piston
5. Condenser
6. Pump may be Reciprocating, centrifugal, diaphragm



Schematic of a solar pump.

Q.3. (c) (Two marks for definition and two for types of turbines)

Micro hydel plant : Micro hydel plants work under a head of 5 meters. Such low head plants can only be build in states of UP, HP and Arunachal Pradesh. These plants can be constructed in short time along a stream of the river.

Axial flow bulb turbine and Axial flow tubular turbines are best suited for the micro hydel plants.

Q.3. (d) (Two marks for definition and two for factors)

Anaerobic digestion: Anaerobic digestion is a biochemical process in which the particular kinds of bacteria digest biomass in an oxygen free environment. The process of anaerobic digestion occurs in a sequence of stages involving distinct types of bacteria.

Hydrolytic and fermentative bacteria first break down the carbohydrates, proteins and fats present in biomass feedstock into fatty acids, carbon dioxide, hydrogen, ammonia and sulfides. This stage is called hydrolysis.



SUMMER– 14 EXAMINATION

Subject Code: **17611**

Model Answer

Next, acetogenic bacteria further digest the products of hydrolysis into acetic acid, hydrogen and carbon dioxide.

Methanogenic bacteria then convert these products into biogas. The combustion of digester gas can supply useful energy in the form of hot air, hot water or steam.

After filtering and drying, digester gas is suitable as a fuel for an I.C. engine, which combined with generator, can produce electricity.+

Factors affecting bio digestion: Following factors are affecting the biodigestion:

- 1) pH or the hydrogen-ion concentration
- 2) temperature
- 3) total solid content of the feed material
- 4) loading rate
- 5) seeding uniform feeding
- 6) Diameter to depth ratio
- 7) Carbon to nitrogen ratio
- 8) Nutrients
- 9) Retention time
- 10) Types of feed stock

Q.3. (e) (one mark for each advantage)

Advantages of small scale hydroelectric plant :

1. Can be built along a stream of river in our country
2. Works in the range of 5 to 20m meter
3. As much as 20000 kW power can be generated
4. Can easily be constructed in shorter time



SUMMER– 14 EXAMINATION

Subject Code: **17611**

Model Answer

Q.3. (f) (four marks for distinction)

Distinction between biomass and biogas:

Sr. No	Biomass	Biogas
01	Biomass is an organic matter produced by plants grown on land and water along with their derivatives and animal manure	Biogas is produced by anaerobic decomposition of organic wastes by suitable bacteria
02	It is a form of solar energy as it is derived from photosynthesis of the plants	Biogas can be produced by digestion pyrolysis

Q.4.A) (a)(One mark each for definition and two marks for importance)

The effective wind velocity produces the total force acting on the blade section called aerodynamic force. It is proportional to the kinetic energy of stream and the projected area of blading. The resultant force can be resolved into two components as :

Lift: F_L which is normal to the direction of approach velocity. It is responsible for an aeroplane to maintain its lift. It is caused due to unbalanced pressure distribution over aerofoil surface.

Drag: F_D which is parallel to the direction of approach velocity. It represents the friction forces. Lift is useful component which gives rotation to the turbine.

Q.4. A) (b) (Two marks for explanation each)

- i. Pyrolysis: It is the heating of biomass in a closed vessel at temperatures in the range of 500°C to 900°C in absence of O_2 / air or with steam. It produces solid, liquid and gases. This process can use all type of organic materials including plastic and rubbers.
- ii. Fermentation: Fermentation is a process of decomposition of complex molecules of organic compound under the influence of micro organism (ferment) such as yeast , bacteria, enzymes etc

Q.4. A) (c)(Two marks for definition and two for necessity)

Energy Audit: An energy Audit is the first step in energy management programme. It shows how efficiently energy is being used and highlights opportunities for energy cost savings. It also shows ways to improve productivity.

