

**DIPLOMA EXAMINATION IN ENGINEERING/TECHNOLOGY  
/MANAGEMENT/COMMERCIAL PRACTICE, NOVEMBER –  
2024**

**CIVIL ENGINEERING  
Renewable Energy Technologies 6022C**

**ANSWER KEY**

**PART-A**

(9x1=9Marks)

1.	Renewable source and Nonrenewable source	.5X2	1
2.	<ul style="list-style-type: none"> <li>• Liquid fuels</li> <li>• Gaseous fuels</li> <li>• Solid fuels</li> </ul>	1	1
3.	<ul style="list-style-type: none"> <li>• Declination</li> <li>• Hour angle</li> <li>• Altitude angle</li> <li>• Incident angle</li> <li>• Zenith angle</li> <li>• Solar azimuth angle</li> </ul>	.5X2	1
4.	<ul style="list-style-type: none"> <li>• Space heating and cooling</li> <li>• Solar distillation</li> <li>• Solar cooking and furnace</li> <li>• Solar pumping</li> <li>• Green house</li> <li>• Agricultural and industrial process heat</li> </ul>	.5X2	1
5.	Gasification is a process by which organic matter is being reacted with heat to form carbon dioxide, carbon monoxide and hydrogen. Less amount of oxygen is utilized in this process. The final product is a gas named syngas (producer gas) which is also a fuel. This can also help in generating electricity and used for various other purposes.	1	1
6.	Axis of rotation parallel to the ground	1	1
7.	<ul style="list-style-type: none"> <li>• Dry steam</li> <li>• Flash steam</li> <li>• Binary cycle</li> </ul>	1	1
8.	Fuel cells are electrochemical devices that convert the chemical energy of a fuel directly into electricity	1	1
9.	Energy education is an important tool to develop various energy technologies, information with new energy resources and various opportunities are available in meeting energy requirements.	1	1

**PART-B**

**(8x3=24Marks)**

1.	<p>The spectrum of solar light at the Earth's surface is mostly spread across the visible and near-infrared ranges with a small part in the near-ultraviolet.</p> <p>Earth reflects about 29% of the incoming solar radiation, and therefore, we say the Earth's average albedo is 0.29.</p> <p>Snow and ice, airborne particles, and certain gases have high albedos and reflect different amounts of sunlight back into space</p>	3	3										
2.	<ul style="list-style-type: none"> <li>• Solar energy</li> <li>• Geothermal energy</li> <li>• Wind energy</li> <li>• Biomass</li> <li>• Hydropower</li> <li>• Marine energy</li> </ul>	3	3										
3.	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;"><b>Advantages</b></th> <th><b>Disadvantages</b></th> </tr> </thead> <tbody> <tr> <td>lower energy costs</td> <td>high upfront costs, Can be expensive to build</td> </tr> <tr> <td>increased crop yields</td> <td>possible maintenance problems</td> </tr> <tr> <td>minimal environmental effects</td> <td>Requires constant monitoring</td> </tr> <tr> <td> </td> <td> </td> </tr> </tbody> </table>	<b>Advantages</b>	<b>Disadvantages</b>	lower energy costs	high upfront costs, Can be expensive to build	increased crop yields	possible maintenance problems	minimal environmental effects	Requires constant monitoring			.5X6	3
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lower energy costs	high upfront costs, Can be expensive to build												
increased crop yields	possible maintenance problems												
minimal environmental effects	Requires constant monitoring												
4.	<ul style="list-style-type: none"> <li>• Paper</li> <li>• Ceramic</li> <li>• Petroleum Refineries</li> <li>• Textile</li> <li>• Sugar</li> <li>• Food and dairy</li> </ul>	3	3										
5.	<ul style="list-style-type: none"> <li>• Fuel compression</li> <li>• Ignition engines</li> <li>• Fuel filters</li> <li>• Heating oils</li> <li>• Oil spill clean-ups</li> <li>• Biodiesel electricity generators</li> </ul>	.5X6	3										
6.	<p>Wind rotates the rotor blades, which convert kinetic energy into rotational energy. This rotational energy is transferred by a shaft which to the generator, thereby producing electrical energy</p>	3	3										

