		UNIT-V			
10	a)	Discuss the potential of geothermal energy as a renewable resource. What are its advantages and limitations compared to other energy sources?	L2	CO5	5 M
	b)	Explain the principle of Ocean Thermal Energy Conversion (OTEC). Discuss the types of OTEC systems, their working mechanisms and the potential advantages and limitations.	L2	CO5	5 M
		OR			
11	a)	Describe the applications of fuel cells across different sectors. How do fuel cells contribute to clean energy and decarbonization?	L2	CO5	5 M
	b)	What is Molten Carbonate Fuel Cells (MCFC)? Discuss their working principle, advantages and challenges in industrial applications.	L2	CO5	5 M

PVP 23

Code: 23ME4501C

III B.Tech - I Semester - Regular Examinations - NOVEMBER 2025

RENEWABLE ENERGY TECHNOLOGIES

(MECHANICAL ENGINEERING)

Duration: 3 hours Max. Marks: 70

Note: 1. This question paper contains two Parts A and B.
2. Part-A contains 10 short answer questions. Each Question carries 2 Marks.
3. Part-B contains 5 essay questions with an internal choice from each unit. Each Question carries 10 marks.
4. All parts of Question paper must be answered in one place.

BL – Blooms Level CO – Course Outcome

PART – A

		BL	CO
1.a)	What factors influence the amount of solar energy reaching Earth's surface?	L2	CO1
1.b)	Explain the working principle of a pyranometer and its role in measuring global solar radiation.	L2	CO1
1.c)	Describe the factors that influence the efficiency of a PV module.	L2	CO2
1.d)	Explain the importance of regular maintenance in photovoltaic battery systems.	L2	CO2
1.e)	What factors affect the performance of solar flat plate collector?	L2	CO3
1.f)	Explain the principle applications of solar distillation systems.	L2	CO3
1.g)	List the characteristics of a good wind power site.	L1	CO4
1.h)	Name various stokers used for the combustion of biomass.	L1	CO4
1.i)	What are the advantages and disadvantages of Geo-thermal energy?	L2	CO5
1.j)	Discuss the applications of fuel cells.	L2	CO5

PART – B

			BL	CO	Max. Marks
		UNIT-I			
2	a)	Discuss the potential of renewable energy sources in meeting global energy demands. How do they compare with conventional sources in terms of sustainability, availability, and environmental impact?	L2	CO1	5 M
	b)	Explain the Sun–Earth relationship and its significance in solar energy applications.	L2	CO1	5 M
		OR			
3	a)	Write a note on solar radiation on tilted surfaces.	L2	CO1	5 M
	b)	What is a sunshine recorder and how does it measure the duration of bright sunshine?	L2	CO1	5 M
		UNIT-II			
4	a)	Explain the circuit design and structural components of a photovoltaic (PV) module.	L2	CO2	5 M
	b)	Describe the mechanical insulation aspects of solar PV modules. What structural elements provide protection?	L2	CO2	5 M
		OR			
5	a)	Compare different types of batteries used in solar PV systems. What are their advantages, limitations, and typical applications?	L2	CO2	5 M

	b)	Explain the step-by-step procedure for installing a battery bank in a solar PV system. What precautions must be taken to ensure safety and optimal performance?	L2	CO2	5 M
		UNIT-III			
6	a)	Compare flat plate collectors and concentrating collectors in terms of design, working principle, efficiency and applications.	L3	CO3	5 M
	b)	Discuss the importance of orientation and tilt angle in the performance of solar collectors.	L2	CO3	5 M
		OR			
7	a)	Describe latent heat storage and its role in thermal energy systems. How does it differ from sensible heat storage?	L2	CO3	5 M
	b)	Explain the working principle of solar water heating systems.	L2	CO3	5 M
		UNIT-IV			
8	a)	How energy from wind can be extracted? Explain the process by using suitable diagram.	L2	CO4	5 M
	b)	Derive Betz limit for Power generation in wind turbine.	L3	CO4	5 M
		OR			
9	a)	Explain any one type of gasifier with neat line diagram. Mention the merits & demerits of the same.	L2	CO4	5 M
	b)	Summarize the modification of SI engines to use biogas.	L2	CO4	5 M

PYP23

Code: 23ME4501C

III B.Tech – I Semester – Regular Examinations – November 2025

RENEWABLE ENERGY TECHNOLOGIES

(MECHANICAL ENGINEERING)

Duration: 3hours Max. Marks: 70

Note 1. This question paper contains two Parts A and B
2. part-A contains 10 short Answer questions. Each Question carries 2 Marks.
3. Part-B contains 5 essay questions with an internal choice from each unit. Each question carries 10marks
4. All parts of Question paper must be answered in one place.

BL – Blooms Level CO – Course Outcome

SCHEME OF EVALUATION

1.a) factors influence – Any 4 factors (2M)
1.b) working principle (1M) & its role (1M) → (2M)
1.c) Any 4 factors (2M)
1.d) Any 4 main importances (2M)
1.e) Any 4 factors affect (2M)
1.f) principle applications explanation (2M)
1.g) List any 4 characteristics (2M)
1.h) Name Various Stokers & explanation (2M)
1.i) advantages (1M) & disdvantages (1M) → (2M)
1.j) Any 4 applications of fuel cells (2M)

Total – 10 × 2M = 20M

PART-B

UNIT-I

2.a) potential (2M) + comparision (3M) → [5M]

2.b) Sun-earth relationship figure (2M) + explanation (1M) + significance (2M) → [5M] } (10M)

(OR)

3.a) Note on tilted surfaces (3M) + figure (2M) → [5M]

3.b) Sunshine recorder figure (1M) + explanation (4M) → [5M] } (10M)

UNIT-II

4.a) PV module figure (2M) + explanation (3M) → [5M]

4.b) Description (3M) + Structural elements explanation (2M) → [5M] } (10M)

(OR)

5.a) types of batteries (2M) + Adv., limitations, appl. (3M) → [5M]

5.b) Figure with step-step procedure (3M) + precaution (2M) → [5M] } (10M)

UNIT-III

6.a) Collectors comparision with figure (5M)

6.b) Importance of orientation & tilt angle explanation (5M) } (10M)

(OR)

7.a) Latent heat storage fig. (2M) + explanation (3M) → [5M]

7.b) Solar water heating system fig. (2M) + explanation (3M) → [5M] } (10M)

UNIT-IV

8.a) Wind energy figure (2M) + Explanation (3M) → [5M]

8.b) Betz limit derivation (5M) } (10M)

(OR)

9.a) Any one type of gasifier fig. (2M) + explanation (3M) → [5M]

9.b) SI engine figure (2M) + Explanation (3M) → [5M] } (10M)

UNIT-V

10.a) potential explanation (1M) + figure (2M) + comparision (2M) → [5M] } (10M)

10.b) OTEC figure (2M) + explanation (3M) → [5M]

(OR)

11.a) fuel cell figure (1M) + applications (2M) + exp. (2M) → [5M]

11.b) MCFCs figure (2M) + explanation (3M) → [5M] } (10M)

Total: 5X10M = 50M

PVP23

Code: 23ME4501C

III B.Tech – I Semester – Regular Examinations – November 2025

RENEWABLE ENERGY TECHNOLOGIES
(MECHANICAL ENGINEERING)

Duration: 3hours Max. Marks: 70

PART-A

1.a) What factors influence the amount of Solar energy reaching Earth's Surface? (L2) (CO1)

