Enrolment No:	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

ONLINE END SEMESTER EXAMINATION, JUNE 2021

Course: Solar Thermal Technologies. **Semester: II**

Program: M Tech Renewable Energy Engineering **Time 03 hrs.**

Course Code: EPEC 7016 **Max. Marks: 100**

SECTION A

1. Each Question will carry 5 Marks

2. Instruction: Write short answers.

S. No.		CO
Q1	Differentiate between solar irradiance and solar insolation.	**CO1**
Q2	List some parameters due to which the performance of solar flat plate collectors is affected.	**CO2**
Q3	Write the properties required for the phase change material used in solar thermal storage system.	**CO3**
Q4	Calculate the concentration ratio, the aperture, the height and the surface area of the collector of compound parabolic collector 1 m long with acceptance angle of 20^o. The absorber surface of the collector is flat and has a width of 10 cm.	**CO4**
Q5	In central tower type solar collector the heliostats: (a) have 1-axis tracking facility (b) have 2-axes tracking facility (c) are fixed (d) are adjusted seasonally	**CO5**
Q6	What is the typical cooking time of a paraboloid dish cooker? (a) 2–3 hours (b) 20–30 minutes (c) 20–30 seconds (d) 6–12 hours	CO2

SECTION B

1. Each question will carry 10 marks

2. Instruction: Write brief notes

Q7	Discuss the working of the instruments used for measuring solar radiation and sunshine. Calculate the angle made by beam radiation with the normal to a flat plate collector on May 1^{st} at 0900 h (local apparent time). The collector is located in New Delhi ($28^o35'$N, $77^o12'$E). It is tilted at an angle of 36^o with the horizontal and is pointing due south.	**CO1**

<table>
<tr><td>Q8</td><td>Outline the key steps for testing Solar Flat Plate Collector and list some collectors available commercially for water heating.</td><td>CO2</td></tr>
<tr><td>Q9</td><td>A cylindrical hot water storage tank 1.7 m in diameter and 2.1 m high is made from a steel plate (ρ = 7800 kg/m^3, Cp = 0.46 kJ/kg-K) 6 mm thick. Apart from the mass of steel required for making the surface an additional 200 kg of steel is required in the form of angles, etc. for strengthening the tank, which is insulated all round with glass wool insulation 20 cm thick (k = 0.4 W/m-K). The initial temperature of the water in the tank is 50^{o}C at 0700 hrs in the morning on a particular day and the variation of q_u and T_a upto 1200 hrs shown below
<table>
<tr><th>Time</th><th>7-8</th><th>8-9</th><th>9-10</th><th>10-11</th><th>11-12</th></tr>
<tr><td>q_u (kJ/h)</td><td>18660</td><td>37496</td><td>54890</td><td>60070</td><td>69890</td></tr>
<tr><td>T_a (^{o}C)</td><td>17.8</td><td>21.9</td><td>25.1</td><td>27.4</td><td>29.1</td></tr>
</table>
The load requirement is such that energy is continuously withdrawn from the tank at a constant rate of 27,000 kJ/h for 8 hrs a day starting at 0500 hrs. Assume that the water in the tank is always well mixed, calculate the variation of its temperature.</td><td>CO3</td></tr>
<tr><td>Q10</td><td>Following data are given for a flat plate collector:
➢ Size of absorber plate = 2.4 m × 1.4m
➢ Absorber plate thickness = 0.18 mm
➢ Thermal conductivity of plate material = 360 W/m-K
➢ Number of tubes attached below abs. plate = 15
➢ Fluid flow rate = 50 kg/h
➢ Water inlet temperature = 40°C
➢ Specific heat of fluid at 50°C = 4174 J/kg-K
➢ Tube to fluid heat transfer coefficient = 200 W/m^2-K
➢ Outer diameter of tubes = 15 mm
➢ Inner diameter of tubes = 13.8 mm
➢ Overall loss coefficient of the collector = 5 W/m^2-K
➢ Average thickness of adhesive = negligible
➢ Length of controller = 2.5 m
➢ Width of controller = 1.5 m
➢ Ambient temperature = 24°C
➢ Beam radiation on horizontal surface = 650 W/m^2
➢ Diffuse radiation (uniformly distributed in the sky) = 150 W/m^2
➢ Tilt factors for beam, diffuse and reflected radiations = 0.95, 0.98 and 0.005 respectively
➢ Transmissivity-absorptivity product for beam radiation falling on the collector =0.8321</td><td>CO4</td></tr>
</table>

	➢ Transmissivity-absorptivity product for diffuse radiation falling on the collector= 0.79 **Calculate:** (i) the collector heat removal factor, F_R (ii) water outlet temperature, T_{fo} (iii) instantaneous efficiency of collector, η_i	
Q11	i. Explain the process of power generation using solar chimney. ii. It is proposed to set up a solar chimney power plant in Rajasthan with a chimney 300m high. Calculate the maximum possible conversion efficiency obtainable with chimney, also estimate the efficiency of the plant as a whole and the daily electrical output in a typical summer month (in kWh), if the solar collection area of the greenhouse is 50,000 m^2.	**CO5**
Section C **1. Each Question carries 20 Marks.** **2. Instruction: Write long answer.** **3. Attempt any one question**		
Q12	i. Describe the spectral power distribution of solar radiation and the solar radiation geometry in detail. ii. Calculate the angle of incidence of beam radiation on a plane surface, tilted by 45° from horizontal plane and pointing 30° west of south located at Mumbai at 1:30 PM (IST) on 15th November. The longitude and latitude of Mumbai are 72° 49'E and 18° 54' N respectively. The standard longitude for IST is 81° 44' E. **OR** i. Explain how the monthly average of terrestrial global radiation is related to sunshine hours. ii. For Coimbatore (11.0183° N, 76.9725° E, and elevation of 411 m above sea level), estimate the value of average daily global radiation on horizontal surface during the month of March. The average sunshine hours per day for the month of March may be assumed as 9.5 h.	**CO1**