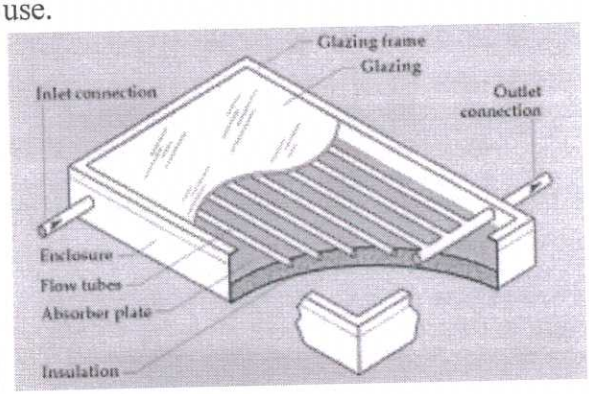
SCHEME OF EVALUATION

(Scoring Indicators)

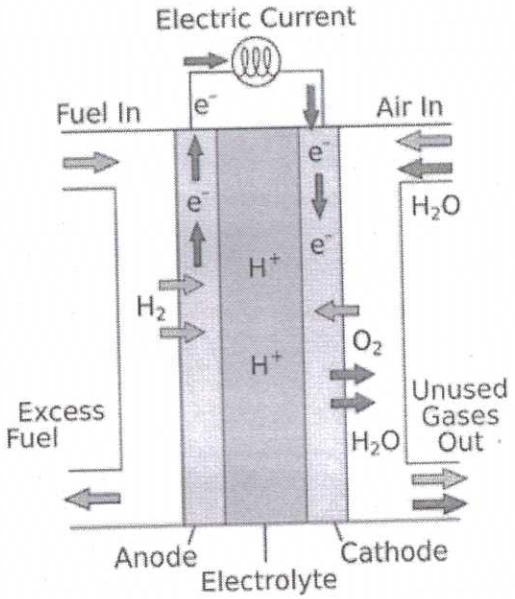
Revision: 2015 Course code: 5024 Course Title: Alternative Energy Sources And Management				
Qn No.	Scoring indicator	Split up score	Sub Total	Total
	PART-A			
1	Renewable resources are replenished naturally and over relatively short periods of time.	2	2	
2	It is the angle between a ray incident on a surface and the line perpendicular to the surface at the point of incidence.	2	2	
3	Maximum percentage of kinetic energy a wind turbine can convert into mechanical energy is 59.3%. This is called power coefficient.	2	2	10
4	It is the process of converting solid biomass fuel into a gaseous combustible gas through a sequence of thermo-chemical reactions.	2	2	
5	It is the source of energy contained in hot fluids found naturally in basement rock.	2	2	
	PART-B			
II(1).	Alternative energy is any energy source that is an alternative to fossil fuel. These alternatives are intended to address concerns about fossil fuels, such as its high carbon dioxide emissions, an important factor in global warming. Marine energy, hydroelectric, wind, geothermal and solar power are all alternative sources of energy. There is a current global need for clean and renewable energy sources. Fossil fuels are non-renewable and require finite resources, which are dwindling because of high cost and environmentally damaging retrieval techniques. So, the need for cheap and obtainable resources is greatly needed. An	6	6	

	efficient and more feasible alternative option is solar energy.			
II(2).	Walk-through (or) preliminary audit The preliminary audit (alternatively called a simple audit, screening audit or walk-through audit) is the simplest and quickest type of audit. It involves minimal interviews with site-operating personnel, a brief review of facility utility bills and other operating data, and a walk-through of the facility to become familiar with the building operation and to identify any glaring areas of energy waste or inefficiency. General audit or Comprehensive Energy audit The general audit expands on the preliminary audit described above by collecting more detailed information about facility operation and by performing a more detailed evaluation of energy conservation measures. Utility bills are collected for a 12- to 36-month period to allow the auditor to evaluate the facility's energy demand rate structures and energy usage profiles. Investment-grade audit The investment-grade audit expands on the detailed audit described above and relies on a complete engineering study in order to detail technical and economical issues necessary to justify the investment related to the transformations.	2 2 2	6	
II(3)	The conversion of solar radiation into heat energy takes place inside the absorber of solar panels. The absorption of "short wave" radiation results in an emission of "long wave" heat radiation (infra-red radiation). To estimate the size, the efficiency and the cost of equipment necessary to transfer a specified amount of heat in a given time, a heat transfer analysis must be made. The dimensions of a solar collector, a heat exchanger or a refrigerator depend not so much on the amount of heat to be transmitted but rather on the rate at which heat is to be transferred under given external conditions. From an engineering view point, the	6	6	

