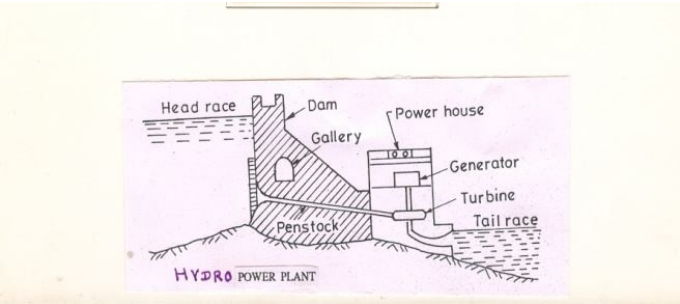
WINTER – 12 EXAMINATION

Subject Code : **12244** **Model Answers**

Q.No	Model Answer	Marks allotted
Q1A) a)	Following are the major sources of energy Thermal energy, Hydro energy, Solar energy, Wind energy, Tidal energy, Nuclear energy , Geo thermal energy, Biomass energy etc. Wind Energy – Wind is the movement of air that occurs when warm air rises and cooler air rushes in to replace it. Wind energy has been used from centuries to sail ships and drive windmills that grind grains. Now a day, wind energy is captured by wind turbines and used to generate electricity.	01 03
Q1A) b)	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. 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.	04
Q1A) c)	**Following are the advantages of Wind Energy (any four)** 1.It generates no pollution 2.It is friendly to the surrounding environment, as no fossil fuels are burnt to generate electricity. 3.It is quiet and does not present any significant hazard to birds or other wildlife. 4. Wind turbines take less space than the average power station. 5. It is free and ample in quantity. 6. Wind turbines are a great resource to generate energy in remote locations, such as mountain.	01 mark for each
Q1A) d)	Properties: (Any two) 1) Can be blended in any ratio with petrol and diesel 2) Existing storage facilities can be used	02

	3) Superior to petrol and diesel from emission point 4) Can provide energy security to remote and rural areas Applications : 1) It can be used in pure form or blended 2) It can be used in Vehicles 3) It can be used in Railways 4) It can be used in Aircraft 5) Use as a heating oil in domestic and commercial boilers	02
Q1B) a)	Energy Management ..... Now a day, with rising fuel costs and the opening of electricity and gas markets to alternative suppliers and climate change, the need to monitor and reduce energy consumption is receiving greater attention. Energy Management is defined as "The judicious use of energy to maximize profits and enhance competitive positions" Therefore any management activity that affects the use of energy falls under energy management. The objectives of energy management are 1) Conserving energy thereby reducing cost 2) Cultivating good communications 3) Developing and maintaining effective monitoring 4) Finding new ways to increase returns from energy 5) Developing interest in energy management programmes.	06
Q1B) b)	Countries constitutes about 40-50% of the total commercial energy consumption. This energy is produced from imported oil , the price of which has increased tremendously. So developing countries spend more than 50% of their foreign exchange earnings on oil imports.	03
	To achieve economic growth, to improve quality of life of people, the expansion of industrial base is necessary which require additional energy inputs. Thus, energy management is one of the most promising profit improvements, cost reduction	03

	program. Energy cost savings of 5-15% are usually obtained quickly without any capital expenditure, when aggressive energy management program is launched.	
Q 2 a)	Construction and working of Hydal power plant :  Working of hydel power plant: Figure shows the construction of hydel plant. It consists of head race, penstock, turbine, electric generator and a power house. When the water flows through the head race to tail race, kinetic energy gets converted into mechanical energy and finally to the electrical energy	02 02
Q 2 b)	Applications of solar energy.(any four applications 4 marks) solar energy applications are categorized as i) Direct thermal applications ii)solar electric applications 1 Direct thermal applications:- a. solar Water heating b. solar Heating, cooling and ventilation c. solar space heating d. solar refrigeration e. solar distillation system f. solar cooker	01 mark for each

g. solar furnace
h. solar drying

2 solar electric applications

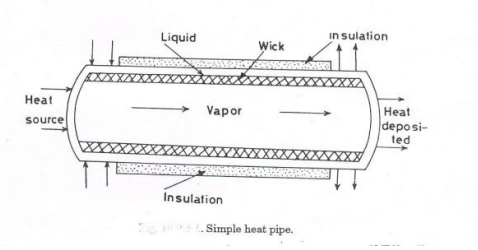
a Solar photovoltaic conversion
b Solar thermal electric conversion

Q 2 c) 02

Heat pipe :