Ans: The angle of incidence, latitude, Surface reflectivity, and Seasonal Variations.
Ex: cloud cover, air pollution, and humidity. (2M)

1.b) Explain the working principle of a pyranometer and its role in measuring global solar radiation. (L2) (CO1)

Ans: Pyranometers play a critical role in measuring global solar radiation by converting the energy received from the Sun in to an electrical Signal. This Signal is then processed to provide a quantitative measure of solar irradiance, which is essential for various applications Such as Solar energy production, weather forecasting, and climate modeling. (2M)

1.c) Describe the factors that influence the efficiency of a PV module. (L2) (CO2)

Ans: The performance characteristics of PV modules are influenced by various factors, including cell efficiency, glass quality, positioning of the glass, quality of Soldering (2M)

1.d) Explain the importance of regular maintenance in photovoltaic battery systems. (L2)(CO2)

Ans: Regular maintenance of photovoltaic battery systems is crucial for ensuring efficiency, safety, longevity, and cost-effectiveness, ultimately - maximizing energy production and return on investment. (2M)

1.e) What factors affect the performance of solar flat plate collector? (L2) (CO3)

Ans: Absorber Temperature, Absorptivity and Emissivity Convection Heat loss Radiative Heat loss, Material of Absorber, Cooling conditions. (2M)

1.f) Explain the principle applications of Solar distillation systems. (L2) (CO3)

Ans: Desalination, Water Purification, Agricultural Drying Industrial Processes, Domestic use (2M)

1.g) List the characteristics of a good wind power site. (L1) (CO4)

Ans: High average wind speed, Sufficient Seperation from noise-sensitive neighbors, Good grid connection, Good Site access, No special environmental or landscape designations, Strong and consistent winds. (2M)

1.h) Name various Stokers used for the combustion of biomass. (L1) (CO4)

Ans: The stokers used for the combustion of biomass energy include:
Mechanical Stokers Reciprocating Gate Stokers, Underfeed Stokers.
Mechanical Stokers are the traditional technology used to automatically supply solid fuels to a boiler. Reciprocating Grate stokers are designed for complete combustion of waste materials with low heating value and high moisture content. Underfeed stokers are suitable for small-scale systems and are relatively cheap and safe for biomass combustion (2M)

1.i) What are the advantages and disadvantages of Geo-thermal energy?

Ans: Advantages of Geo-thermal Energy: Sustainable and Renewable, Low Emissions, Reliable Energy Source, Small Land Foot print, Long Life Span & Cost efficiency
Dis advantages of Geo-thermal Energy: High Initial costs, location Dependency, Environmental concerns Resource Depletion. (2M)

1.j) Discuss the applications of fuel cells. (L2) (CO5)

Ans: Fuel cells are versatile energy devices with applications in transportation, stationary power generation, portable power, and more, offering clean and efficient energy solutions. (2M)

Total = 10 x 2M = 20M

PART-B

UNIT-I

2.a) Discuss the potential of renewable energy sources in meeting global energy demands. How do they compare with conventional sources in terms of sustainability, availability and environmental impact? (L2) (CO4) (5M)

Ans: Potential of Renewable energy in meeting Global demands:

Rapid growth: Renewables are projected to account for nearly 20% of global final energy consumption by 2030, up from 13% in 2023.

Diverse Sources: solar, wind, hydro, geothermal, and biomass provide energy from naturally replenishing flows.

policy support: Over 130 countries have policies driving renewable adoption

climate targets: To meet net-zero goals, global renewable capacity must triple by 2030, alongside doubling energy efficiency.

Aspect	Renewable Energy	Conventional Energy
Sustainability	Derived from infinite natural flows (Sun, wind, water). Long-term Sustainable.	Finite reserves of coal, oil, gas Depleting & unsustainable.
Environmental Impact	Minimal emissions during operation. Reduces air pollution, acid rain, and greenhouse gases.	High emissions of CO_2, CH_4 & pollutants Major driver of climate change & health risks.

Availability	Widely distributed globally; Solar and wind accessible in most regions Seasonal/ geographic variability requires Storage and Smart grids.	concentrated in Specific regions geopolitical risks and Supply chain Vulnerabilities.

(5M)

2.b) Explain the Sun-Earth relationship and its Significance in Solar energy applications. (L2)(CO1)(5M)

Ans: The Sun-earth relationship is crucial for understanding Solar energy applications. The Sun is the primary Source of energy for earth, influencing climate, weather and renewable energy applications. The sun's radiation, which includes visible light, ultraviolet and infrared is absorbed by Earth's atmosphere and Surface, converting it into heat. This heat is responsible for the Seasons and the Earth's climate. The Sun's position relative to the Earth, influenced by the Earth's rotation and revolution, affects the intensity and direction of Solar radiation, which is measured using instruments like pyranometers and pyrheliometers these instruments help in assessing solar potential and optimizing Solar energy systems. The sun's energy also plays a role in the Earth's magnetosphere, influencing space weather and the occurrence of auroras. Understanding these relationships is essential for designing efficient Solar energy systems and harnessing the sun's energy effectively for various applications

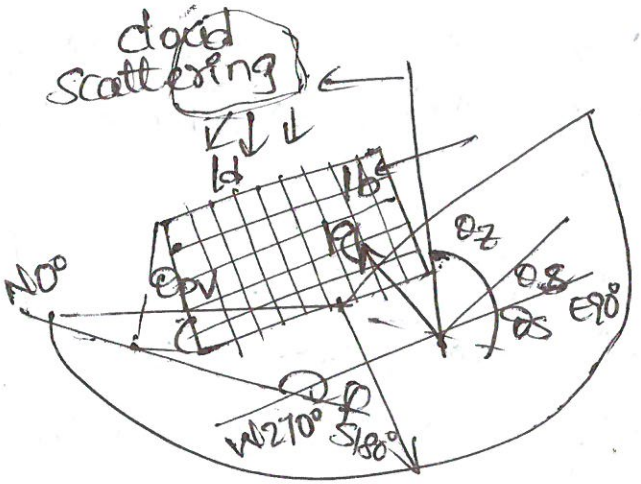
(5M)

Total: (10M)

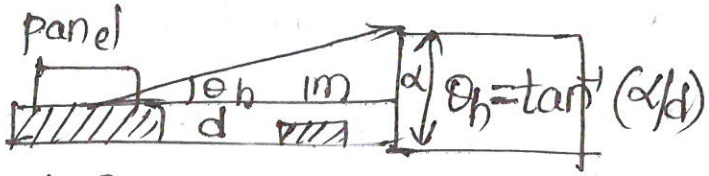
OR

3-a) Write a note on Solar radiation on tilted Surfaces (L2)(CO1)(5M)

Ans:



explore beam blocking
range: 250m
radius: 360°



Solar radiation on tilted surfaces is influenced by the angle of the sun, the surface orientation, and the ground's albedo. The optimal tilt angle for maximizing Solar energy capture is often close to the local latitude, with potential for seasonal adjustments. The total Solar radiation incident on a titled Surface comprises direct, diffuse, and ground-reflected components each requiring Specific calculation methods. Direct Beam Radiation is heavily dependent on the angle of incidence, while diffuse radiation is often modelled as uniformly distributed over the hemisphere. Ground-Reflected radiation is influenced by the ground's albedo, which ranges from 0.1 (asphalt paved road) to 0.9 (snow). For optimal energy capture, the ideal tilt angle is often close to the local latitude, with potential for seasonal adjustments. (5M)

.b) What is a Sunshine recorder and how does it
b) measure the duration of bright Sunshine?
(L2) (CO1) (5M)

ns: A sunshine recorder is a device that records the amount of Sunshine at a given location or region at any time. The results provide information about the weather and climate as well as the temperature of a geographical area. This information is useful in meteorology, science, agriculture, tourism and other fields. It has alsobeen called a heliograph.