	determination of the rate of heat transfer at a specified temperature difference is the key problem in sizing a solar collector to provide a given temperature in a home or building.			
II(4)	The flat-plate solar collectors are probably the most fundamental and most studied technology for solar-powered domestic hot water systems. The overall idea behind this technology is pretty simple. The Sun heats a dark flat surface, which collects as much energy as possible, and then the energy is transferred to water, air, or other fluid for further use.  	6	6	30
II(5)	• Wind Energy is an inexhaustible source of energy and is virtually a limitless • Energy is generated without polluting environment. • This source of energy has tremendous potential to generate energy on large scale. • Renewable & Sustainable • Cost Effective • Industrial and Domestic Installation • Job Creation (Any 6)	6x1=6	6	
II(6)	Combustion The most obvious way of extracting energy from biomass, the technology of direct combustion is well understood, straightforward and commercially available. Combustion systems come in a wide range of shapes and sizes burning virtually any kind of fuel, from chicken manure and straw bales to tree trunks, municipal refuse and scrap tyres. Some of the ways in which heat from burning wastes is currently used include space and water heating, industrial processing and electricity generation. One problem with this method is its			

	very low efficiency. With an open fire most of the heat is wasted and is not used to cook or whatever. One method of improving this in developing countries is to build stoves out of mud and scrap iron. Pyrolysis A wide range of energy-rich fuels can be produced by roasting dry woody matter like straw and woodchips. The process has been used for centuries to produce charcoal. The material is pulverised or shredded then fed into a reactor vessel and heated in the absence of air. Pyrolysis can also be carried out in the presence of a small quantity of oxygen ('gasification'), water ('steam gasification') or hydrogen ('hydrogenation'). One of the most useful products is methane, which is a suilable fuel for electricity generation using high-efficiency gas turbines. Anaerobic Digestion Biogas is produced when wet sewage sludge, animal dung or green plants are allowed to decompose in a sealed tank under anaerobic (oxygen-free) conditions. Feedstocks like wood shavings, straw and refuse may be used, but digestion takes much longer. Each kilogram of organic material (dry weight) can be expected to yield 450-500 litres of biogas. Gasification This process, usually using wood produces a flammable gas mixture of hydrogen, carbon monoxide, methane and other non flammable by products. This is done by partially burning and partially heating the biomass (using the heat from the limited burning) in the presence of charcoal (a natural by-product of burning biomass). The gas can be used instead of petrol and reduces the power output of the car by 40%. It is also possible that in the future this fuel could be a major source of energy for power stations. Fermentation If the biomass used is (or can be converted into) mostly sugar, then yeast can be added. The fermentation that follows produces alcohol which is a very high energy fuel that makes it very practicle for use in cars.	6	6	
II(7)	A fuel cell is a device that converts chemical potential energy (energy stored in molecular bonds) into electrical energy. A			

PEM (Proton Exchange Membrane) cell uses hydrogen gas (H_2) and oxygen gas (O_2) as fuel. The products of the reaction in the cell are water, electricity, and heat. Since O_2 is readily available in the atmosphere, we only need to supply the fuel cell with H_2 which can come from an electrolysis process.



The anode, the negative post of the fuel cell, has several jobs. It conducts the electrons that are freed from the hydrogen molecules so that they can be used in an external circuit. It has channels etched into it that disperse the hydrogen gas equally over the surface of the catalyst.

The cathode, the positive post of the fuel cell, has channels etched into it that distribute the oxygen to the surface of the catalyst. It also conducts the electrons back from the external circuit to the catalyst, where they can recombine with the hydrogen ions and oxygen to form water.

The electrolyte is the proton exchange membrane. This specially treated material, which looks something like ordinary kitchen plastic wrap, only conducts positively charged ions. The membrane blocks electrons. For a PEMFC, the membrane must be hydrated in order to function and remain stable.

