Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER II– EXAMINATION – WINTER - 2016

Subject Code: 2722108 **Date: 18/11/ 2016**

Subject Name: Solar Energy Engineering

Time: 2:30 pm to 5:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Use of Solar Energy Data book is permissible after verification.**
4. **Figures to the right indicate full marks.**

Q.1	**(a)**	Explain the principle and working of indirect solar drying with neat and clean figure.	**07**
	(b)	Explain the working and construction of solar pond with neat and clean figure.	**07**
Q.2	**(a)**	Write a short note on Packed bed type storage system.	**05**
	(b)	A flat plate collector is tilted at latitude angle facing due south at location (25.57^0N, 91.88^0E). Determine monthly mean total radiation falling on the surface for the 10th December, 2015. Average sunshine hours are 10. Elevation of location is 1496 m. Consider no snow condition.	**09**
		OR	
	(b)	(i) Define (1) Solar altitude (2) Solar Azimuthal angle	**02**
		(ii) A solar water heating system is installed at location (20.63^0N, 72.93^0E) with collector inclined at 22^0 facing due south. Determine the instantaneous radiation on tilted surface at 11:30 A. M. on 21st March, 2015 using ASHRE model. Consider no snow condition.	**07**
Q.3	**(a)**	Explain the testing procedure of solar liquid flat plate collector with neat and clean layout.	**06**
	(b)	A combined solar and fuel system to meet the energy need. The proposed collector and associated equipment will supply energy, so as to reduce fuel purchase by 56%, will cost Rs. 20000/- and will be 90 % financed over 5 years at an interest of 9%. The 1st year's fuel cost for a system without solar would be Rs.1300/-. Fuel cost is expected to rise at 10% per year. It is expected that the equipment will have a resale value at the end of 5 years of 40 % of original cost. In 1st year, extra insurance, maintenance and parasitic energy costs are Rs. 200/- . Extra property tax is estimated to be Rs. 300/-. These are expected to rise at a general inflation rate 6% per year. Extra property taxes and interest on mortgage are deductible from the income for the tax purpose. The effective income tax rate is expected to be 45% through the period of analysis. What is the present worth of solar saving for this process over 5 years if the market discount rate is 8%.	**08**
		OR	
Q.3	**(a)**	Derive an expression of heat removal factor for the compound parabolic collector.	**08**
	(b)	(i) Define (1) Solar fraction (2) Solar Saving	**02**

(ii) For non-solar process, calculate the present worth and present worth factor of fuel cost over 8 years if the 1st year's cost is Rs. 30000/-, it inflates at 10% per year for 3 years and then it inflates at 6% per year. The market discount rate is 8%. **04**

Q.4 (a) Calculate the overall loss coefficient, heat lost from top, heat loss from bottom, heat loss from side, over all heat loss and for a flat plate collector with two glass covers with the following data: **10**

Flux incident on the top cover of collector = 860 W/m^2
Solar flux absorbed in absorber plate = 600 W/m^2
Size of absorber plate = 1.1 m x 2.2 m
Spacing between first and second glass cover = 5 cm
Spacing between absorber plate and first glass cover = 6 cm
Absorber plate emissivity = 0.93, Glass cover emissivity = 0.83
Collector tilt = 22° , Mean absorber plate temperature = 78° C
Ambient air temperature = 22° C, Wind speed = 2.7 m/sec
Back insulation thickness = 9 cm, Side insulation thickness = 5 cm
Thermal Conductivity of insulation = 0.05 W/m K. Use McAdams correlation.

(b) Explain the working principle of intermittent solar absorption refrigeration system with neat and clean sketch. **04**

OR

Q.4 (a) Calculate the (1) instantaneous collector efficiency (2) pressure drop of a conventional solar air heater with the following data: **10**

Length of absorber plate = 1.9 m, Width of absorber plate = 1.0 m
Spacing between absorber plate and bottom plate = 1.3 cm
Air flow rate = 213 Kg/h
Air inlet temperature = 49° C, Ambient temperature = 27° C
Solar flux incident on collector face = 830 W/m^2
Average transmissivity-absorptivity product = 0.84
Top Loss coefficient = 7.0 W/m^2 K,
Emissivity of absorber plate and bottom plate = 0.9
Assume mean fluid/air temperature = 60° C
Assume very small difference of temperature between absorber plate and bottom plate. Neglect heat loss from the sides.

(b) Explain the working of natural circulation of solar water heating system with neat and clean sketch. **04**

Q.5 (a) Explain in brief the concept of central receiver system for solar thermal power generation. **04**

(b) A cylindrical parabolic collector is used for heating a thermic fluid, has dimensions as follows: **10**

Aperture width =1.25 m, Length of collector = 3.65 m
Absorber tube, inner diameter = 3.8 cm, outer diameter = 4.1cm
Glass cover, inner diameter = 5.5 cm, outer diameter = 6.4cm
Overall loss coefficient = 13.3 W/m^2 K, Absorbed flux = 490 W/m^2

Ambient temperature = 32° C, Fluid inlet temperature = 150° C
Mass flow rate of water =0.091 Kg/sec

The properties of thermic fluid at mean fluid temperature is ρ = 750 Kg/m^3, ν = 2.42 x 10^{-6} m^2/s, C_p = 2.4 kJ/Kg-K, k = 0.12 W/m-K.

Calculate,

1) Calculate the twisted tap ratio to obtain an outlet temperature from the collector is 156°C.
2) Mean temperature of Absorber tube.

OR

Q.5 (b) Explain in brief the concept of *f*-chart for estimating the annual thermal performance of solar active system. **04**

(a) A CPC with evacuated tube having a concentration ratio 6, the width of its absorber plate is 6 cm and its length is 2 m. The collector is used for heating a fluid (C_p = 2.35 kJ/kg-K) which enters at a temperature of 130ºC. Calculate (1) over all loss coefficient (2) Heat transfer coefficient on inside surface of absorber tube using the following data: **10**

Location = 28.38^{0}N, 77.12^{0}E, Date: 24th May, 2016, LST = 1:00P.M.
Global radiation = 0.740 kW/m^2, Diffuse radiation = 0.160 kW/m^2
Number of evacuated tube = 2, Aperture slope = 40^0
Tube outer diameter = 18 mm, Tube inner diameter = 14 mm
Specular reflectivity of concentrator surface = 0.88
Glass cover transmissivity for solar radiation = 0.9
Absorptivity of Absorber surface = 0.95
Absorber surface emissivity = 0.2, Ambient temperature = 25° C
Mean temperature of Absorber tube = 225° C
Mass flow rate of fluid = 75 Kg/hr
Instantaneous efficiency of collector = 53.2 %

****