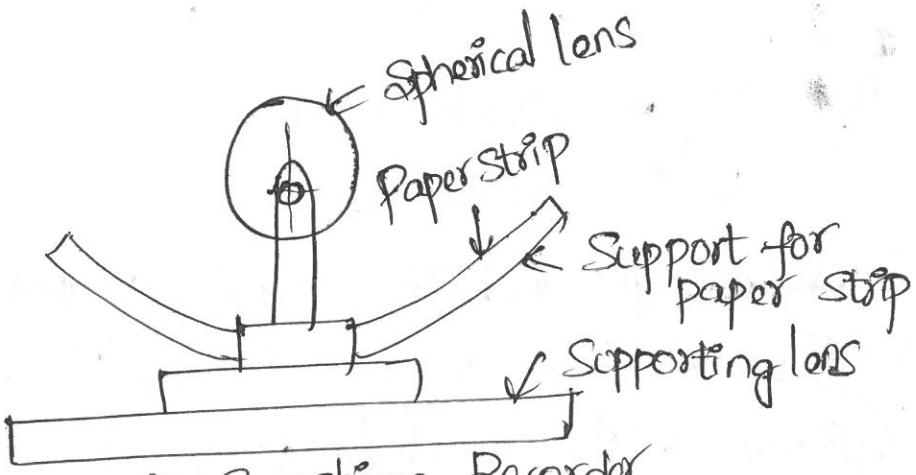
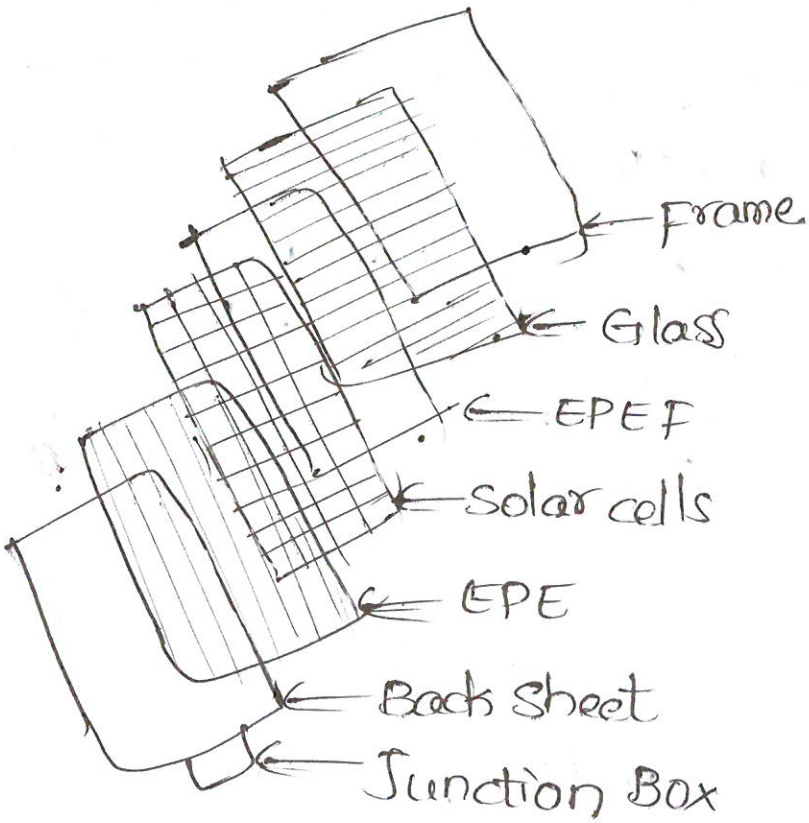


Fig: Sunshine Recorder

A shine recorder measures the duration of bright Sunshine. by focusing Sunlight on to a recording medium, Such as a card or paper, which burns or chars a traceas the Sun's rays pass through. The length of this trace is then measured to determine the duration of shine. This method is simple and has been used for over a century. Modern Sunshine recorders often use solar power cells to measure the strength of direct Sunlight which can then be converted in to hours of Sunshine. (5M)

4.a) Explain the circuit design and structural components of a photovoltaic (PV) module. (L2)(CO2)(5M)



The circuit design and structural components of a photovoltaic module are crucial for its functionality and efficiency. The module is constructed as a durable, layered sandwich, with the outermost layer being a sheet of tempered glass for mechanical strength and protection. The photovoltaic cells, the active components responsible for energy conversion, are encased by a polymer material to prevent movement and seal the cells from air and water ingress. The backsheet, usually a polymer composite, form the rear protective barrier against moisture and provides electrical insulation. The entire assembly is held together by a rigid aluminum frame for structural

Stability and Support. Finally a junction box is attached to the back of the module, housing the output cables and bypass diodes that manage the flow of electricity to the external system. (5M)

4.b Describe the mechanical insulation aspects of solar PV modules. What structural elements provide protection? (L2) (CO2) (5M)

Ans: Mechanical Insulation aspects of Solar PV modules:
The mechanical insulation of Solar PV modules is crucial for ensuring their safety and performance. The IEC 61730 Standard outlines the requirements for electrical insulation of PV modules, which include adequate insulation between electrical components and protection against lightning strikes. This insulation is essential to prevent electrical shock hazards and ensure the safe operation of the Solar system.

Structural elements provide protection:
Structural elements play a crucial role in providing protection within a building. They are designed to withstand various forces and conditions, ensuring the safety and integrity of the Structure. Here are some key structural elements that contribute to protection:
Beams, Columns, Walls, Foundation, Roof. (5M)

Total (10M)