6 (3+3)

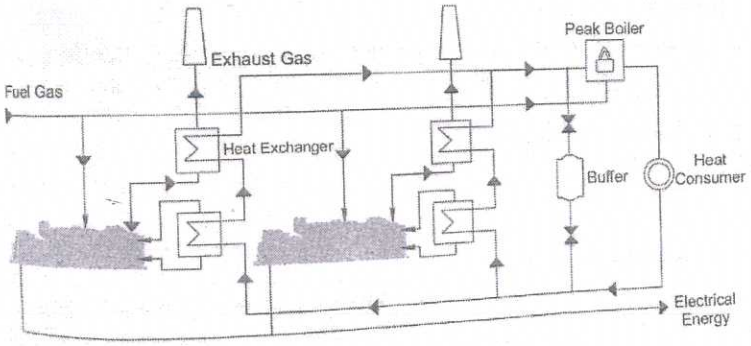
6

PART-C

III(a) Cogeneration, also known as combined heat and power (CHP), is the production of electricity and heat from a single fuel source.
Powered by a gas turbine, a cogeneration system is a highly efficient way of capturing heat which would otherwise be lost during the production of electricity and converting it into useful thermal energy.

A cogeneration system is both flexible and reliable and, because of its efficient use of energy, industrial-scale cogeneration/CHP is more economical and environmentally attractive than conventional fossil fuel power plants.

9 (5+4) (fig) | 9 | 15



f electricity and heat, both of which are used.

III(b) Primary sources can be used directly, as they appear in the natural environment: coal, oil, natural gas and wood, nuclear fuels (uranium), the sun, the wind, tides, mountain lakes, the rivers (from which hydroelectric energy can be obtained) and the Earth heat that supplies geothermal energy.

Secondary sources derive from the transformation of primary energy sources: for example petrol that derives from the treatment of crude oil and electric energy obtained from the conversion of mechanical energy (hydroelectric plants), chemical plants, or nuclear (nuclear plants). Electric energy is produced by electric plants, i.e. suitable installations that can transform primary energy into electric energy.

6 | 6

IV(a)

Energy management includes planning and operation of energy production and energy consumption units. Objectives are resource conservation, climate protection and cost savings, while the users have permanent access to the energy they need. It is connected closely to environmental management, production management, logistics and other established business functions.

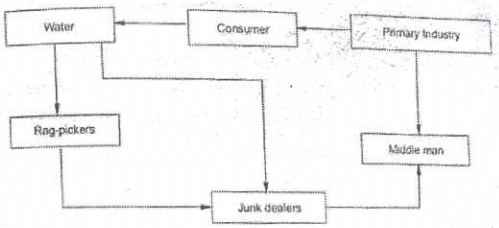
The some of the energy management techniques are :

- Analysis of input
- Reuse and recycling of waste
- Energy education
- Conservative technique and energy audit

It is important to understand what is the type of inputs that can consuming the energy and analysis how it is effecting the environment, cost etc, thereby proper management of energy is very crucial.

Recycling involves the collection of used and discarded materials processing these materials and making them into new products. It reduces the amount of waste that is thrown into the community dustbins thereby making the environment cleaner and the air more fresh to breathe.

Most of the garbage generated in the household can be recycled and reused. Organic kitchen waste such as leftover foodstuff, vegetable peels, and spoilt or dried fruits and vegetables can be recycled by putting them in the compost pits that have been dug in the garden.



RECYCLING OF WASTES

Source : CPCB Report on Management of Muncipal Solid Waste

Waste recycling has some significant advantages. It

- leads to less utilization of raw materials.
- reduces environmental impacts arising from waste treatment and disposal.
- makes the surroundings cleaner and healthier.
- saves on landfill space.
- saves money.
- reduces the amount of energy required to manufacture new products.

