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CMR INSTITUTE OF TECHNOLOGY, BENGALURU.
ACCREDITED WITH A+ GRADE BY NAAC

Internal Assessment Test 1 – Sept. 2025

Sl.	Answer any FIVE FULL Questions	Marks	CO	RBT
1	Explain briefly energy resources and its classification. an energy resource is any material object that contains energy in abundance and can be converted into a usable form. These resources power industries, transportation, agriculture, and households, making them vital for economic growth and technological advancement. Energy resources are classified based on various criteria such as origin, renewability, and commercial viability. The major classifications are: **1. Primary vs. Secondary Energy Resources** Primary energy resources are those found in nature and used directly without transformation. • Examples: Coal, crude oil, natural gas, solar radiation, wind, biomass. Secondary energy resources are derived from primary sources through conversion processes. • Examples: Electricity, hydrogen, refined fuels. This classification helps in understanding the flow of energy from natural sources to end-use applications. **2. Renewable and Non-Renewable Resources** • Renewable energy resources are naturally replenished and considered inexhaustible over human timescales. Examples: Solar, wind, geothermal, tidal, wave, biomass. Characteristics: Eco-friendly, decentralized, sustainable, and increasingly cost-effective. • Non-renewable energy resources are finite and deplete over time due to continuous extraction and use. Examples: Coal, petroleum, natural gas, uranium. Characteristics: High energy density, established infrastructure, but environmentally harmful and unsustainable. **3. Commercial and Non-Commercial Energy** • **Commercial**: Bought and sold in markets (e.g., electricity, petrol). • **Non-Commercial**: Traditionally used and not traded (e.g., firewood, animal waste). 4. **Conventional vs. Non-Conventional Energy Resources** **Conventional energy resources** are traditional sources used extensively since the industrial revolution.	[10]	CO1	L1

	• Examples: Fossil fuels (coal, oil, gas), large-scale hydroelectricity. • Issues: Pollution, resource depletion, geopolitical tensions. **Non-conventional energy resources** are newer, sustainable alternatives gaining prominence due to environmental concerns and energy scarcity. • Examples: Solar, wind, tidal, wave, biomass, hydrogen, fuel cells, ocean thermal energy. • Benefits: Clean, renewable, decentralized, and suitable for rural electrification.			
2	With schematic representation, explain the mechanism of absorption, scattering, beam and diffuse radiation received at earth surface. Also write the expression for tilt factor and for the beam and diffuse radiation. **1. Absorption** • Solar radiation is absorbed by atmospheric gases (like ozone, CO_2, water vapor). • This reduces the intensity of radiation reaching the surface. **2. Scattering** • Caused by air molecules, dust, and aerosols. • Changes the direction of solar rays, converting some beam radiation into diffuse radiation. **3. Beam (Direct) Radiation** • Travels in a straight line from the sun to the Earth's surface. • Most intense and useful for concentrating solar collectors. **4. Diffuse Radiation** • Result of scattering; comes from all directions. • Important for flat-plate collectors and shaded areas. **1. Tilt Factor (Rb)** Tilt factor accounts for the orientation of a surface relative to the sun. $$R_b = \frac{\cos\theta}{\cos\theta_z}$$ Where: • θ = angle of incidence on the tilted surface • θ_z = angle of incidence on a horizontal surface (solar zenith angle) **2. Beam Radiation on Tilted Surface (I_bT)** $$I_{bT} = I_b \cdot R_b$$ Where: • I_b = beam radiation on a horizontal surface • R_b = tilt factor	[10]	CO2	L2

	3. Diffuse Radiation on Tilted Surface (I_dT) Assuming isotropic sky model: $$I_{dT} = I_d \cdot \left(\frac{1+\cos\beta}{2}\right)$$ Where: • I_d = diffuse radiation on a horizontal surface • β = tilt angle of the surface			