7.	<ul style="list-style-type: none"> <li>• Animal waste</li> <li>• Wood</li> <li>• Oil-seed crops</li> <li>• Municipal solid waste</li> <li>• Food waste</li> <li>• Crop waste</li> <li>• algae/kelp</li> </ul>	1X3	3
8.	<ul style="list-style-type: none"> <li>• Analysis of input</li> <li>• Reuse and recycling of waste</li> <li>• Energy education</li> <li>• Conservative technique and energy audit</li> </ul>	1x3	3
9	<ul style="list-style-type: none"> <li>• Hydrogen Infrastructure</li> <li>• Cost</li> <li>• Durability and Lifespan</li> <li>• Hydrogen Storage</li> <li>• Fuel Source</li> <li>• Catalyst Dependency</li> <li>• Safety Concerns</li> </ul>	.5X6	3
10	<ul style="list-style-type: none"> <li>• High Efficiency</li> <li>• Zero Emissions</li> <li>• Quiet Operation</li> <li>• Modularity and Scalability</li> <li>• Quick Refuelling</li> </ul>	3	3

**PART-C**

**(6x7=42Marks)**

IV	<ul style="list-style-type: none"> <li>• Energy management is the set of actions and processes aimed at optimizing energy consumption in order to rationalize and reduce costs without affecting consumers.</li> <li>• Energy management involves the planning of energy production and consumption.</li> <li>• Proactive and systematic monitoring</li> <li>• Control and optimization of an organization's energy consumption to conserve use and decrease energy costs.</li> <li>• Energy management includes minor actions such as monitoring monthly energy bills and upgrading to energy-saving lightbulbs.</li> </ul> <p><b>Energy management techniques</b></p> <ul style="list-style-type: none"> <li>• Analysis of input</li> <li>• Reuse and recycling of waste</li> <li>• Energy education</li> <li>• Conservative technique and energy audit</li> </ul>	7	7
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III.

**OR**

- Energy audit is an inspection, survey and analysis of energy flow for energy conservation in a building
- An Energy Audit is a survey conducted by an Energy Auditor to determine how much energy a building uses and identify ways to reduce energy consumption
- They will also ask questions about your energy consumption
- It is done with a view to reduce the amount of energy input into the system without negatively affecting the output
- These are used to improve the energy efficiency of homes, businesses, and other buildings.