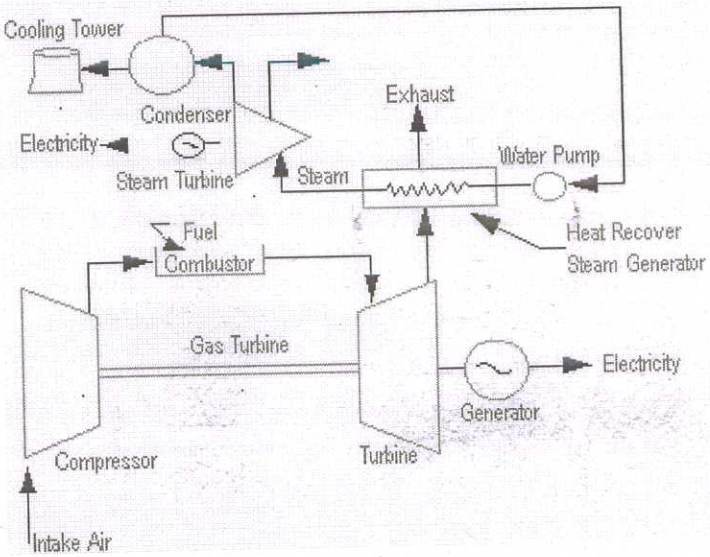
In fact recycling can prevent the creation of waste at the source.

Energy education is the most important for the energy management techniques that can be used. Education is about more than teaching people the importance of managing the energy by its proper conservation, and exploring the alternative choices that can be used in various fields.

An energy audit is an inspection, survey and analysis of energy flows, for energy conservation in a building, process or system to reduce the amount of energy input into the system without negatively affecting the output(s). In commercial and industrial real estate, an energy audit is the first step in identifying opportunities to reduce energy expense and carbon footprints.

8 | 8 | 15

IV(b)



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Similar to a simple cycle gas turbine plant, the combined cycle gas turbine involves air inlet as the first stage. The air passes through a sizeable section where it undergoes cleaning and cooling depending on the control conditions. The aim of this process is to ensure that inlet air is safe for the turbine compressor. It is worth noting that air has several impurities that may damage the compressor and other turbine components. These impurities are generally categorized as solid state, liquid state and gaseous state contaminants. After purification, the air undergoes compression, combines with natural gas and then ignites. The ensuing expansion creates pressure that spins the turbine blades. At this point, the generator spins and produces power.

V(a)

There are two types of solar power plants. They are differentiated depending on how the energy from the sun is converted into electricity - either via photovoltaic or "solar cells," or via solar thermal power plants.

Photovoltaic plants

A photovoltaic cell, commonly called a solar cell or PV, is a technology used to convert solar energy directly into electricity. A photovoltaic cell is usually made from silicon alloys.

Particles of solar energy, known as photons, strike the surface of a photovoltaic cell between two semiconductors.

These semiconductors exhibit a property known as the photoelectric effect, which causes them to absorb the photons

and release electrons. The electrons are captured in the form of an electric current - in other words, electricity.

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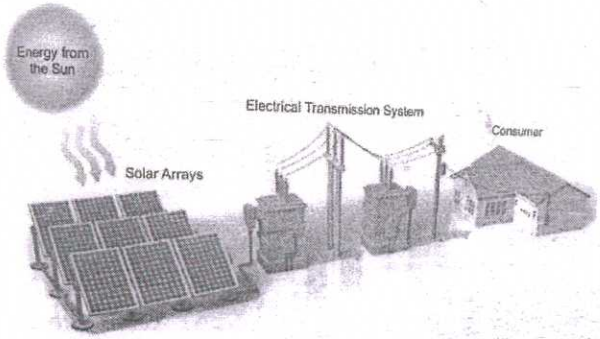
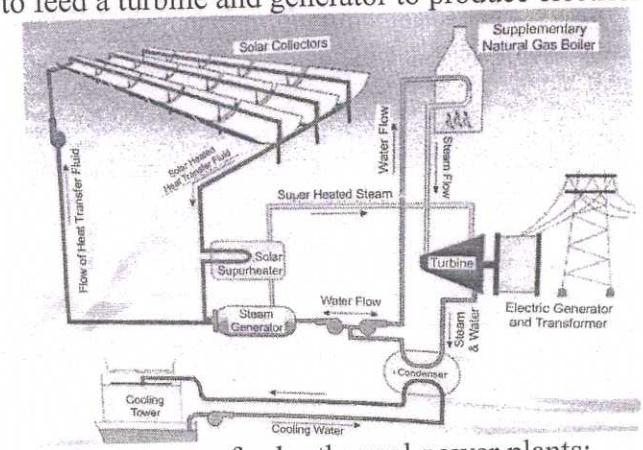
Theory 5
Proj - 4



Solar thermal power plants

A solar thermal plant generates heat and electricity by concentrating the sun's energy. That in turn builds steam that helps to feed a turbine and generator to produce electricity.