3	Write short notes on collector efficiency factor and collector heat removal factor.
	
	The collector efficiency factor F′ represents the effectiveness of a solar collector in transferring absorbed solar energy from the absorber surface to the working fluid. It accounts for the thermal resistance between the absorber plate and the fluid, including conduction through the absorber and convection to the fluid.
	Value Range: Typically ranges between 0 and 1. A value close to 1 indicates minimal thermal losses and high efficiency.
	Influencing Factors:
	• Thermal conductivity of absorber material
	• Flow channel geometry
	• Heat transfer coefficient between absorber and fluid
	
	Collector heat removal factor:
	• **Definition:** The heat removal factor F_R quantifies the actual heat collected by the fluid compared to the maximum possible heat if the entire absorber were at fluid inlet temperature.
	• **Expression:**
	$$F_R = \frac{\text{Actual useful heat gain}}{\text{Maximum possible heat gain}}$$
	• **Significance:** It combines the effects of collector efficiency factor and fluid flow rate, and is used in the Hottel–Whillier–Bliss equation for flat-plate collectors.
	• **Influencing Factors:**
	  ◦ Flow rate of the fluid
	  ◦ Collector area
	  ◦ Absorber plate properties
	  ◦ Temperature difference between fluid and ambient
		[10]	CO2	L1

Sl.	Answer any FIVE FULL Questions	Marks	CO	RBT

Subject/Code: Non-conventional Energy Resources /BME755D				
Date: 30/9/2025	Duration: 90 mins	Max. Marks: 50	Semester: 07	Branch: ECE

	Explain the working principle and characteristics of photovoltaic conversion. **Photon Absorption** Sunlight consists of photons. When these photons strike the surface of a solar cell, they transfer energy to electrons in the semiconductor. **Electron Excitation** The energy from photons excites electrons, causing them to jump from the **valence band** to the **conduction band**, creating **electron-hole pairs**. **Electric Field Creation** A **p-n junction** (formed by combining p-type and n-type semiconductors) creates an internal electric field that drives electrons toward the n-side and holes toward the p-side. **Current Flow** When the cell is connected to an external circuit, the movement of electrons generates **direct current (DC)** electricity. **Energy Output** The generated electricity can be used immediately, stored in batteries, or fed into the grid.	[10]	CO2	L1

Characteristics of Photovoltaic Conversion

1. Efficiency

- Defined as the ratio of electrical output to incident solar energy.
- Influenced by material properties, temperature, and cell design.
- Typical commercial solar cells have efficiencies between 15–22%.

2. I-V Characteristics

- The **current-voltage (I-V) curve** describes the performance of a solar cell.
- Key points include:
  - **Short-circuit current (Isc)**: Maximum current when voltage is zero.
  - **Open-circuit voltage (Voc)**: Maximum voltage when current is zero.
  - **Maximum power point (MPP)**: Optimal operating point for maximum energy output.

3. Fill Factor (FF)

$$FF = \frac{V_{mp} \times I_{mp}}{V_{oc} \times I_{sc}}$$

- Indicates the quality of the solar cell.
- Higher FF means better performance.

4. Temperature Sensitivity

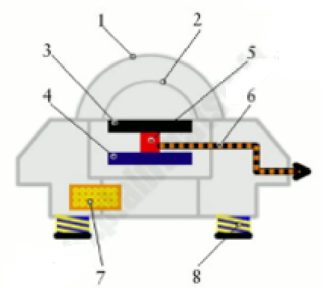
- Efficiency decreases with rising temperature.
- Cooling mechanisms or material choices can mitigate this effect.

5. Material Dependence

- Common materials: Silicon (monocrystalline, polycrystalline), thin films (CdTe, CIGS), organic PV.
- Each has unique cost, efficiency, and durability profiles.

6. Modularity and Scalability

- PV systems can be scaled from small devices (solar lanterns) to large solar farms.
- Easily integrated into buildings, vehicles, and remote installations.