An energy audit has three parts

- Evaluation
- Testing
- Efficiency recommendations

7

7

V.	<p>Solar geometry is the measurement of the angle of the sun to the earth and the corresponding amount of solar energy hitting a given object or surface</p> <p>It is helpful to consider the position of the sun when deciding the placement of a structure's windows and the amount of sunlight entering the building.</p> <p>Solar Radiation Geometry</p> <ul style="list-style-type: none"> <li>• Declination</li> <li>• Hour angle</li> <li>• Altitude angle</li> <li>• Incident angle</li> <li>• Zenith angle</li> <li>• Solar azimuth angle</li> </ul>	7	7
VI.	<p style="text-align: center;"><b>OR</b></p> <ul style="list-style-type: none"> <li>• Solar collector transforms solar radiation into heat and transfer that heat in to a medium (water, air, fluid etc.)</li> <li>• Solar collectors are of two types <ol style="list-style-type: none"> <li>1. <b>Non concentrating collector</b> (collector area is equal to absorber area) e.g.: - Flat plate collector</li> <li>2. <b>Concentrating collector</b> (collector area is greater than absorber area) e.g.: - Parabolic trough collector, Parabolic dish/mirror strip collector, central tower receiver collector</li> </ol> </li> </ul> <p>Flat plate solar collector</p> <ul style="list-style-type: none"> <li>• It consists basically of an insulated metal box with a glazed glass cover and a dark-colored absorber plate and a pipe for fluid passage</li> <li>• Heat from the sun strikes the absorber plate and is transferred to a fluid that circulates through the collector in tubes</li> <li>• The glass front cover must be sealed so that heat does not escape, and dirt, insects or humidity do not get into the collector itself</li> <li>• The back and sides of the metal box are insulated to avoid heat loss</li> <li>• water- heating systems in residential, commercial and industrial</li> </ul> <p>Parabolic trough collectors</p> <ul style="list-style-type: none"> <li>• Reflector is in the form of a trough with parabolic cross section</li> <li>• A parabolic trough concentrates incoming solar radiation onto a line running along the length of the Trough (reflector).</li> <li>• A tube (receiver) carrying heat transfer fluid is placed along this line, absorbing concentrated solar radiation and heating the fluid inside</li> <li>• Temperatures up to 400°C can be reached</li> </ul> <p>Parabolic dish / mirror strip collectors</p> <ul style="list-style-type: none"> <li>• It has a collector (dish parabola) and a receiver</li> <li>• The collector is a mirror reflector shaped as a parabolic dish .It focuses the incoming solar radiation to the central axis</li> <li>• The receiver is the absorber tube located at the central axis of the parabolic dish .It carries the heat to which the heat is transferred</li> <li>• Temperatures up to 800°C can be reached</li> </ul>	7	7

VII.	<ul style="list-style-type: none"> <li>• Combustion</li> <li>• Gasification</li> <li>• Pyrolysis</li> <li>• Bio digestion</li> <li>• Fermentation</li> <li>• Hydrogenation</li> </ul> <p><b>Combustion</b> Combustion is the process by which, the organic matter is burnt in the presence of oxygen which generates heat. Due to this heat water is boiled, steam is produced, turbine is turned and electricity is generated.</p> <p><b>Gasification</b> Gasification is a process by which organic matter is being reacted with heat to form carbon dioxide, carbon monoxide and hydrogen. Less amount of oxygen is utilized in this process. The final product is a gas named syngas (producer gas) which is also a fuel. This can also help in generating electricity and used for various other purposes.</p> <p><b>Pyrolysis</b> Pyrolysis is a process by which organic matter is made into the required form at a very high temperature in the absence of oxygen. Here the organic matter does not get burnt because oxygen is not present. So it is transformed into 3 forms namely- bio oil, bio char and syngas</p> <p><b>Bio digestion</b> Bio digestion is a process by which bacteria breaks down the organic matter in the absence of oxygen. This can also be termed as anaerobic respiration. The final product is biogas and combusted again to generate electricity.</p> <p><b>Fermentation</b> Fermentation is a process by which organic matter gets converted into alcohol with the help of yeast. The byproduct of this reaction is ethanol which is commonly used to power automobiles.</p> <p><b>Hydrogenation</b> Addition of hydrogen to unsaturated hydrocarbons in presence of a catalyst such as nickel or palladium to form saturated hydrocarbons is called hydrogenation. The process of hydrogenation is used in industry to convert vegetable oils to Ghee.</p>	7	7
VIII.	<p style="text-align: center;"><b>OR</b></p> <p><b>Vertical Axis wind turbines</b>-Axis of rotation perpendicular to the ground</p> <ol style="list-style-type: none"> <li>a. Savonius type</li> <li>b. Darrieus type</li> <li>c. Giromill or H-Type</li> </ol> <p>Savonius type</p> <ul style="list-style-type: none"> <li>• The basic equipment is a drum cut in two halves vertically. The two parts are attached to the two opposite sides of a vertical shaft.</li> <li>• As the wind blowing into the structure, meets with two dissimilar surfaces one convex and the other concave</li> <li>• Pressure difference between the two sides develops a torque which causes the rotation of the rotor.</li> </ul>	7	7