OR

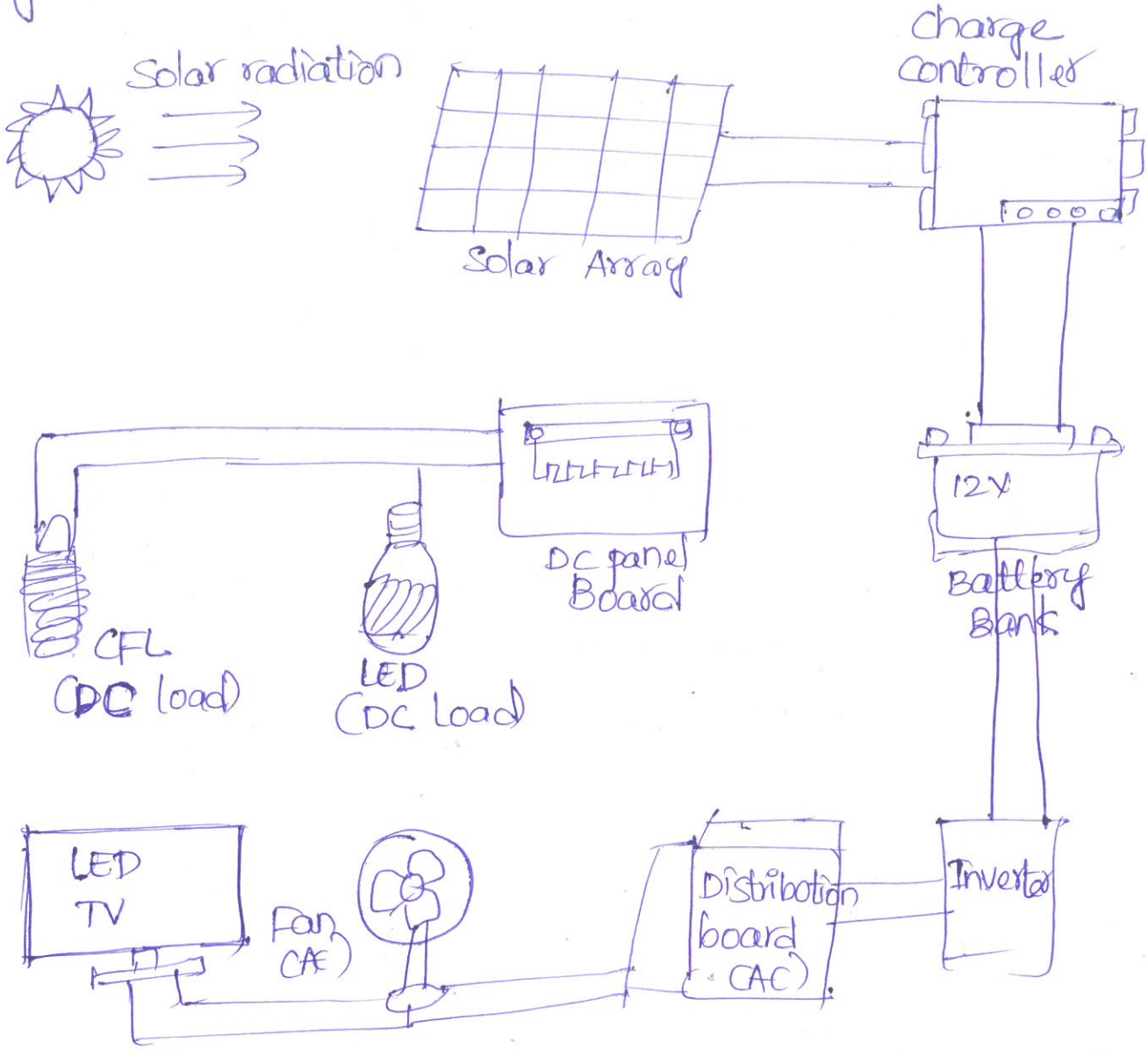
5.a) Compare different types of batteries used in Solar PV systems. What are their advantages, limitations, and typical applications? (CO2)(CO4)(5M)

Ans: There are four main types of battery technologies that pair with residential Solar Systems:

1. Lead acid batteries: Known for their reliability and low cost, lead-acid batteries are Suitable for off-grid Solar systems and emergency backup Storage. They come in various types, including flooded lead acid (FLA), Absorbent Glass Mat (AGM), and Gel batteries.
2. Lithium-Ion batteries: These batteries are light weight, have a long life span, and require no maintenance. They are ideal for residential solar installations due to their high energy density and ability to hold more power in a limited space.
3. Nickel-cadmium Batteries: Suitable for commercial-scale projects, nickel-cadmium batteries can operate at extreme temperatures and do not require complex battery management systems.
4. Flow Batteries: Large in size and expensive, flow batteries are mostly used for large-scale battery Storage. Each type of battery has its own set of unique characteristics, making them best for different types of Solar systems. It's important to choose the right battery technology based on

the specific needs and goals of the Solar energy system. (5M)

5.b) Ans:



Step by step procedure for installing a Battery bank in a Solar PV System: The installation of a battery bank in a solar PV system involves several key steps to ensure optimal performance and longevity. Here is a detailed procedure: 1. Assess Energy Needs 2. Select the right batteries 3. Size the Battery bank 4. Prepare the installation site 5. Install the battery racking System 6. Connect the battery bank 7. Test the System 8. Mount the Solar

Precautions to ensure Safety and optimal performance:

When installing a battery bank in a Solar PV system, it is crucial to take Several precautions to ensure safety and optimal performance. Here are Some key Safety and performance considerations:

1. Safety protocols 2. Environmental conditions 3. Battery Interconnect cables 4. Battery Monitoring System 5. Inverter Compatibility 6. Maintenance (5M)

Total (10M)

UNIT-III

6.a) Compare flat plate collectors and Concentrating collectors interms of design, working principle, efficiency and applications. (3) (CO3) (5M)

Ans:

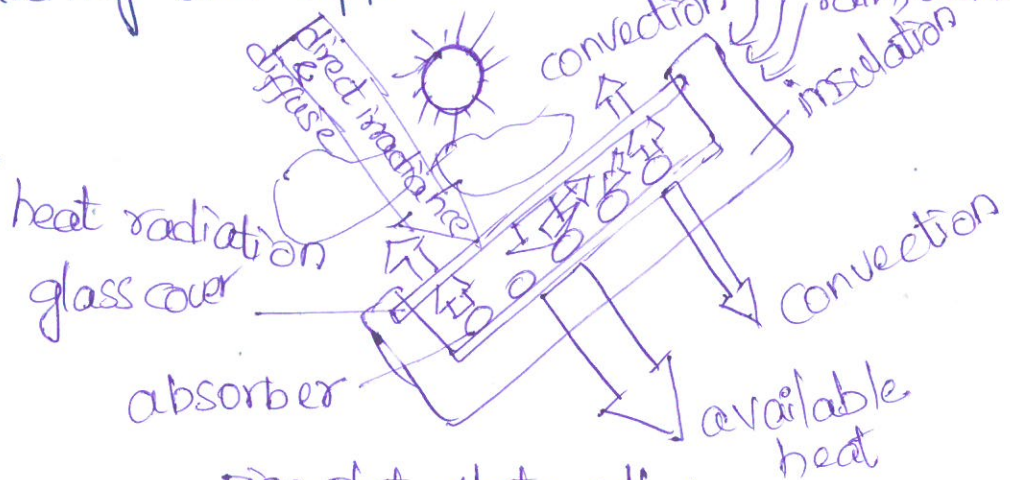


Fig: Flat plate collector

Design: Flat plate collectors have a Simple design with a flat or grooved absorber plate, while Concentrating collectors use reflective Surfaces to focus Sunlight on to a Smaller absorber area.

Working Principle: Flat plate collectors absorb both direct and diffuse Solar radiation, while Concentrating collectors use mirrors to concentrate Sunlight, achieving high temperatures.

Efficiency: Flat plate collectors have a lower efficiency, especially at higher temperatures, while

concentrating collectors are more efficient, especially for applications requiring higher temperatures.

Applications: Flat plate collectors are suitable for moderate temperature applications, while concentrating collectors are ideal for high-temperature applications, such as electricity generation.

