Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER–IV • EXAMINATION – SUMMER 2015

Subject Code: 743901 **Date: 01/05/2015**

Subject Name: Solar and Photovoltaics

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

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Use of solar energy data book is permitted after verification.**

Q.1 **(a)** Discuss the solar cell characteristics and prove that maximum power for solar cell is product of fill factor (F.F.), open circuit voltage (V_{oc}) and light generated current (I_L). **07**

(b) Explain the working of photovoltaic solar cell with neat sketch and define the Packing factor for solar Panel. **07**

Q.2 **(a)** Explain in brief the life cycle analysis for the solar water heating system. **07**

(b) Derive the expression for (i) reflectivity (ii) transmissivity based on reflection and refraction for two component system. **07**

OR

(b) (i) Define the transmissivity-absorptivity product. **02**

(ii) Find the transmissivity for the following cover system: **05**

Material : Glass
Number of Covers = 3
Thickness of each cover = 5 mm
Refractive index of glass relative to air = 1.6
Extinction coefficient of glass = 15 m^{-1}
Angle of incidence = 35°

Q.3 **(a)** Define the following terms: **07**

(i) Solar Constant
(ii) Air Mass
(iii) Beam Radiation
(iv) Zenith
(v) Hour angle
(vi) Sunôs Declination
(vii) Diffuse Radiation

(b) A surface is tilted at 35° and faces 10° west of south at New Delhi [28° 35ô N, 77° 12ô E]. Determine the Angle of incidence at 13 hrs 13 min on 19th September, 2015. **07**

OR

Q.3 **(a)** Explain (i) Surface Azimuth angle (ii) incident angle and (iii) Slop with neat sketch. **05**

(b) A solar air heater is installed at Jodhpur [26° 18ô N, 73° 01ô E] faces due south and tilted at 10° with horizontal. Determine the monthly mean beam radiation and global diffusion for the 13th April, 2015. Assume monthly mean of sunshine is 11 hrs. **09**

Q.4 **(a)** Derive the expression for the collector efficiency factor for the flat plate collector. **07**

(b) Calculate the overall loss coefficient, heat lost from top, heat loss from bottom, heat loss from side and over all heat loss for a flat plate collector with two glass covers with the following data: **07**

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

OR

Q.4 **(a)** Explain the Testing procedure for the flat plate collector. **05**

(b) Calculate the useful energy of solar collector at 11 a.m. on 10th August, 2015 for the location [20.63^o N, 72.93^o E]. Collector tilt is 19°. The measured beam radiation intensity is 450 W/m^2 over a horizontal surface. Ambient air temperature is 36° C. For collector take overall loss coefficient is 8 W/m^2 K. Thermal conductivity of the plate is 210 W/ m^2 K. Centre to centre distance between two tube is 13 cm , fin thickness is 0.08 cm, the tube outer and inner diameters are 1.3 cm and 1.0 cm respectively. Fluid to tube heat transfer coefficient is 1500 W/m^2 K. With the negligible bond resistance and wall resistance, cover transmittance for solar radiation is 0.84 and is independent of direction, solar absorptance of absorbing plate is 0.96 and independent of direction, collector width is 1 m and length is 2 m, water flow rate is 0.02 kg/sec and water inlet temperature is constant and equal to 78° C. C_p for water 4.187 KJ/Kg K. **09**

Q.5 **(a)** Derive the expression for the collector efficiency factor, heat removal factor and instantaneous efficiency for the cylindrical parabolic collector. **07**

(b) Calculate the performance parameters of a conventional solar air heater with the following data: **07**

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 = 6.2 W/m^2 K
Bottom Loss coefficient = 0.8 W/m^2 K
Emissivity of absorber plate and bottom plate = 0.9
Assume mean fluid/air temperature = 55° C
Assume very small difference of temperature between absorber plate and bottom plate. Neglect heat loss from the sides. Properties of air at 55° C are: ρ = 1.077 Kg/m^3, C_p=1.005 KJ/Kgï K, μ=19.85 x 10^{-6} N-s/ m^2, k = 0.0287 W/m-K. All Notations have their usual meanings. Use relations, N_u=0.0158 x $R_e^{0.8}$ and f = 0.079 x $R_e^{-0.25}$.

OR

Q.5 **(a)** Derive the expression for the collector efficiency factor, heat removal factor for the conventional air heater. **07**

(b) Explain the working of solar pond with neat sketch. **07**