Enrolment No.____

GUJARAT TECHNOLOGICAL UNIVERSITY ME - SEMESTER-II • EXAMINATION – SUMMER - 2017

Subject Code: 2722108 Subject Name: Solar Energy Engineering Time: 02:30 PM To 05:00 PM

Date: 26/05/2017

Total Marks: 70

04

Instructions:

- 1. Attempt all questions.
- 2. Make suitable assumptions wherever necessary.
- 3. Figures to the right indicate full marks.
- Q.1 (a) Explain in brief 2nd law analysis for concentrating collector. Derive the expression for the 10 minimum entropy generation rate and optimum collector temperature for concentrating collector.
 - (b) Explain in brief with neat sketch how solar pond is constructed?
- **Q.2** (a) A cylindrical parabolic collector is used for heating water. The concentrator has an aperture of 1.3 m and a length of 3.7 m while absorber tube (having inner diameter = 3.8 cm, outer diameter = 4.2 cm) has a concentric glass cover (having inner diameter = 5.5 cm, outer diameter = 6.3 cm) around it. Consider, wind speed = 5.5 m/sec, mass flow rate of water = 0.09 Kg/sec, mean temperature of absorber tube = 140° C, temperature attained by cover is 60° C, ambient temperature is 20 °C. Take inlet and outlet temperature of water is 138° C and 142° C respectively. Assume flow through absorber tube is fully developed. Find (i) heat transfer coefficient between absorber tube and cover (ii) heat transfer coefficient on inside surface of absorber tube. (iv) Concentration ratio.
 - (b) Discuss the effect of mass flow rate on the performance of air heater and liquid flat plate 04 collector.

OR

- (b) Define the solar swing. Discuss the effect of concentration ratio on the tracking 04 requirement of CPC.
- Q.3 (a) Explain in brief how passive space heating system is distinguished from active space
 08 heating system. Explain the working of various arrangement of passive space heating system with neat sketch.
 - (b) Explain in brief the working of solar chimney as solar power generation with neat sketch. 06

OR

- Q.3 (a) Explain in brief working of solar based continuous absorption cooling system with neat 07 sketch.
 - (b) Explain in brief active water heating system with neat sketch. What precautions to taken 07 against the freezing of water in collector?
- Q.4 (a) Explain the concept of (1) hourly utilizability and (2) Daily utilizability. 07

(b) Find out the total flux falling on a tilted surface facing due south at location 24°36'N on 21st March of non-leap year. The solar altitude angle is 54°. The day length for the tilted surface is 12.0051 hrs. Take hour angle for location, before the solar noon. Assume no snow condition.

OR

- Q.4 (a) Explain with neat sketch f chart method for the standard heating system using air as 07 heat transfer fluid.
 - (b) A surface is tilted at an angle of 35° at location (28.58°N) and faces at a surface 07 azimuthal angle. The difference between the surface azimuthal angle and solar azimuthal angle is 19.34°. The solar altitude angle is 58.67°. Determine the angle of incident on 19th September of non-leap year. Take hour angle for location, after the solar noon. For the calculation of solar azimuthal angle, use $\sin \gamma_s = \sec \alpha \cos \delta \sin \omega$.
- A combined solar and fuel system to meet the energy requirement for the society. The 10 Q.5 (a) proposed collector, having area 50 m², and associated equipment will supply energy so as to reduce fuel purchase by 56%, will cost Rs.11,00,000/- and will be 90% financed over 20 years at an interest rate of 9%. The first year's fuel cost for a system without solar would be Rs.1,25,500/-. Fuel costs are expected to rise at 10% per year. It is expected that the equipment will have a resale value at the end of 20 years of 40% of the original cost. In the first year, extra insurance, maintenance, and parasitic energy costs are estimated to be Rs. 11,000/-. Extra property tax is estimated to be Rs. 22,000/-. These are expected to rise at a general inflation rate of 6% per year. Extra property taxes and interest on mortgage are deductible from income for tax purposes; the effective income tax rate is expected to be 45% through the period of the analysis. What is the present worth of solar savings for this process over a 20-year period if the market discount rate is 8%? Use present worth factor method.
 - (b) Explain in brief the working of measuring device for the sunshine hours with neat sketch. 04

OR

Q.5 (a) A solar water heater is proposed to install on a residence. The annual load is estimated 10 to be 22.2 GJ. The following table shows collector area, tank capacity, installed cost and fraction of annual hot water load carried by solar saving.

Design	Collector	Tank	System cost	Fraction by
	area (m ²)	capacity	(Rs.)	solar
		(kg)		
А	5.49	454	240000/-	0.56
В	7.32	454	280000/-	0.67

The water heater could be purchased by a 20 % down payment with the balance to pay over a 10 year period with interest at 9 % per year. The present cost of electrical energy is Rs.1400/- per GJ and it is inflated at 8.5 % per year. Insurance, maintenance and parasitic power cost in 1st year are expected to be 1 % of system cost. The real estate tax increment in 1st year will be 1.5% of system cost. The insurance, maintenance, parasitic power cost and real estate tax are expected to rise at a general inflation rate of 6 % per year. The owner's effective income tax is 0.45. The market discount rate is to be 8 % per year. If the analysis is done over 15 year and system is assumed to have no appreciable resale value at that time, which system should be brought? For the best system how long would it take to recover the system cost in saving on the purchase of electricity?

(b) Explain in brief the working of measuring device for the beam radiation with neat 04 sketch.