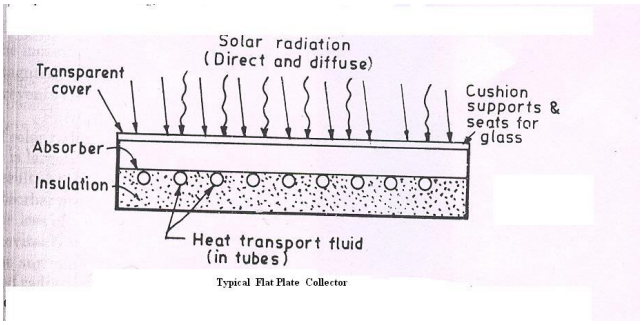
Heat pipe is tube containing vapour with the condensate recycled by a wick and offers an effective conductivity much greater than that of copper. Usually heat pipe is a means for transporting heat efficiently from a source to a cooler receiver by utilizing the latent heat of vaporization of a liquid. A heat pipe is a closed space containing a suitable working liquid and its vapor. One part of the space is in contact with the heat source and with the cooler material to which the heat is to be transported. The interior wall of the space is lined with a porous material called a wick.

In the hotter part of the heat pipe, the working fluid is vaporized thereby taking up the latent heat of vapourisation. The vapour diffused towards the cooler region because the pressure is lower there & condensed to liquid. In doing so it deposits the heat of vaporization taken up from the source. The liquid is returned to the heat source region by capillary action of the wick. There is thus a continuous movement of vapour from the heat source to the receiver and of condensed liquid back to the source, accompanied by the transfer of heat. 02



. Simple heat pipe.

Q 2 d) **Flat plate collector** It basically consists of a flat surface with high absorptivity for solar radiation called the absorbing surface. Typically, a metal plate usually of copper, steel or Aluminum material with tubing of copper in thermal contact with the plates. The absorber plate is usually made from a metal sheet 1 to 2 mm in 02

	thickness while the tubes which are also of metal ranges in dia. From 1 to 1.5 cm. They are soldered, brazed or clamped with the bottom of the absorber plate with the pitch ranging from 5 to 15 cm. Heat is transferred from the absorber plate to a point of use by circulation of fluid across the solar heated surface. Thermal insulation of 5 to 10 cm thickness is usually placed behind the absorber plate to prevent the heat losses from the rear surface. Insulation material is generally mineral wool or glass wool. The front covers are generally glass i.e. transparent to incoming solar radiation and opaque to the infrared re radiation from the absorber.  Typical Flat Plate Collector	02
Q 2 e)	Principles of energy conservation (Any four) • Energy conservation is the practice of reducing the quantity of energy used. • It may be achieved through efficient energy use . • The two principles which govern energy conservations policies are Maximum thermodynamic efficiency and Maximum cost effectiveness in energy use. • Maximum thermodynamic efficiency in energy use is defined as o maximum work = (Energy input)-(Energy loss in transfer)-(Energy discharge) • The first and second law of thermodynamics measure the efficiency of energy use & allocation of available production factors determine cost effectiveness of energy conservation.	01 mark for each

Q 2 f)	**Co generation** Co-generation is procedure for generating electric power and useful heat in a single installation. The useful heat may be in the form of steam, hot water, or hot air. In the cogeneration system, a mechanical work is converted into electrical energy in an electric generator and the discharged heat, which would otherwise be dispersed to the environment, is utilized in an industrial process or in other ways. The net result is an overall increase in the efficiency of fuel utilization.	02
	Applications:- 1. Sugar industries 2. Distilleries 3. Petrochemical sector 4. Other industries such as fertilizers, steel, cement pulp and paper etc.	02
Q 3 a)	Parameters of site selection of wind mill: (Any four) 1) Availability of higher constant wind speed 2) Availability of wind at site through year 3) Altitude of the site 4) Availability of land 5) Connectivity to grid 6) Connectivity to the road 7) Easy access to locality/infrastructure 8) Ecology 9) Ground condition	01 mark for each
Q 3 b)	i) Solar 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 radiation is that solar radiation received from the sun after its direction has been changed	
	ii) Solar constant: The rate at which soar energy arrives at the top of the atmosphere is called the solar constant Isc. This is the amount of energy received in unit area perpendicular to the suns direction at the mean distance of the earth from the sun. The solar constant includes all types of solar radiation not just the visible light.	02
		02