Maintenance: Concentrating collectors require more complex maintenance due to the use of mirrors and lenses, whereas flat plate collectors are simpler and easier to maintain. (5M)

6. b) Discuss the importance of orientation and tilt angle in the performance of Solar collectors. (L2) (CO3) (5M)

Ans. The orientation and tilt angle of Solar collectors are crucial for maximizing the efficiency of Solar energy systems. The tilt angle determines the angle of the collector with respect to the horizontal plane, which affects the amount of Solar radiation reaching the collector surface. A tilt angle that is too low or too high can lead to a significant reduction in the amount of solar radiation that can be collected. Optimal tilt angles are determined by considering the local climatic conditions, geographic latitude, and the period of use. For example, in India, the optimum tilt angle can change throughout the year, with adjustments made monthly to maintain the maximum solar radiation. This approach can lead to a yearly

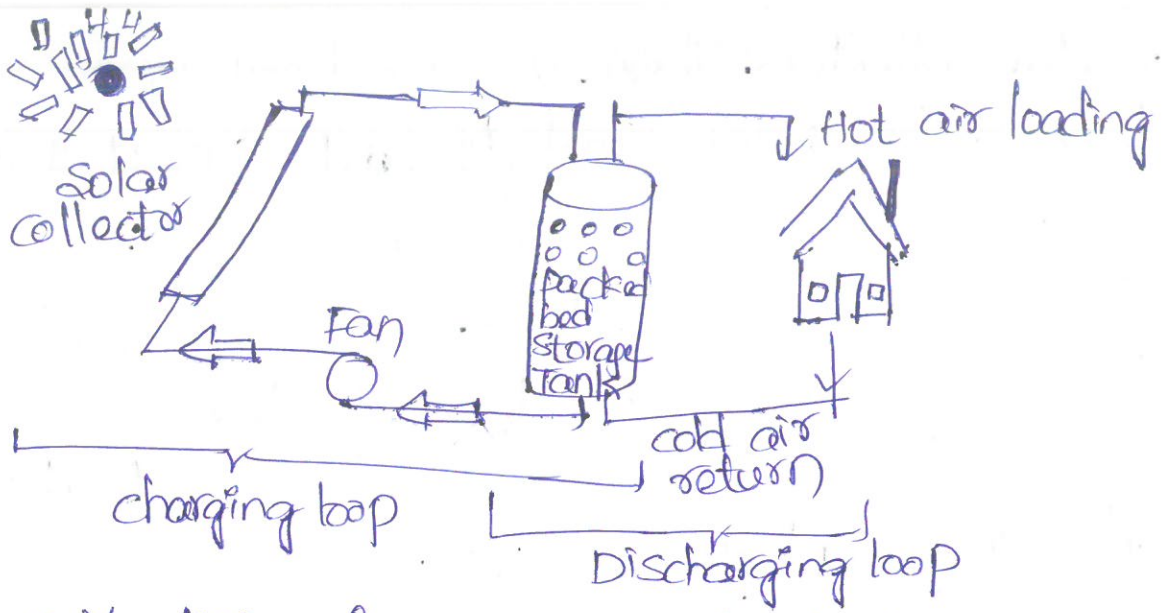
gain of approximately 4.56% in solar radiation compared to a solar collector fixed on a horizontal surface. The performance of solar collectors is also influenced by the orientation of the collector, which can affect the reflectivity, transmission, and absorption of solar radiation. Proper orientation ensures that the collector is positioned to capture the maximum amount of sunlight possible, which is essential for the efficient operation of solar energy systems (5M)

Total (10M)

OR

7.a) Describe latent heat storage and its role in thermal energy systems. How does it differ from sensible heat storage? (L2) (CO3) (5M)

Ans: Latent heat storage systems play a crucial role in thermal energy systems by efficiently absorbing storing, and releasing thermal energy. These systems utilize phase change materials (PCMs) that change their state, such as from solid to liquid, to store heat without a significant temperature change. this property allows for high storage density and isothermal nature, making latent heat storage an effective solution for energy management and sustainability. the process of latent heat storage involves three main steps: 1. Energy Absorption, 2. Energy Storage., 3. Energy Release.



How does it differ from Sensible heat storage:.
Latent heat storage differs from Sensible heat storage in Several key ways: 1. phase change
2. Temperature Stability 3. Energy density
4. Applications 5. Material Selection. (5M)

7.b) Explain the working principle of Solar water heating Systems. (L2) (CO3) (5M)

Ans:

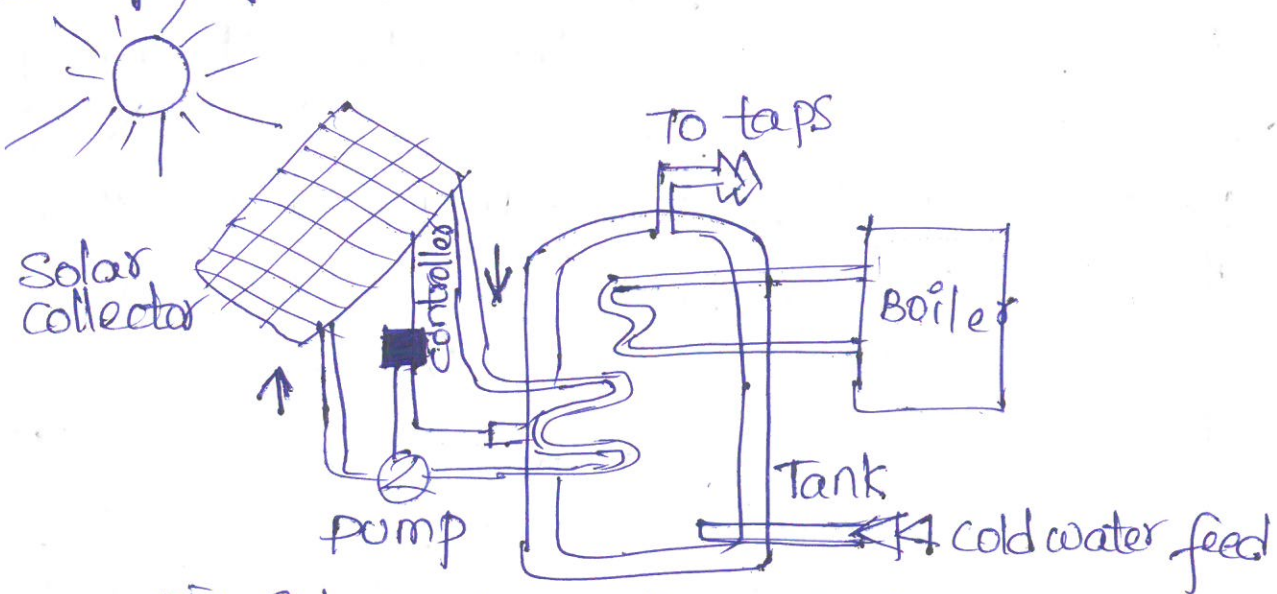


Fig: Solar water Heating System

A solar water heating System captures Sunlight using solar collectors, converts it in to heat, and transfer that heat to water Stored in an insulated tank for domestic use. Key components:

1. Solar collectors: These are the heart of the system, designed to absorb sunlight and convert it into heat. There are two main types of collectors.

- Flat-plate collectors: these consist of a flat, insulated box with a dark absorber plate that captures solar energy. A transparent cover minimizes heat loss while allowing sunlight to enter.
- Evacuated Tube collectors: These consist of glass tubes with a vacuum between them, which reduces heat loss. They are more efficient in colder or cloudier conditions compared to flat plate collectors.

2. Storage Tank: the heated water is stored in an insulated tank, which minimizes heat loss and ensures hot water is available when needed. The size of the tank depends on the hot water demand and the size of the solar collector system.