There are three types of solar thermal power plants:

1) Parabolic troughs

This is the most common type of solar thermal plant. A "solar field" usually contains many parallel rows of solar parabolic trough collectors. They use parabola-shaped reflectors to focus the sun at 30 to 100 times its normal intensity.

The method is used to heat a special type of fluid, which is then collected at a central location to generate high-pressure, superheated steam.

2) Solar power tower

This system uses hundreds to thousands of flat sun-tracking mirrors called heliostats to reflect and concentrate the sun's energy onto a central receiver tower. The energy can be concentrated as much as 1,500 times that of the energy coming in from the sun.

A test solar power tower exists in Juelich in the western German state of North-Rhine Westphalia. It is spread over

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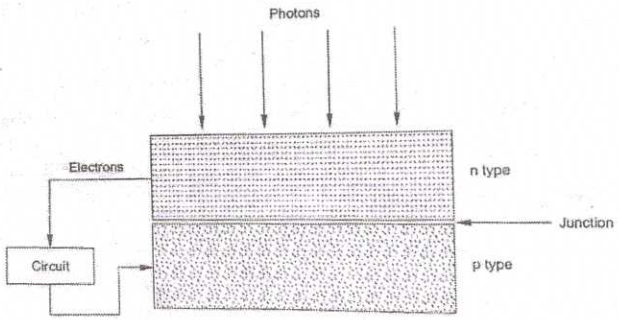
	18,000 square meters (194,000 square feet) and uses more than 2,000 sun-tracking mirrors to reflect and concentrate the sun's energy onto a 60-meter-high (200 foot high) central receiver tower. The concentrated solar energy is used to heat the air in the tower to up to 700 degrees Celsius (1,300 degrees Fahrenheit). The heat is captured in a boiler and is used to produce electricity with the help of a steam turbine. Solar thermal energy collectors work well even in adverse weather conditions. They're used in the Mojave Desert in California and have withstood hailstorms and sandstorms. 3) Solar pond This is a pool of saltwater which collects and stores solar thermal energy. It uses so-called salinity-gradient technology. Basically, the bottom layer of the pond is extremely hot - up to 85 degrees Celsius - and acts as a transparent insulator, permitting sunlight to be trapped from which heat may be withdrawn or stored for later use. This technology has been used in Israel since 1984 to produce electricity. **Explain at least one type of power station with diagram.**			
V(b)	Solar process heating systems are designed to provide large quantities of hot water or space heating for nonresidential buildings. A typical system includes solar collectors that work along with a pump, a heat exchanger, and/or one or more large storage tanks. The two main types of solar collectors used - an evacuated-tube collector and a parabolic-trough collector - can operate at high temperatures with high efficiency. An evacuated-tube collector is a shallow box full of many glass, double-walled tubes and reflectors to heat the fluid inside the tubes. A vacuum between the two walls insulates the inner tube, holding in the heat. Parabolic troughs are long, rectangular, curved (U-shaped) mirrors tilted to focus sunlight on a tube, which runs down the center of the trough. This heats the fluid within the tube. The heat from a solar collector can also be used to cool a building. It may seem impossible to use heat to cool a building, but it makes more sense if we just think of the solar heat as an energy source. Our familiar home air conditioner uses an energy source, electricity, to create cool air. Solar absorption coolers use a similar approach to create cool air from solar energy. Solar energy can also be used with evaporative coolers (also called "swamp coolers") to extend their usefulness to more humid climates, using another	6	6	