Q 3 c) Comparison of biomass with conventional fuels (Any four) — 01 mark for each

sr. No	Biomass	Conventional fuel
01	It is available in abundant quantity	Petroleum products are available at selected sites
02	It can be converted into several forms of energy	It can be converted only few types of marketable fuels
03	It is cheap compared to other energy sources	Petroleum products are costly fuels
04	Unused agricultural land can be used	Its exploration is costly
05	It is produced on a renewable basis	It leads to emission of carbon dioxide
06	It is very low in sulphur	It contains sulphur

Q 3 d) 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. — 04

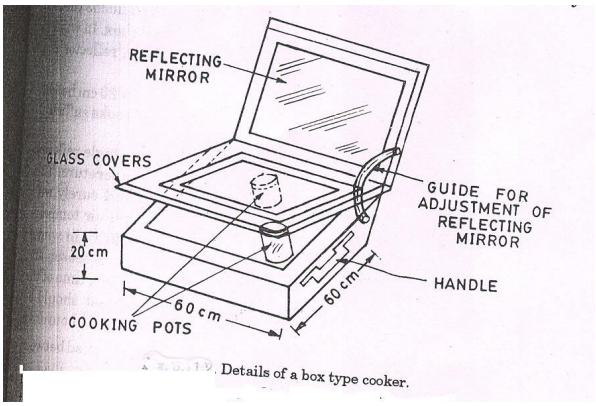
Electricity can be produced by solar cells whose principle component consists of a semiconductor that is typically made of silicon. Solar cells are often electrically connected and encapsulated as a module often has a sheet of glass. To make practical use of solar generated energy the electricity is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

Q 3 e) Types of energy audit: The types of Energy Audit are classified as — 02

1) Preliminary Audit
2) Detailed Audit

Preliminary Audit: It is quick exercise to establish energy consumption in the organization. It estimates the scope for saving. It identifies the most likely areas for attention and immediate saving in energy. It also sets a reference point and identifies areas for more detailed study of energy. — 02

Q 3 f)	Benefits of reuse: i) Energy and raw materials savings. ii) Reduced disposal needs and costs iii) Refurbishment can bring sophistication iv) Cost saving for business and consumers v) Some older items were better handcrafted and appreciate in value	02
	Benefits of recycle: i) Prevents the waste of potentially useful materials ii) Reduces the consumption of fresh raw materials iii) Reduce energy usage iv) Reduces air pollution and water pollution v) Lower greenhouse gas emission	02
Q 4 A)a)	i) Altitude angle(α): It is a 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.) ii) Incident angle (θ) : it is the angle being measured between the beam of rays and normal to the plane iii) Zenith angle (θz): It is complementary angle of suns altitude angle. It is a vertical angle between the sun's rays and a line perpendicular to the horizontal projection of the sun's rays. iv) Azimuth angle (□) : 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.	01 mark for each
Q 4 b)	Solar cooker (Box Type): Figure shows the box type solar cooker. The solar rays penetrate through the glass covers and absorbed by a blackened metal tray kept inside the solar box. Two glass covers are provided to again minimize the heat loss. The loss due to convection is minimized by making the box air tight by providing a rubber strip all rounds between the upper lid and the box. When the cooker is placed in the sun, the blackened surface starts absorbing sun rays and temperature inside the box starts rising. The blackened cooking pots	02

	get heat energy and food will be cooked in a period of time.  Details of a box type cooker.	\ 02
Q 4 c)	Advantages of alternative energy sources in India with current context: • The technical potential for the use of alternative energy; sources is very large exceeding all other readily available sources. • India is blessed with a variety of renewable energy sources, the main ones being biomass, biogas, the sun, wind and small hydro power. • Municipal and industrial wastes can also be useful sources of energy, but are basically different forms of biomass. Biogas plants, improved wood stoves, solar water heaters solar cookers, solar lanterns can be used at large.	04
Q 4 d)	Limitations of wind energy (Any four) i) Wind energy is available in dilute and fluctuating in nature. ii) Unlike water energy, wind energy needs storage capacity because of its irregularity. iii) Wind energy systems are noisy in operation: a large unit can be heard many kilometers away iv) Wind power systems have a relatively high overall weight because they involve the construction of high tower v) Large areas are needed, vi) Systems are neither maintenance free not practically reliable.	01 mark for each