SUMMER– 14 EXAMINATION

Subject Code: **17611**

Model Answer

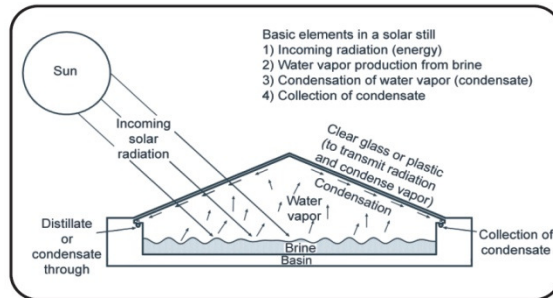
Necessity of Energy Audit : Energy audit takes a thorough look at a particular facilities, process or technologies. A compressive audit provides a detailed energy project implementation plan for a facility. This type of audit offers the most accurate estimate of energy savings and cost

Q.4. A) (d)

Solar distillation plant : figure shows various components of conventional double slope type solar distillation system. It is a air tight basin usually made up of concrete or special fiber with a transparent cover to accept radiation from the sun.

The inner surface of solar still is blackened to absorb maximum solar radiation. The blackened surface is known as basin liner.

The saline water is taken into basin for purification. The depth of the water is around 5 to 10 cms. Solar radiations after going through the still kept absorb by the blackened surface of the basin and thus temperature of water increases. Evaporated water increases the percentage of moisture which later on gets condensed on the cooler underside of the glass and then it is collected by means of condensate channel. in this way with the use of solar energy distillation process is completed.



Q.4.B) (a) (Two marks for definition, two for methods each)

Energy conservation: It means reduction in energy consumption without making any sacrifice of quality and quantity of production or for same energy consumption getting higher production.

It may be achieved through efficient energy use.

It may result in increase of financial capital, security, and human comfort.

SUMMER- 14 EXAMINATION

Subject Code: **17611**

Model Answer

Individuals and organizations that are direct consumers of energy may want to conserve energy in order to reduce cost and promote economic security.

Methods of energy conservation in boiler

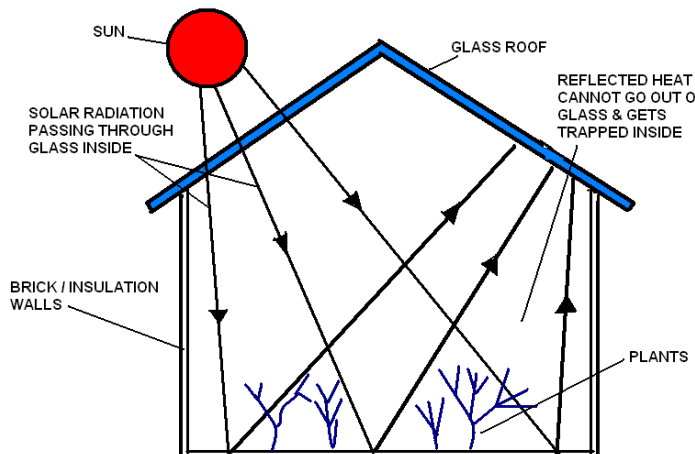
1. Control of temperature of exhaust gases at entry to chimney and utilization of flue gases
2. Control of excess air to ensure complete combustion of fuel
3. Reduction in radiation and convection heat losses
4. Control of steam pressure in boiler
5. Quality of feed water

Methods of energy conservation in furnace

1. Complete combustion with minimum excess air
2. Proper distribution of heat
3. Furnace must operate at optimum temperature
4. Heat losses due to furnace opening
5. Heat losses from walls
6. Heat recovery from hot flue gases leaving the furnace
7. Other heat recovery methods from flue gases

Q.4.B) (b) (three marks for each)

i. Solar Green House:





SUMMER- 14 EXAMINATION

Subject Code: **17611**

Model Answer

Green house is the chamber where the plants can be grown throughout the year. These are effective solar collectors. It provides crop cultivation in controlled environment. It has a brick or wooden walls with transparent roof of glass and arrangement for ventilation and temperature control for plant environment including soil temperature, air humidity, soil moisture, light, air composition etc.

As shown in figure solar radiations enter in green house and gets absorbed inside. Heating of inside surface results in emission of heat which has long wave length and cannot pass through glass and gets trapped inside the green house.

- ii. **Global Warming:** It is also called as climate change. It refers to the long term fluctuations in temperature, precipitation, wind and earth elements of the earth climate system.