VI(a)	chemistry trick called desiccant cooling A solar panel works by allowing photons, or particles of light, to knock electrons free from atoms, generating a flow of electricity. Solar panels actually comprise many, smaller units called photovoltaic cells. (Photovoltaic simply means they convert sunlight into electricity.) Many cells linked together make up a solar panel. Each photovoltaic cell is basically a sandwich made up of two slices of semi-conducting material, usually silicon — the same stuff used in microelectronics. To work, photovoltaic cells need to establish an electric field. Much like a magnetic field, which occurs due to opposite poles, an electric field occurs when opposite charges are separated. To get this field, manufacturers "dope" silicon with other materials, giving each slice of the sandwich a positive or negative electrical charge.  Specifically, they seed phosphorous into the top layer of silicon, which adds extra electrons, with a negative charge, to that layer. Meanwhile, the bottom layer gets a dose of boron, which results in fewer electrons, or a positive charge. This all adds up to an electric field at the junction between the silicon layers. Then, when a photon of sunlight knocks an electron free, the electric field will push that electron out of the silicon junction. A couple of other components of the cell turn these electrons into usable power. Metal conductive plates on the sides of the cell collect the electrons and transfer them to wires. At that point, the electrons can flow like any other source of electricity.	9 (6+1+2)	9	15
VI(b)	• Although solar energy can still be collected during cloudy and rainy days, the efficiency of the solar			

	system drops. • The initial cost of purchasing solar panels is very high. • Solar energy has to be used right away, or it can be stored in large batteries. These batteries, used in off-the-grid solar systems, can be charged during the day so that the energy is used at night. This is a good solution for using solar energy all day long but it is also quite expensive. • The more electricity you want to produce, the more solar panels you will need, as you want to collect as much sunlight as possible. Solar panels require a lot of space • Replacing solar panels is a very difficult job. • Finding quality, local installers and easily comparing quotes can be difficult • Solar isn't ideal if you're about to move (Any 6)	6	6	
VII(a)	**Power generating wind mills or wind turbines :** Electricity is the major source of energy used worldwide for various devices used by us in home or commercially. Since the invention of electricity almost every device used by us requires electricity as the source of energy. The conventional way to generate electricity requires the use of petroleum product or coal which generates heat for the production of energy. This leads to the emission of various toxic gases and waste products causing harm to the environment. Wind turbines are one such power generating machines that use wind energy as the source of energy to generate power. Many such turbines are being used worldwide on a large scale and even individual smaller turbines are also used. The principle is to tap the ever flowing energy of the wind to rotate the propellers that rotates the turbines to generate electricity. This electricity is then stored in the batteries and/or used to run electric devices. These days wind turbines are being used to provide green power to various industries and residential complexes. **Wind powered water pumps :** In many countries and communities the power of wind energy has been used to pump water out of the ground. The process is simple and just used the same wind mill that is used in wind turbine and this time this mill is not used to rotate the turbine but used to move the water pump, in turn forcing the water to pump out of the ground. The use of wind energy to pump water is a great way to help a village or community where a continuous supply of water is needed and the area is devoid of any river to provide water for daily needs as well as for irrigation purposes for farming. **Wind electric generators (WEG) :** Wind electric generators (WEG) Wind electric generator converts kinetic energy available in wind to electrical energy by using rotor, gear box and generator. There are a large number of manufacturers for wind electric generators in India who have foreign collaboration with different manufacturers of Denmark, Germany, Netherlands, Belgium, USA, Austria, Sweden, Spain, and U.K. etc. At present, WEGs of rating ranging from 225 kW to 1000 kW are being installed in our country. **Wind Farm :** A wind farm is a group of wind turbines in the same location used to produce electricity. A large wind farm may consist of several hundred individual wind	10	10	15

turbines and cover an extended area of hundreds of square miles, but the land between the turbines may be used for agricultural or other purposes. A wind farm can also be located offshore.

Many of the largest operational onshore wind farms are located in Germany, China and the United States. For example, the largest wind farm in the world, Gansu Wind Farm in China has a capacity of over 6,000 MW of power in 2012 with a goal of 20,000 MW by 2020. The Muppandal Wind farm in Tamil Nadu, India is the largest onshore wind farm outside of China, with a capacity of 1,500 MW. As of April 2013, the 630 MW London Array in the UK is the largest offshore wind farm in the world, followed by the 504 MW Greater Gabbard wind farm in the UK.

Wind powered vehicles :

Recently it was proved in Australia that wind energy can be used to run vehicles where recently a car was made to run 3100 miles in Australia with the help of kites harnessing the power of wind. When in motion the cars batteries were charged and then this stored power was used to run the car when there was no wind. But it was proved that a car can be run solely on just wind energy. The total cost of running the car to 3100 mile came out to be $15, it's really green and economical.