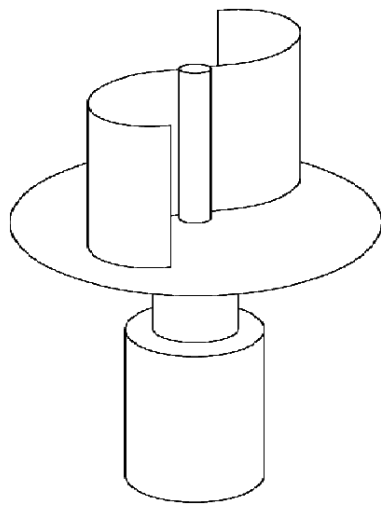


Figure 2-4 Savonius Rotor

Darrieus type

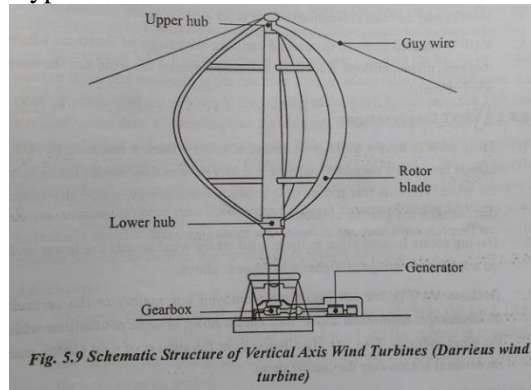
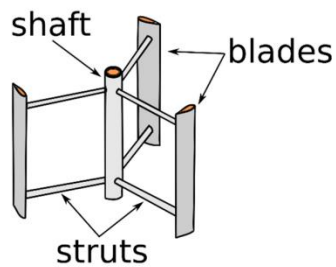


Fig. 5.9 Schematic Structure of Vertical Axis Wind Turbines (Darrieus wind turbine)

- This rotor has two or three thin curved blades made of flexible metal strips
- It looks like an egg beater and operates with the wind coming from any direction.
- Both the ends of the blades are attached to a vertical shaft
- It can be installed close to the ground eliminating the cost of the tower structure