Q.5. (a)

i. Classifications of Renewable energy sources :

Renewable energy sources are 1) Solar energy 2) Wind energy 3) Tidal energy
4) Geothermal energy 5) Bio mass energy

ii. Non Solar renewable energy sources :

Non Renewable energy sources are 1) Thermal energy 2) Nuclear energy
3) Coal 4) L.P.G 5) Crude oil 6) Hydraulic energy

Q.5. b) (one mark for each comparison)

- i. Comparison between small and mini hydroelectric plant

Sr. No	Small hydroelectric plants	Mini hydroelectric plants
01	Water head ranges upto 30 mts	Water head ranges between 5 to 20 mts.
02	Can be built on small dams	Can be built along the stream of the river
03	Capital cost per KW is less	Capital cost per KW is high
04	Longer time for construction	Shorter time for construction



SUMMER– 14 EXAMINATION

Subject Code: **17611**

Model Answer

ii. **Horizontal axis wind turbine : (03 marks for description and 03 marks for sketch)**

Wind mill: Basic structure of windmill consists of the following components.

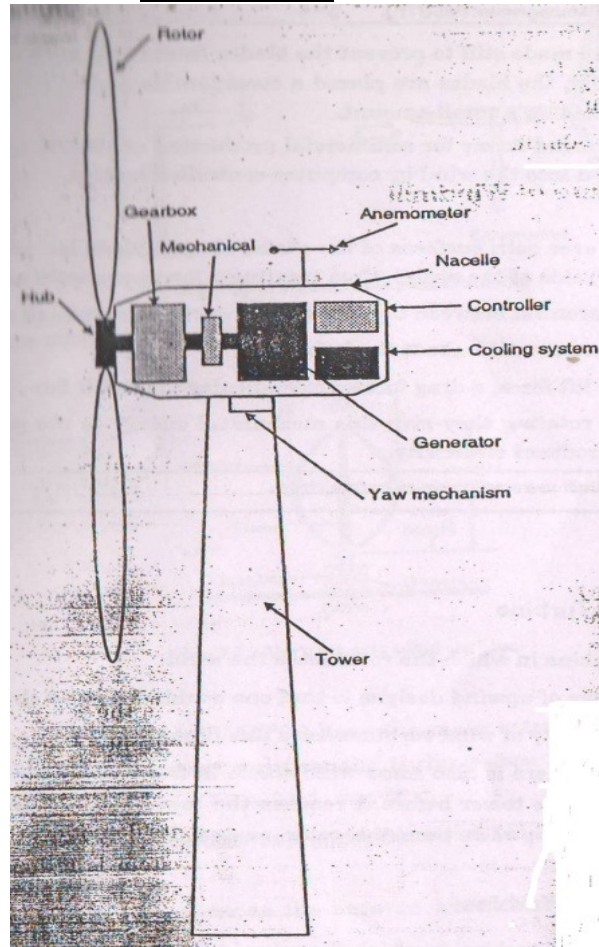
- i) Rotor blades: The rotor blades extract the wind energy and converts it into rotational form
- ii) Gearbox: It converts the rotational speed from low speed shaft and transforms it into faster rotation on the high speed shaft
- iii) Hub: It is the connection point for the rotor blades and low speed shaft
- iv) Mechanical brake: It is a disc brake used for repairs and maintenance of the wind mill.
- v) Generator :It converts the rotational speed of high speed shaft to electrical energy
- vi) Yaw mechanism. This mechanism keeps the rotor blades parallel to the flow of wind
- vii) Anemometer and wind vane: They are the instruments for measuring wind speed