3. Circulation System: this system transfers the heated water from the collectors to the storage tank. There are two main types of circulation systems
i) Active systems ii) Passive systems (5M)

Total (10M)

UNIT-III

3.a) How energy from wind can be extracted? Explain the process by using suitable diagram. (L2) (CO4) (5M)

Ans: Wind energy extraction involves several key principles and mechanisms: Drag and Lift forces, Air foils, pitch Angle, Solidity and Tip Speed ratio, Generator.

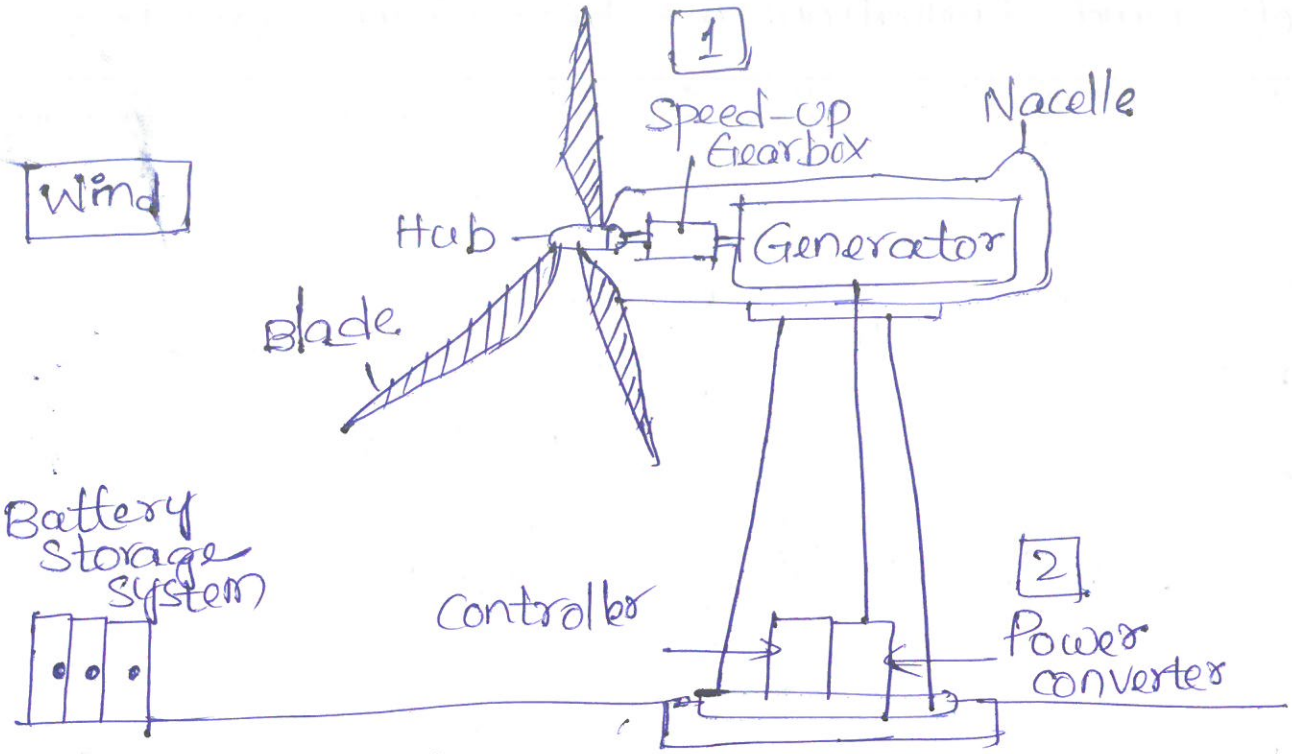
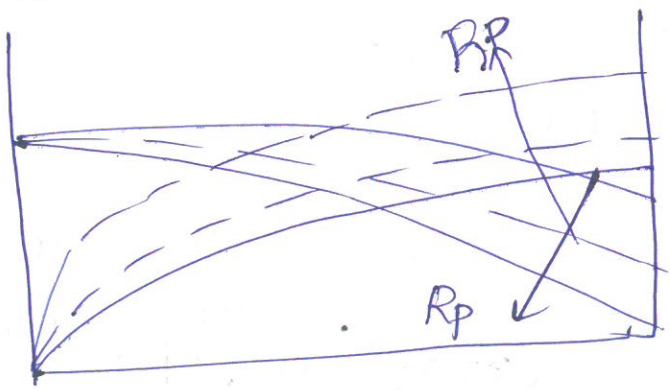


Fig: Wind Energy flow diagram

The process of extracting energy from wind involves several steps, starting with the wind hitting the blades of a wind turbine. The blades generate lift and drag forces, which cause the turbine to spin. This rotation is then transferred to a generator, which converts the mechanical energy in to electrical energy. The diagram below illustrates this process, showing the wind hitting the blades, the rotation of the turbine, and the subsequent conversion of energy. (5M)

8.b) Derive Betz limit for Power generation in wind turbine. (CO3) (CO4) (5M)

Ans:



— $v_{f,v}$ with $R_p = 1.25$

-- $v_{f,v}$ with $R_p = 2$

---- $v_{f,v}$ with $R_p = 4$

Betz Limit Derivation: The Betz limit derivation shows that extracted power depends on air density, the swept area of the turbine blades, and the cube of wind velocity.

Now due to this mass the kinetic energy of wind at the inlet of the duct is,

$$E_1 = \frac{1}{2} m V_1^2$$

Similarly, due to this mass the kinetic energy of wind at the outlet of the duct is,

$$E_2 = \frac{1}{2} m V_2^2$$

Hence, the kinetic energy of wind changed, during the flow of this quantity of air from the inlet to the outlet of the imaginary duct is,

$$E_1 - E_2 = \frac{1}{2} m (V_1^2 - V_2^2)$$

We define power as the change of energy per second. Hence, this extracted power can be written as,

$$P_K = \frac{1}{2} m (V_1^2 - V_2^2) = \frac{1}{2} \rho A V_a (V_1^2 - V_2^2)$$

Hence, $V_a = \frac{V_1 + V_2}{2}$

$$P_K = \frac{1}{4} \rho A V_1^3 \left(1 - \frac{V_2^3}{V_1^3} - \frac{V_2^2}{V_1^2} + \frac{V_2}{V_1}\right)$$

$$\frac{dP_K}{dV_2} = \frac{1}{4} \rho A V_1^3 \left(-3\frac{V_2^2}{V_1^3} - 2\frac{V_2}{V_1^2} + \frac{1}{V_1}\right) = 0$$

$$P_K = 0.5925 \times \frac{1}{2} \rho A V_1^3$$

(5M)

OR

Total (10M)

3.a) Explain any one type of gasifier with neat line diagram. Mention the merits & demerits of the same.