Giromill or H-Type

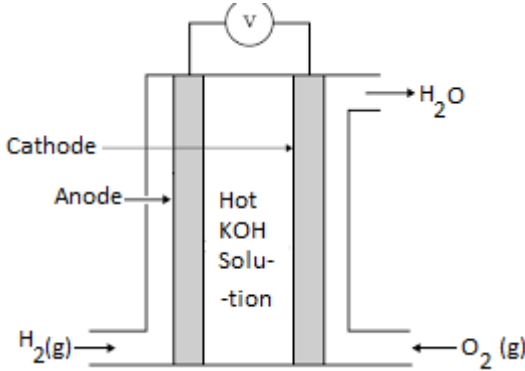


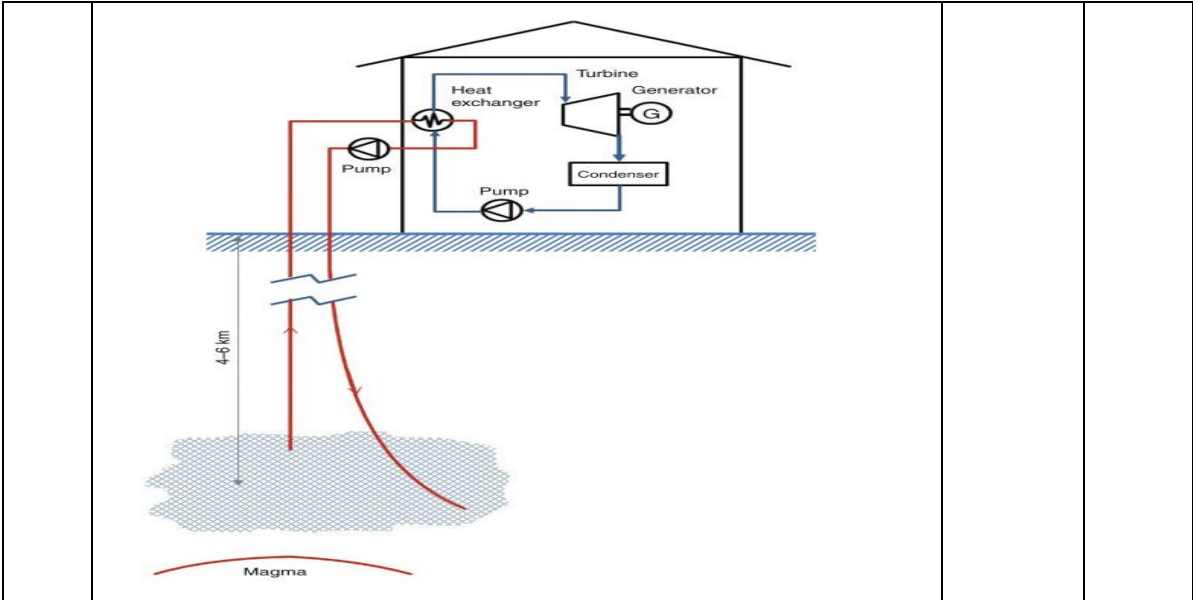
(a)

- A variant of Darrieus wind turbine
- The blades are straight resulting in simple construction
- The rotor blades are shaped as the alphabet H

IX	<p>Magnetohydrodynamic (MHD) power generation is a method of generating electricity directly from ionized gases (plasma) or conducting fluids (like seawater) passing through a magnetic field and an electric field.</p> <p><b>Principle of MHD</b></p> <p>MHD power generation relies on the interaction between a conducting fluid (such as a plasma or a conducting gas) and a magnetic field. When a conducting fluid moves through a magnetic field, it induces an electric current perpendicular to both the fluid flow and the magnetic field.</p> <p><b>Working of MagnetoHydroDynamic (MHD) power generation</b></p> <ul style="list-style-type: none"> <li>• <b>Fluid Flow:</b> The process starts with a conductive fluid being forced to flow through a duct or channel. This fluid can be heated to high temperatures to increase its conductivity. The fluid can be sourced from various systems such as nuclear reactors, coal combustion, or natural gas combustion.</li> <li>• <b>Magnetic Field Application:</b> A strong magnetic field is applied perpendicular to the direction of fluid flow. This magnetic field can be generated using powerful electromagnets or permanent magnets. The magnetic field exerts a force on the charged particles within the fluid, such as ions and electrons.</li> <li>• <b>Electromagnetic Induction:</b> As the conductive fluid moves through the magnetic field, it experiences a force known as the Lorentz force, which induces (lead) an electric current perpendicular to both the fluid flow and the magnetic field. This phenomenon is based on the principles of electromagnetic induction, as described by Faraday's law.</li> <li>• <b>Electricity Generation:</b> The induced electric current can be collected using electrodes placed within the fluid flow or along the duct walls. This electric current can then be harnessed and utilized to generate electricity. The generated electricity can be used to power various devices or fed into an electrical grid for distribution.</li> </ul> <p style="text-align: center;"><b>OR</b></p>	7	7
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X.	<ul style="list-style-type: none"> <li> <b>Anode Reaction:</b> At the anode, hydrogen gas (H<sub>2</sub>) is supplied and undergoes oxidation, releasing electrons and protons according to the following reaction:  <math display="block">\text{H}_2 \rightarrow 2\text{H}^+ + 2e^-</math> </li> <li> <b>Electron Flow:</b> The released electrons flow through an external circuit, generating electric current, and performing useful work such as powering electrical devices or charging batteries.         </li> <li> <b>Cathode Reaction:</b> At the cathode, oxygen gas (O<sub>2</sub>) from the air is supplied and reacts with electrons and protons to form water (H<sub>2</sub>O) according to the following reaction:  <math display="block">\text{O}_2 + 4\text{H}^+ + 4e^- \rightarrow 2\text{H}_2\text{O}</math> </li> <li> <b>Overall Reaction:</b> The overall reaction of the H<sub>2</sub>-O<sub>2</sub> fuel cell involves the combination of the anode and cathode reactions, resulting in the production of electricity and water:  <math display="block">\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}</math> </li> <li> <b>Electrolyte:</b> The electrolyte in the H<sub>2</sub>-O<sub>2</sub> fuel cell can vary depending on the type of fuel cell. Commonly used electrolytes include proton exchange membranes (PEM), alkaline electrolytes, and solid oxide electrolytes.         </li> </ul> 	7	7
XI.	<p><b>Dry rock system</b></p> <p>It is an abundant source of geothermal energy available for use, a vast store of thermal energy is contained within hot but essentially dry they found almost everywhere deep beneath the earth's crust.</p> <p>Extracting energy from dry, hot rocks would be possible by drilling holes into the hot rock mass and creating cracks and cavities by one of the method used in conjunction</p> <ul style="list-style-type: none"> <li>Oil and gas well stimulation,</li> <li>Blasting conventional</li> <li>Nuclear explosive would generate opening in the rock</li> </ul>	7	7



