24/05/2017

M·E/Sem-I/CBCGS/Mech (Thermal)/USE/M-J-17

Q.P. Code : 859500

(3 Hours) **[Total Marks : 80**

N.B. : (1) Solve any **FOUR** questions.
(2) Assume suitable additional data if necessary & draw the sketches wherever required.
(3) Refer annexure for empirical formula.

1. a) Write a note on building orientation and design. **7**
   b) Explain Government policies for promotion of Solar Energy Use in India. **6**
   c) Explain Solar distillation. **7**

2. a) A PV array at a place [26° 18' N, 73° 01' E] is kept facing due south. How many hours the array would get sunshine for following data. **10**
   Date : August 25
   Slope angle : 20°
   b) Elaborate effects of following parameters on performance of Liquid Flat Plate Collector **10**
   i) Selective surfaces
   ii) Number of covers
   iii) Collector tilt
   iv) Spacing
   v) Effect of shading

3. a) Discuss various types of Solar Energy Collectors. **10**
   b) Calculate the angle made by beam radiation with the normal to flat plate collector on December 17 at 0900 h (LAT) and 1200 h (LA T). The collector is located in Mumbai (19° 07' N, 72° 51' E). It is tilted at an angle of 36° with the horizontal and pointing due south. **10**

4. a) What do you understand by Extra-terrestrial and Terrestrial radiation in regards of SUN, discuss in detail? Explain Solar constant and its significance. **10**
   b) Discuss in detail Initial cost, Annual cost, Life cycle savings, and Payback period, in solar thermal systems. **10**

[TURN OVER]

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5. a) In an installation, 14 identical collectors are connected in series and are operated under normal atmospheric condition. The individual collector parameters are as follows: **10**

$F_R (\tau\alpha)_{eff} = 0.69$; $F_R U_L = 4.1$ W/m²-K, Ap = 2m²

Water is used as the working fluid, which enters the installation at 28°C at flow rate of 0.04 kg/s. Total radiation incident on the collector plane is 860W/m² and the ambient temperature is 24°C. What is the outlet temperature of the installation? What is the useful heat gain rate due to the last collector? If one more collector is added to the series, what would be the rise in the outlet temperature? Comment on your result. Take C_p of water = 4187 J/kg-K.

b) State the factors affecting Angle of incidence. **10**

6. Write short notes **any FOUR** : **20**

i) F- chart method
ii) Solar drying
iii) PV generators
iv) Economics of solar systems
v) Pyranometer
vi) Evaporative Cooling

Annexure: Formula Sheet

Extra terrestrial radiation

$$I'_{sc} = I_{sc}\,(1 + 0.033 \cos(360n/365))$$

Angle of Incidence (θ)

$$\cos\theta = \sin\phi(\sin\delta\cos\beta + \cos\delta\cos\gamma_s\cos\omega\sin\beta) + \cos\phi(\cos\delta\cos\omega\cos\beta - \sin\delta\cos\gamma_s\sin\beta) + \cos\delta\sin\omega\sin\gamma_s\sin\beta$$

Zenith angle (θ_z)

$$\cos\theta_z = \sin\phi\sin\delta + \cos\phi\cos\delta\cos\omega$$

Azimuth angle (γ) is given by

$$\cos\gamma = \frac{\sin\phi\cos\delta\cos\omega - \cos\phi\sin\delta}{\sin\theta_z}$$

Zenith angle(θz) is given by

$$\cos\theta_z = \sin\phi\sin\delta + \cos\phi\cos\delta\cos\omega$$

Sunrise and sunset hour angle is given by

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

Time difference between noon sunrise or sunset (hour)

$$h_{sunrise} = \frac{1}{15}\left[-\cos^{-1}(\tan\phi\tan\delta)\right]$$

Day length

$$T_{day\_length} = \frac{2}{15}\left[-\cos^{-1}(\tan\phi\tan\delta)\right]$$

Equation of time correction

E = 229.18 (0.000075 + 0.001868 cos B – 0.032077 sin B – 0.014615 cos 2B – 0.04089 sin 2B)

where B = (n - 1) 360/365 and n is the day of the year

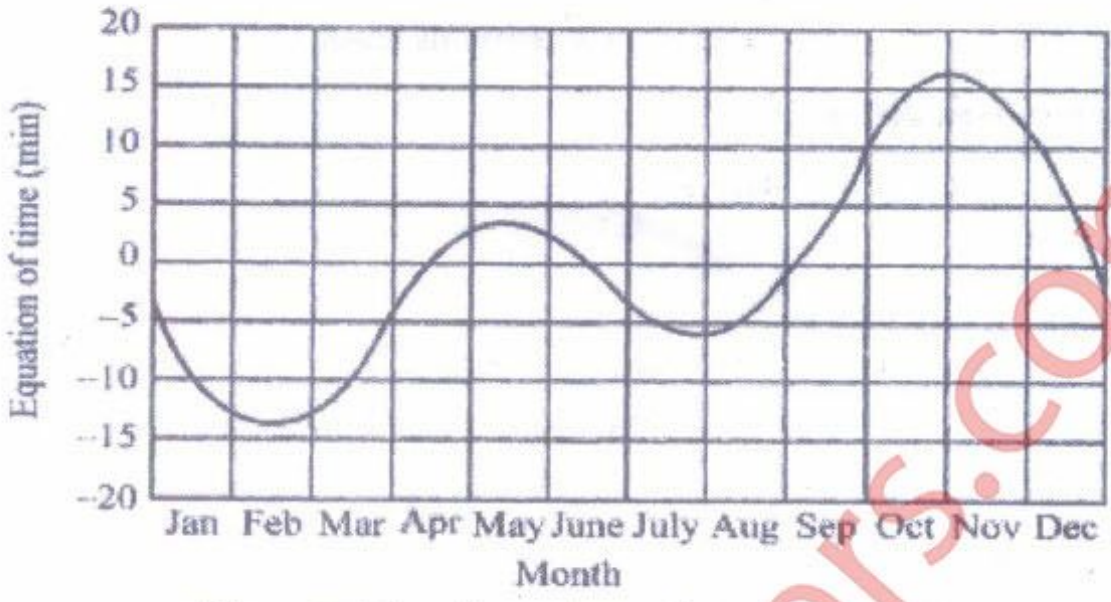

Fig. 3.14 *Equation of time correction*

LAT = Standard time ± 4 (standard time longitude – longitude of location)

+ (equation of time correction)

Declination (δ)

$$\delta = 23.45^{\circ} \sin\left[\frac{360^{\circ}}{365}(284 + n)\right]$$

Useful heat gain by the collector

$$q_u = F_R A_p [\, I_T (\tau\alpha)_{av} - U_L (T_{fi} - T_a)]$$

$$m = - (A_P U_L F') / \{C_p \,.\, \ln\{ 1 - [U_L (T_{fo} - T_{fi}) / S - U_L (T_{fi} - T_a)\}$$

For array of identical collectors

$$F_R(\tau\alpha) = F_{R1}(\tau\alpha)_1 \{ [1-(1-K)^N / NK]\}$$

$$F_R U_L = F_{R1} U_{L1} \{[1-(1-K)^N / NK]\}$$

Where $K = (A_p F_R U_L) / m C_p$