Q 4B) a)	Biodiesel Transesterification: Biodiesel is an alternative diesel fuel. Vegetable oil is too thick to flow through modern diesel engines without causing damage, so we can lower its viscosity through a process called Transesterification. Transesterification is the chemical process which replaces one type of alcohol for another in an ester. An ester is made by combining an alcohol with an acid. Vegetable oil is an ester of glycerol with long chain fatty acids. The formula for vegetable oil is C3H5(RCOOH)3, with the fatty acids represented by RCOOH attached to a glycerol (C3H5(OH)3) molecule. Examples of fatty acids are Stearic acid, Palmitic acid, Linoelic acid, and Oleic acid. Methanol (CH3OH) is used to replace glycerol (C3H5(OH)3). A strong alkali is used as a catalyst to break apart the fatty acids from the glycerol. In commercial production we typically see Sodium Methylate (CH3NaO) dissolved in methanol used as the catalyst. The chemical formula for biodiesel transesterification is: C3H5(RCOOH)3 + 3CH3OH <-> 3RCOCH3O + C3H5(OH)3 The biodiesel transesterification process is slightly reversible making it difficult to get 100% conversion. To push the reaction to it most complete status we use LeChtelier's Principle and offset the reactants to drive the reaction in a more favorable direction.	06
Q 4 B)b)	Horizontal axis wind mill. In this wind mill rotor drives a generator through a step up gearbox. The components are mounded on a bed plate which is mounted on a pintle at the top of the tower. The arrangement is shown in the figure. The rotor blades are continuously flexed by unsteady aerodynamic, gravitational and inertial loads. The tower is subjected to unsteady load and dynamic interactions between the components of the machine tower system can cause serious damage.	03

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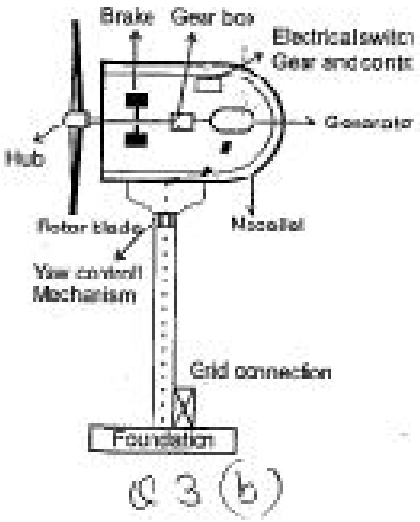


Q 3 (b)

03

Q 5 a) Differences of Horizontal axis wind mill and Vertical axis wind mill (Any four)

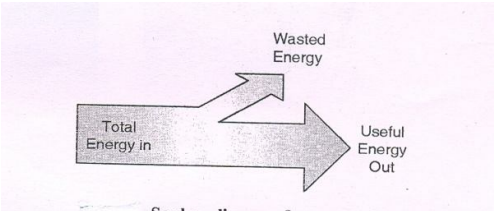
01 mark for each

sr. No	Horizontal axis wind mill	Vertical axis wind mill
01	Optimum angle of attack is available	Have additional drag due to blades rotate into wind
02	The tall tower base allows access to stronger wind in sites	Do not have advantage of the stronger wind at higher elevation
03	Horizontal axis wind mill have difficulty operating in near ground due to tall structure	Can be located nearer the ground
04	Horizontal axis wind mill require an additional yaw control mechanism	Do not need to turn to face the wind
05	Proper foundation is required	No massive tower structure
06	Need high starting speed	Lower start up speeds

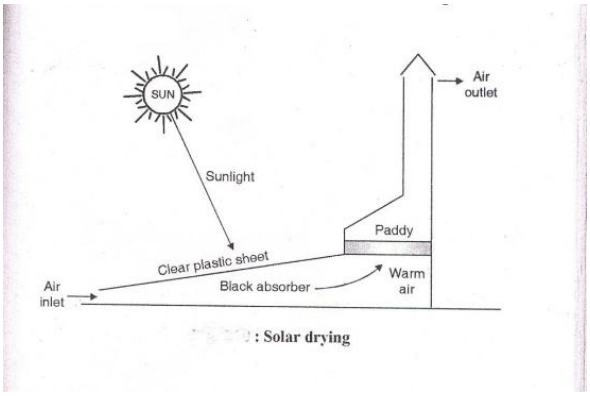
Q 5 b) Different methods for obtaining biomass

1. Briquetting or pelleting of solid biomass
2. Thermo chemical processes
   - Combustion
   - Pyrolysis

	Gasification 3. Bio chemical processes Anaerobic digestion Trans-esterification	04
Q 5 c)	Purpose of insulation • For reducing overall energy consumption • Offers better process control by maintaining process temperature • Prevents condensation on cold surfaces and hence prevention from corrosion • Provides fire protection to equipments • Absorbs vibrations	02 02
	The thickness of insulation at which the heat loss begins to decrease is described as critical thickness	
Q 5 d)	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	02
	Space cooling: A Vapour refrigeration system uses the principle of space cooling. The common refrigerant mixtures used in absorption chillers are water lithium bromide and ammonia. Systems use a low temperature liquid refrigerant that absorbs the heat from the water to be cooled and converts to a vapor. This is used for space cooling	02
Q 5 e)	Different ways for improving boiler efficiencies (Any four) • Reducing excess air • Installing economizer • Reducing scale and deposits • Reducing blow down • Recovering waste heat from blow down	01 mark for each