Wind powered sea ships :

One of the most ancient uses of wind power as seen in history is the use of wind energy to power the motion of sailing ships in the sea. Even today this is one of the most abundant sources of energy, the one that never veins off. This green source of energy once used to power small boats and ships to sail is now recently been used to power a cargo ship too. This was done by attaching a huge kite. By doing so this dramatically reduced the consumption of fuel and also reduced carbon dioxide emission, thus conserving the nature.

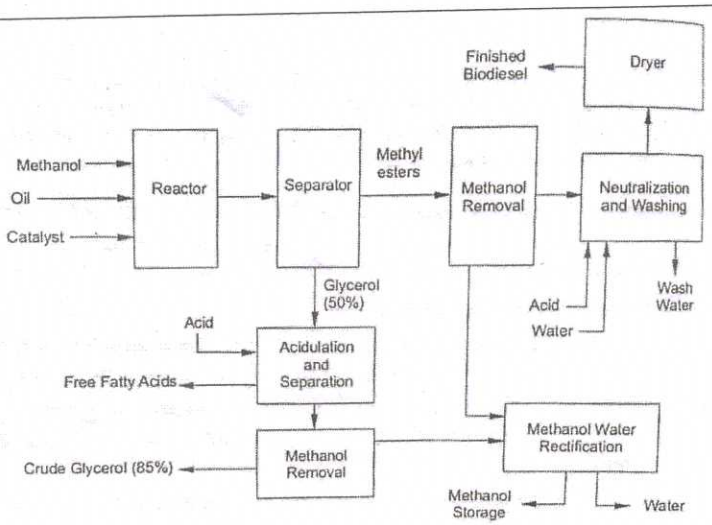
Wind powered sports :

Hundreds of sports have used the power of wind to energize our passion for sports. Adventure lies in speed and there are many sports that use the energy of wind to speed up these sports. Everything from simple kite flying to sailing in the river/sea, kite surfing, para-sailing, wind-skiing and many more are being powered by the energy of wind. Hot air balloon sports also use the power of wind energy to move from one place to another. Being a natural source of energy that is 100% green and leaves no harmful residue the power of wind is a great way to energize the sports.

VII(b) Some of the most common (and/or most promising) biomass feedstocks are : 5 5

- **Grains and starch crops** - sugar cane, corn, wheat, sugar beets, industrial sweet potatoes, etc.
- **Agricultural residues** - Corn stover, wheat straw, rice straw, orchard prunings, etc.
- **Food waste** - waste produce, food processing waste, etc.
- **Forestry materials** - Logging residues, forest thinnings, etc.
- **Animal byproducts** - Tallow, fish oil, manure, etc.
- **Energy crops** - Switchgrass, miscanthus, hybrid poplar, willow, algae, etc.
- **Urban and suburban wastes** - municipal solid wastes (MSW), lawn wastes, wastewater treatment sludge, urban wood wastes, disaster debris, trap grease, yellow grease, waste cooking oil, etc.

VIII(a) Biodiesel production is the process of producing the biofuel, biodiesel, through the chemical reactions transesterification and esterification. This involves vegetable or animal fats and oils being reacted with short-chain alcohols (typically methanol or ethanol). The alcohols used should be of low molecular weight, ethanol being one of the most used for its low cost. However, greater conversions into biodiesel can be reached using methanol. Although the transesterification reaction can be catalyzed by either acids or bases the most common means of production is base-catalyzed transesterification.



Also, brief explanation of different stages in the production process.

- Glycerol separation
- Methanol separation
- Washing the biodiesel
- Handling free fatty acids

10 | 10

Theory - 5
Explanation - 5

VIII(b)

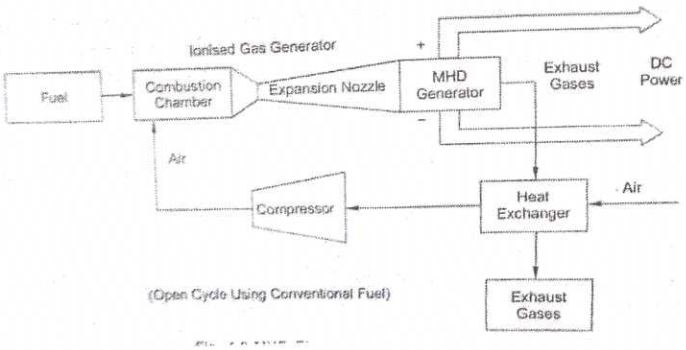
Biomass is vegetable matter. It is something that has been grown recently from the natural plant growth cycle. Materials such as grass, sugarcane, corn, and wood all qualify as being biomass.