SUMMER- 14 EXAMINATION

Subject Code: 17611

Model Answer



Basic structure of windmill

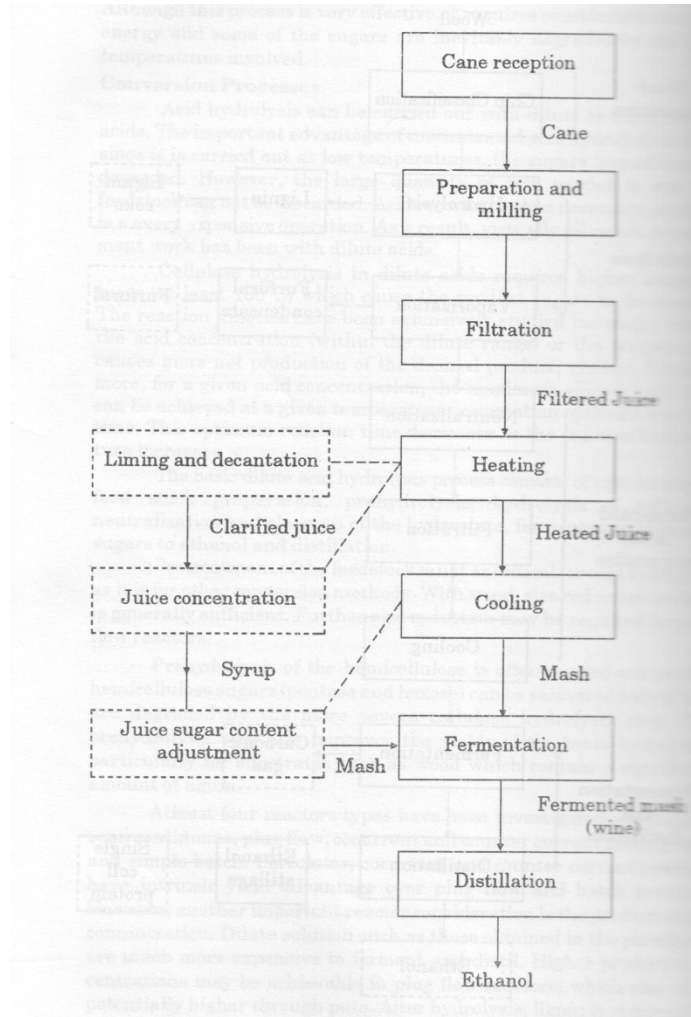
SUMMER- 14 EXAMINATION

Subject Code: 17611

Model Answer

Q.5. c)

i. Production of ethanol from sugarcane



ii. (Four marks)

Detailed Energy Audit Methodology: It is a comprehensive analysis of an energy project and offers the accurate estimate of energy savings and cost. It covers the detailed study of present energy consumption, the use of energy for various processes with calculations of energy efficiency and to evaluate the improvements which can be carried out in its energy use. Detailed audit finally recommends the energy conservation proposals with cost of



SUMMER- 14 EXAMINATION

Subject Code: **17611**

Model Answer

investment needed. It also presents the detailed study of expected savings in energy cost.

The detailed energy audit report consists of the following :

1. Details about plant
2. Description of production processes involved
3. Description of energy and utility system
4. Detailed process flow diagram and energy
5. Calculation of energy efficiency and process systems
6. Recommendations for energy conservation

Q.6. a) (Two marks for list and two for functions)

Instruments used in measurement of solar radiation:

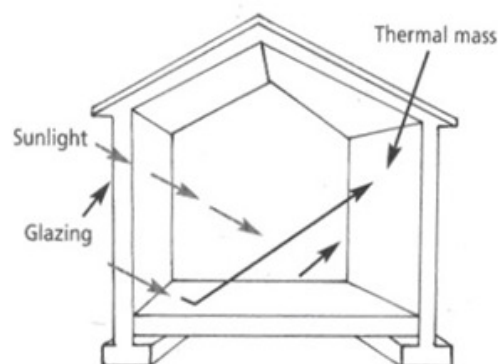
- 1) Lux meter: To measure illumination level
- 2) Pyranometer : To measure global radiations
- 3) Sunshine recorder : To measure the hours of bright sunshine in a day
- 4) Pyrheliometer : To measure beam radiations only

Q.6. b) (Two marks for working and two for sketch)

Solar space heating :

Space heating by passive method.(02 marks for sketch, 02 marks for explanation)

Space heating: A solar space heating can consist of a passive system, an active system or combination of both. Passive systems are typically less costly and less complex than active system. Passive solar space heating takes advantage of warmth from the sun through design features such as large south facing windows and materials in the floors or walls that absorb warmth during the day. A sunspace or greenhouse is a good example of passive system for solar space heating





SUMMER- 14 EXAMINATION

Subject Code: **17611**

Model Answer

Q.6. c) ((Two marks for each))