XII.	<ul style="list-style-type: none"> <li>• A photovoltaic (PV) cell, commonly called a solar cell, is a non-mechanical device that converts sunlight directly into electricity.</li> <li>• Some PV cells can convert artificial light into electricity</li> <li>• Photovoltaic solar energy is a clean, renewable source of energy that uses solar radiation to produce electricity</li> </ul> <p><b>Photovoltaic cell</b></p> <p>A solar cell is basically PN junction. It consists of two layers. The top layer is the N type silicon semiconductor where sun rays hits, it is heavily doped and made thin to penetrate sun rays to the PN junction. The bottom layer is the P type silicon semiconductor, it is lightly doped and made thicker. These two layers are sandwiched to form a PN junction. The whole arrangement is kept inside a thin glass to avoid mechanical shock.</p> <p><b>Conversion of photovoltaic panels</b></p> <p>When the sun shines onto a solar panel, energy from the sunlight is absorb photons (light particles) by the PV cells in the panel. This energy creates or (release electrons) electrical charges that move in response to an internal electrical field in the cell, causing electricity to flow</p> <p><b>Advantages of Solar Cell</b></p> <ul style="list-style-type: none"> <li>• No pollution associated with it.</li> <li>• It must last for a long time.</li> <li>• No maintenance cost.</li> </ul> <p><b>Disadvantages of Solar Cell</b></p> <ul style="list-style-type: none"> <li>• It has high cost of installation.</li> <li>• It has low efficiency.</li> <li>• During cloudy day, the energy cannot be produced and also at night we will not get solar energy</li> </ul>	7	7

<p>XIII.</p>	<p>Environmental Aspects:</p> <p>Environmental Aspect is an element of an organization's activities, products or services that can interact with the environment</p> <p>Negative or positive impact on the environment</p> <p>Negatives:</p> <ul style="list-style-type: none"> <li>• Generate emissions to air</li> <li>• Discharges to water</li> <li>• Waste arisings</li> </ul> <p>which can cause negative environmental impacts such as</p> <ul style="list-style-type: none"> <li>• Global warming</li> <li>• Water pollution</li> <li>• Contaminated land</li> </ul> <p style="text-align: center;"><b>OR</b></p>	7	7
<p>XIV.</p>	<p>Gasification is a process of conversion of the fuel or organic wastes/matter into a gas called producer gas</p> <ul style="list-style-type: none"> <li>• Used for irrigation purpose</li> <li>• Agricultural industries</li> <li>• Forestry industries</li> <li>• Sawmills, wood cutting industries</li> <li>• Pulp industries</li> <li>• Cement industries</li> <li>• Metallurgy</li> <li>• Lime industries</li> </ul>	7	7

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