Fossil fuels are taken straight from the planet. It is a natural resource that is finite because it has been created through the natural cycle of evolution that is in place on our planet.

In terms of energy production, fossil fuels are generally less costly to produce energy when compared to biomass. Coal, in particular, is very cost effective as it generally runs 20% cheaper than biomass energy. Natural gas is also particularly affordable.

In order for energy to be created, conventional fuels are generally consumed through burning. This creates emissions and pollutants that go into the planet's atmosphere. Coal, as a fossil fuel, is responsible for creating more carbon emissions and miscellaneous atmospheric pollutants than any other fuel

5 | 5 | 15

IX(a)	source. Biomass, in comparison, is often carbon-neutral because it comes from various sources of vegetation. Although burning these items does create pollution, the growth cycle of the plant material helps to absorb and convert these pollutants into the energy and nutrients the planet needs. The carbon dioxide created from burning biomass is then absorbed into the next growth cycle of the crop, so the cycle repeats itself.  A magnetohydrodynamic generator (MHD generator) is a magnetohydrodynamic converter that transforms thermal energy and kinetic energy into electricity. MHD generators are different from traditional electric generators in that they operate at high temperatures without moving parts. MHD was developed because the hot exhaust gas of an MHD generator can heat the boilers of a steam power plant, increasing overall efficiency. MHD was developed as a topping cycle to increase the efficiency of electric generation, especially when burning coal or natural gas. MHD dynamos are the complement of MHD accelerators, which have been applied to pump liquid metals, seawater and plasmas. An MHD generator, like a conventional generator, relies on moving a conductor through a magnetic field to generate electric current. The MHD generator uses hot conductive ionized gas (a plasma) as the moving conductor. The mechanical dynamo, in contrast, uses the motion of mechanical devices to accomplish this. MHD generators are technically practical for fossil fuels, but have been overtaken by other, less expensive technologies, such as combined cycles in which a gas turbine's or molten carbonate fuel cell's exhaust heats steam to power a steam turbine.	Diagram -5 Explanation-5	10	15

IX(b)	Brief explanation of applications of MHD in • Geophysics • Earthquakes • Astrophysics • Sensors • Engineering • Magnetic drug targeting	5	5	
X(a)	Hot dry rock (HDR) is an abundant source of geothermal energy available for use. A vast store of thermal energy is contained within hot - but essentially dry - impervious crystalline basement rocks found almost everywhere deep beneath the earth's surface. Hot Wet Rock (HWR) hydrothermal technology makes use of hot fluids found naturally in basement rock; but such HWR conditions are rare. By far the bulk of the world's geothermal resource base (over 98%) is in the form of basement rock that is hot but dry—with no naturally available water. This means that HDR technology is applicable almost everywhere on earth.	8	8	15
X(b)	1. Efficient conversion to electricity - in comparison to other electrical generating technologies, fuel cells are able to efficiently convert the fuel into electricity because there isn't any form of combustion involved. 2. Extremely reliable - the different parts of the fuel cells are stacked well including the controls, pumps, and fans; unlike generators that are noisy, fuel cells are quieter and more reliable. 3. Does not degrade - fuel cells can provide a continuous source of reliable electricity unlike their battery counterparts. 4. Doesn't require huge facilities or power plants - a great advantage of fuel cells is that it is also suitable for transportation, residential, and portable use; you can expect high efficiency rates regardless of scale. 5. Clean and efficient - fuel cells can be used in both rural and urban areas, providing reliable and robust electricity while enhancing key infrastructures' security including water and communication systems. 6. Flexible and easy installation - it is an economical solution to the increasing demand for a more reliable energy source since it is flexible and easy to install, thereby making the whole process less costly for any user.	7	7	

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