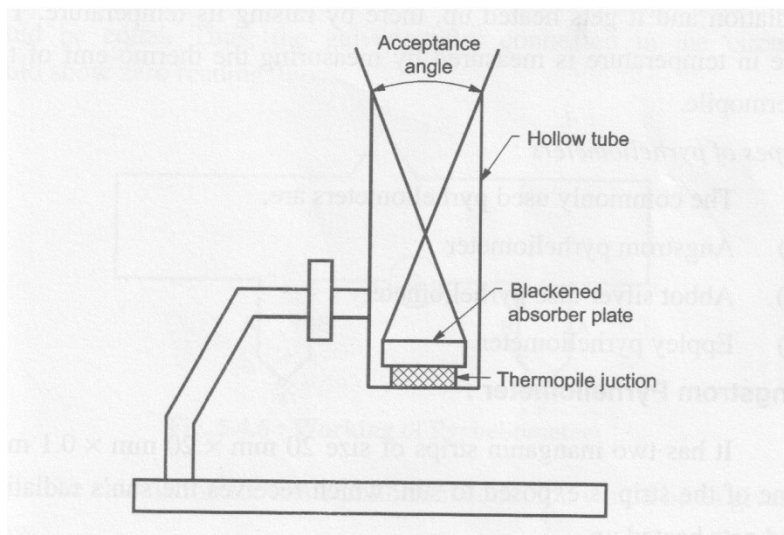
Direct or beam radiation: Sunlight is the total spectrum of electromagnetic radiation given by the Sun. Solar radiation that has not been absorbed or scattered and reaches the ground directly from the Sun is called direct or beam radiation.

Diffuse Solar radiation: It is that solar radiation received from the sun on the earth after its direction has been changed.

Q.6. d) (Two marks for explanation and two for sketch)

Pyrheliometer: It measures the beam radiations only coming from the Sun. The hollow receiver tube can be tilted about an axis perpendicular to its length. Thus the tube can be made to face the sun, thereby receiving only the beam radiation. No diffuse radiation can enter the tube.

When the radiation falls on the absorber plate, it absorbs the radiation and it gets heated up, thereby raising its temperature. The rise in temperature is measured by measuring the thermo emf of the thermopile.



SUMMER- 14 EXAMINATION

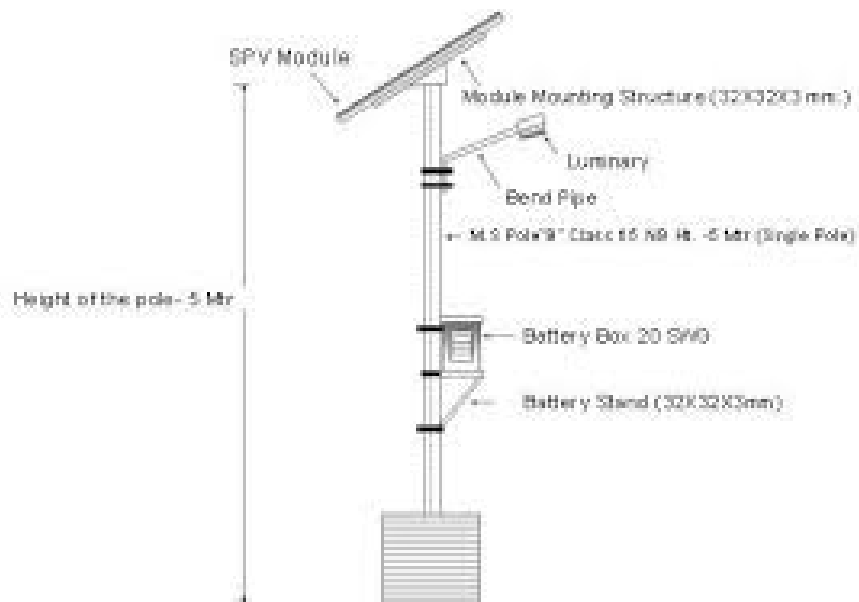
Subject Code: **17611**

Model Answer

Q.6. e) (One marks for each)

- i. Detection of gas leakage : Halide lamp, leak detection torch, soap bubble
- ii. Wind velocity : Pitot Tube
- iii. Calorific value : Bomb calorimeter, Boys gas calorimeter
- iv. Intensity of Solar radiation : Pyrometer, Pyronometer, Pyrheliometer

Q.6. f) (Three marks for description and one for sketch)



SPV Solar Street light: Solar cells are often electrically connected and encapsulated as a module. SPV modules have a sheet or glass on the front side allowing light to pass while protecting semiconductor wafers from the rain hail etc. Modules are then connected in series or parallel both to create an array. The power output of the array is measured in Watts.