5	Explain the working of Pyranometer with the help of relevant Sketch **Pyranometer** • A pyranometer is an instrument which measure's either global or diffuse radiation falling on a horizontal surface. • Pyranometer are classified as 'A', 'B' or 'C' based on specifications such as response time, directional response, temperature response, tilt response and calibration method. • Based on the Seebeck- or thermoelectric effect, a pyranometer is operated based on the measurement of a temperature difference between a clear surface and a dark surface. • The main components of pyranometer are a thermopile, a glass dome, and an occultating disc. • Outer dome made from a hemisphere of optical-quality glass. • Inner dome made from a smaller hemisphere of optical glass. • Black carbon disk (illuminated by the Sun) absorbs a broad range of wavelengths of solar radiation and acts as the sensing element. • Control disk (not illuminated by the Sun) acts as a comparison. • Thermopile temperature sensor compares the temperature rise of the two disks. • Output lead (usually about 10m or 30ft long). • Replaceable silica gel cartridge absorbs moisture to prevent dew forming inside on cold nights. • Adjustable screw legs let you level the pyranometer. 	[10]	CO2	L1
6	A Solar cell array is required to deliver 100 W peak output at 120V DC bus voltage. The solar cells to be used are rated for 0.1 W peak output at 0.4V. Assuming that there are no assembly losses, define the array. **Solution** Maximum power rating of each cell (P_C) = 0.1 W Let N_T is the total number of cells. Total output power of array (P_{MAX}) = 100 W Hence, $N_T = P_{MAX}/P_C$ = 100/0.1= 1,000 cells Further, number of cells in series = N_S = array output voltage (V_a)/V_{MP} =120/0.4 = 300 cells Since $N_T = N_S \times N_P$ N_P = 1,000/300 = 3.33 parallel strings Therefore, a decision must be taken to use either 3 or 4 parallel strings. With $N_P = 4$, N_T = 1,200 and array power = 0.1 × 1,200 = 120W With $N_P = 3$, N_T = 900 and array power = 0.1 × 90 = 90 W	[10]	CO2	L3
7	Find the Sunrise and Sunset time and length of the day at CMRIT on 28th July 2019, Take the latitude and Longitude of CMRIT as Latitude: 12.97160° N and Longitude: 77.59456 ° E	[10]	CO2	L3

local longitude = ...

latitude (ϕ) = ~~12°58'38"N~~ 12.9667°N

longitude = ~~77.4833°E~~ 77.7115°E

ep 1

find Declanation angle (δ) = $23.45 \sin\left[360 * \frac{(284+n)}{365}\right]$

(* calculate n from January 1 to July 29th 2019)

J F M AP MA JUN July

$31+28+31+30+31+30+28$

= 209 days

$\delta = 23.45 \sin\left[360 \times \frac{(284+209)}{365}\right]$

= 18.91

ep 2 measure Solar hour Angle (ws)

$\cos ws = -\tan\delta \tan\phi$

$ws = \cos^{-1}(-\tan\delta \tan\phi)$

$ws = \cos^{-1}[-\tan(18.97)\tan(12.9833)]$

$ws = \cos^{-1}(-0.07925)$

$= 94.55^\circ$

p 3 Daylength (Smax)

$S_{max} = \frac{2}{15} \times ws$ (In hours)

$= \frac{2}{15} \times 94.55 = 12.606$ hours

Step: 4 EOT $9.875 \sin 2B - 7.53 \cos B - 1.5 \sin B$

$B = \frac{360}{364}(n-81)$

$B = \frac{360}{364}(209-81) = 126.593$

$9.875 \sin(2(126.593)) - 7.53 \cos 126.593 - 1.5 \sin(126.593)$

~~9.875~~.

= −6.12 minutes

Step:5

Sunrise time = solar time + [4($\underset{\text{standard longitude}}{82.5}$ − $\underset{\text{local longitude}}{77.7115^\circ}$ + $\underset{\text{EOT}}{(-6.12)}$)]

Solar time = 12 − 0.5max = 5.698

5hrs [0.698x60 = 42minutes]

5hrs 42minutes

5hrs 42mins + [4(82.5 − 77.115° + (−6.12)]

5hrs 42minutes + [15.42 minutes]

5 hrs 57 minutes Am

Sunset time 0.5(max)

0.5 x 12.604

= 6.308

take 0.308x60

= 18.48

6hrs 18minutes + 15.42minutes.

= 6:33pm.