	• Stopping dynamic operation • Reducing boiler pressure • Operating at peak efficiency • Preheating combustion air • Switching from steam to air atomization • Switching to lower cost fuel etc. (any four 4 marks)	
Q 5 f)	Sankey diagrams: **Sankey diagrams** are a specific type of flow diagram in which the width of the arrows is shown proportionally to the flow quantity. They are typically used to visualize energy or material cost transfers between processes. They are also commonly used to visualize the energy accounts or material flow accounts on a regional or national level. Sankey diagrams put a visual emphasis on the major transfers or flows within a system. They are helpful in locating dominant contributions to an overall flow. Often, Sankey diagrams show conserved quantities within defined system boundaries, typically energy or mass, but they can also be used to show flows of non-conserved quantities such as exergy . Sankey Diagrams drop their arrows when energy is being used.	02
	 Sankey diagram for energy flow	02
Q 6 a)	Energy management cell Every industry; should have a dedicated energy management cell. It should provide necessary structure and formalize the process of energy conservation. The cell should interact with manufacturing and other divisions like production engineering maintenance utilities and even finance. The cell should carry out the activities like planned internal and external energy audits, conceptualization and implementation of projects. The cell will be the focal point for effective energy management in the plant Energy management is a Mission with a Target. It needs coordinated effort by	04

	team of energy conscious people with a milestone to be established.	
Q 6 b)	Techniques of Energy conservation in fans (Any four) Following are the techniques of energy conservation in fans 1) Minimizing excess air level in combustion systems to reduce FD fan and ID fan load. 2) Minimizing air in leaks in hot flue gas path to reduce ID fan load. 3) In-leaks and out-leaks in air conditioning systems also have a major impact on energy efficiency and fan power consumption and need to be minimized. 4) Change in impeller by a high efficiency impeller along with cone. 5) Change of fan assembly as a whole, by a higher efficiency fan 6) Impeller derating 7) Fan speed reduction by pulley dia modifications for derating 8) Option of two speed motors or variable speed drives for variable duty conditions.	01 mark for each
Q 6 c)	Payback and return on investment (ROI) The payback period, in business and economics refers to the period of time required for the return on an investment to repay the sum of the original investment. It initially measures how long something takes to pay for itself shorter payback periods are obviously preferable to longer payback periods. Return on investment: It is a rate of profit or sometimes just return is the ratio of money gained or lost (realized or unrealized) on an investment relative to the amount of money invested. The amount of money gained or lost may be referred to as interest, profit/loss, and gain/loss. Or net income/loss. ROI is usually expressed as a percentage rather than decimal value.	02 02
Q 6 d)	Energy education: It is very important tool in energy management. Cost of energy I having important share in total production cost. Hence saving energy will be directly addition into profit. Energy education and training is important for awareness which can be imparted from school levels to college levels. Facts of energy availability its wastage and importance of conservation will help to change mindset of people. It can be given through workshops and printed books along with audiovisual aids.	04

Q 6 e)	Solar drying for foods in agriculture. Removing moisture from dissolved solids, paper, hanks of yarn fresh cut lumber can be done various thermal methods for which solar thermal energy can be used between 30 to 80 deg. Celsius. Figure shows one of such solar drying system. As it is simple and no storage needed. Production of coffee, tea maize and tobacco drying are carried out by solar drying  : Solar drying	02 02

Q 6 f) Differences between renewable and non renewable energy sources (Any four) — 01 mark for each

Sr. No	Non Renewable sources	Renewable sources
01	These sources are used for mass generation of power	These sources are used for power in less magnitude
02	These sources generate pollution	These sources will not generates pollution
03	Initial investment cost is more	Initial investment cost is more but sources are free of cost
04	Use of conventional fuels like coal, petrol, diesel, nuclear etc	No fuel is used
05	More frequently used all over the world	Becoming famous now a days
06	These sources may be finished in coming years	These sources available in huge quantities
07	Example : Thermal, nuclear, diesel etc	Example : Solar, Wind tidal,hydro etc