(L2) (CO4) (5M)

Updraft Gasifier

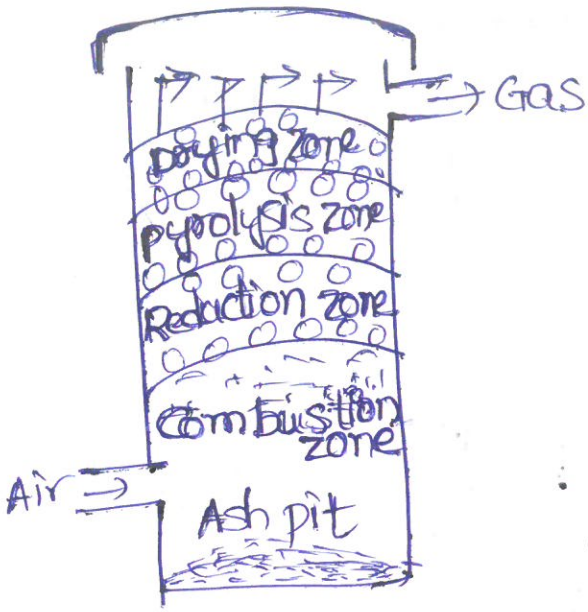


Fig: Updraft Gasifier / counter-current

→ In the updraft gasifier, the feed (biomass) is introduced from the top and moves downwards while gasifying agents (air, steam, etc.) are introduced at the bottom of the gate.

→ the product gas moves upwards.

→ In this case, the combustion takes place at the bottom of the bed which is the hottest part of the gasifier and product gas exits from the top at lower temperature (around 150°C)

→ Because of the lower exit temperature, the product gas contains large amounts of tar.

→ the tar and volatiles produced during this process will be carried in the gas stream.

→ Ashes are removed from the bottom of the gasifier.

Merits and Demerits of updraft Gasifier:

Merits: Simplicity, High Efficiency, Versatile Feed Stock, High Equipment Efficiency.

Demerits: Sensitivity to Tar and moisture, long Start-up time, Poor Reaction Capability, channelling Risk, Tar Entrainment. (5M)

9.b) Summarize the modification of SI engines to use biogas (L2) (CO4) (5M)

Ans: The modification of SI engines to use biogas involves

Several key changes and optimizations to enhance performance and reduce emissions.
Here are some of the modifications made:

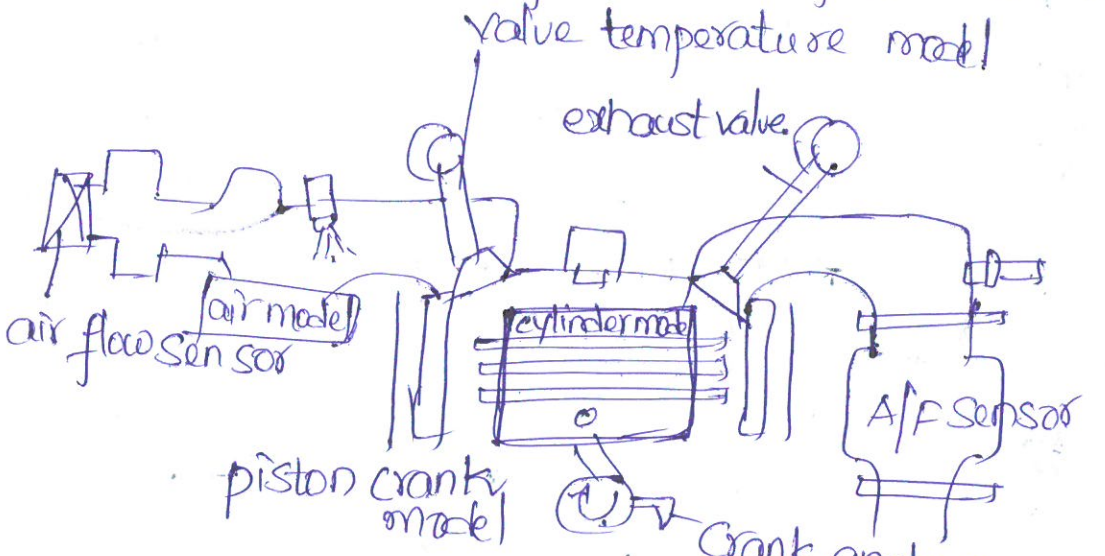


Fig: Engine Model

Optimizing Ignition parameters: Higher ignition energy is required for biogas due to its high ignition temp. and low flame speed compared to gasoline. this can be achieved by adjusting ignition timing and other parameters to improve combustion efficiency.

Intake system Improvements: the intake system for the biogas-fueled SI engine is modified to ensure a well-defined air-fuel mixture. This includes the use of a Venturi and other devices to maintain the flow of biogas and enhance the combustion process.

optimal operating Parameters: Various techniques such as altering the compression ratio, ignition timing, and throttle position are employed to optimize the performance and combustion characteristics of biogas-fueled SI engines.

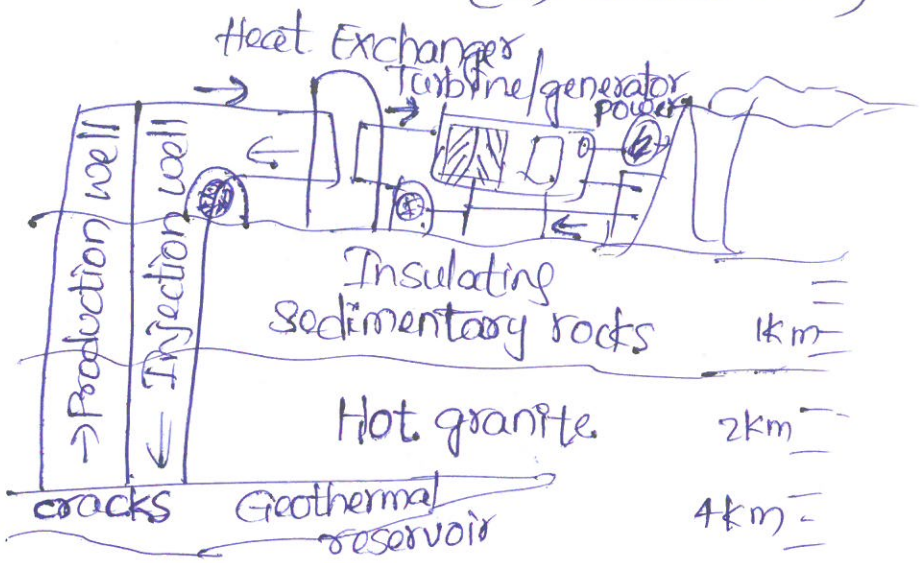
(5M)

Total (10M)

UNIT-V

10.a) Discuss the potential of geothermal energy as a renewable resource. What are its advantages and limitations compared to other energy sources?
(L2) (CO5) (5M)

Ans:



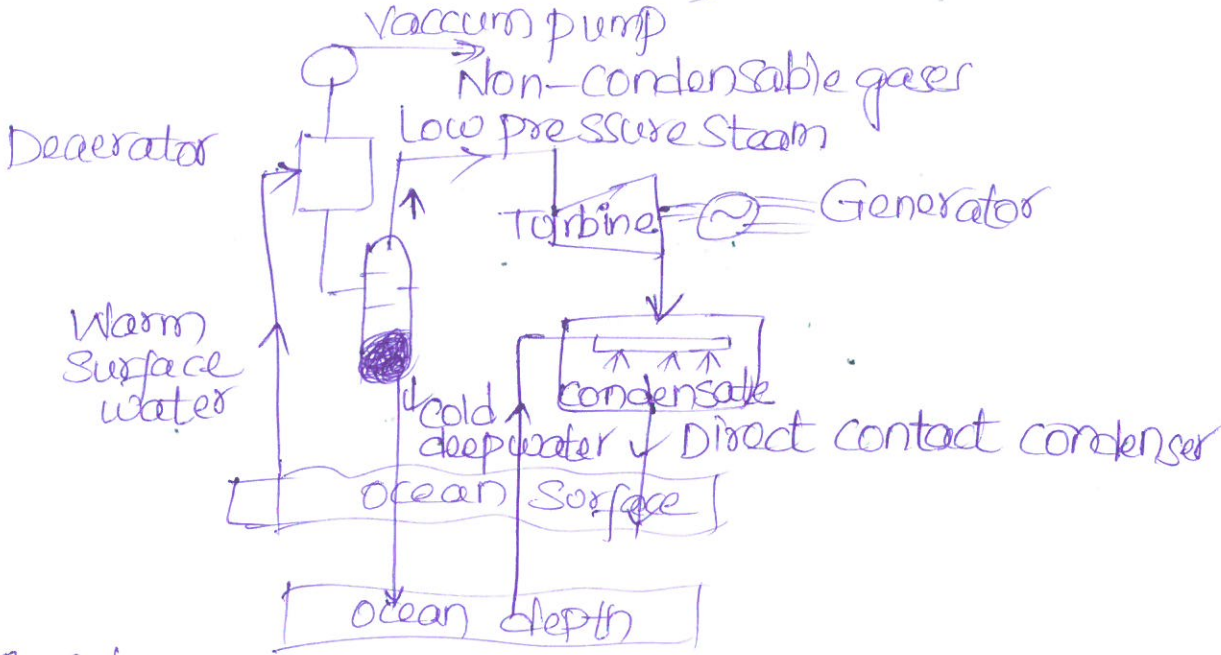
Powering a Sustainable future: Geothermal energy is a promising renewable resource that offers several advantages for a sustainable future. It provides a consistent and long-lasting supply of energy, making it an invaluable addition to India's renewable energy portfolio. Unlike solar or wind power, geothermal energy can be accessed 24/7, contributing to grid stability and reducing fossil fuel dependence.
The energy is produced with minimal emissions and requires a relatively small land footprint compared to other energy sources.
Advantages and Limitations Compared to other Energy Sources
Fossil Fuels: Advantages include high energy density, established infrastructure, and reliability. Limitations include environmental impact, finite resources and pollution.

Renewable Energy Sources: Advantages include Sustainability low greenhouse gas emissions, and diversifying energy sources. Limitations include intermittency, high initial costs, and the need for large investments in infrastructure

Non-Renewable energy sources: Advantages include high energy density and established infrastructure. Limitations include finite resources, environmental impact, and the potential for accidents. (5M)

10.B) Explain the principle of Ocean Thermal Energy conversion (OTEC). Discuss the types of OTEC systems their working mechanisms and the potential advantages and limitations. (CL2) (CO5) (5M)

Ans:



The principle of OTEC involves harnessing the temperature difference between warm surface waters and cold deep waters in tropical oceans. This process utilizes a working fluid, such as ammonia, to heat the working fluid causing it to vaporize and drive a turbine connected to a generator, producing electricity.

OTEC systems are categorized into two main types based on their working mechanisms and efficiency: closed cycle OTEC, open cycle OTEC.

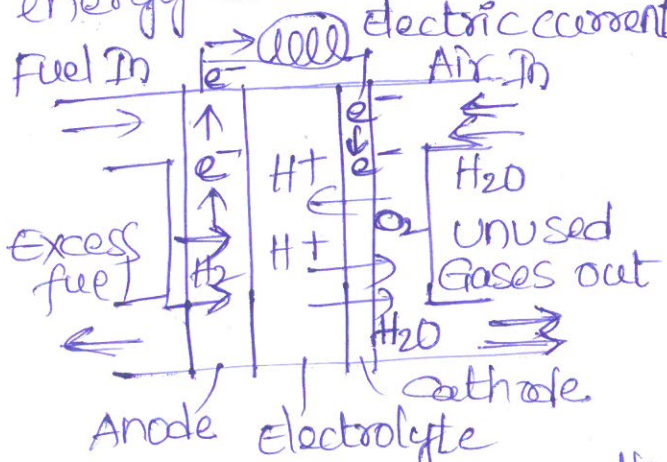
OTEC systems work by utilizing the temperature difference between warm surface water and cold deep ocean water to generate electricity. The basic principle involves heating a working fluid to create steam, which drives a turbine to generate electricity. The working fluid is then cooled and condensed back into a liquid, repeating the cycle. OTEC systems offer several advantages, including renewable energy, pollution-free operation, and the potential for fresh-water production. However, they also face limitations such as high costs, environmental impacts, and the need for specific conditions for efficient operation. (5M)

Total (10M)

OR

11.a) Describe the applications of fuel cells across different sectors. How do fuel cells contribute to clean energy and decarbonization. (12) (COS) (5M)

Ans:



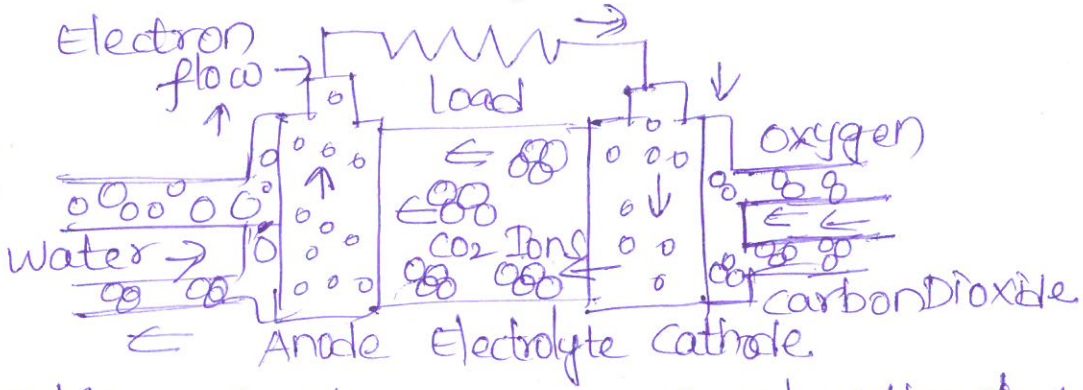
Fuel cells are versatile devices that can be applied in various sectors, each with its unique benefits and challenges. Here's a brief overview of their applications across different sectors: Transportation, stationary power generation, portable power Applications Tele communications.

Fuel cells are a key player in the transition to clean

energy and decarbonization. They operate by converting the chemical energy of a fuel, typically hydrogen, into electricity with minimal by products, such as water and heat. This process is highly efficient and environmentally friendly, making fuel cells a promising alternative to traditional fossil fuel power generation. (5M)

1.b) What is Molten Carbonate Fuel cells (MCFC)? Discuss their working principle, advantages and challenges in industrial applications. (L2) (CO5) (5M)

Ans: A molten carbonate fuel cell (MCFC) is a high-temperature fuel cell that uses a molten carbonate salt as an electrolyte to convert chemical energy from fuels directly into electrical energy, achieving high efficiency and low emissions.



The working principle of MCFCs involves the electro-chemical reaction between a fuel and an oxidant to produce electricity.

MCFCs offer several advantages in industrial applications, including high efficiency, fuel flexibility, and the ability to capture carbon dioxide emissions. However, they also face challenges such as high operating temperatures, corrosion, and the need for specialized materials and cooling systems. Ongoing research and development aim to improve MCFC's performance, efficiency and cost, widely adopted in industrial settings. (5M)

Total (10M)