ME/sem I/ CBCGS/ MECH Thermal / USE/ M-J-18 22/05/18

Q.P.Code: 21501

(3 Hours) **[80 Marks]**

N. B. :

i) Solve any **FOUR** questions.
ii) Assume suitable additional data if necessary & draw the sketches wherever required
iii) Refer annexure 1 for empirical formulae

Q.1 a) Enlist various thermal applications of where Solar energy can be utilized. Describe briefly any two such systems available in India. **10**

b) Write a note on Building orientation and design. **10**

Q.2 a) Describe Thermo-chemical storage system **10**

b) Describe Indian Government Policies and Utilisation of Solar Energy in India **10**

Q.3 a) Discuss in detail Initial cost, Annual cost, Cumulative solar savings, Payback period & Life cycle savings in solar thermal systems. **10**

b) Explain Flat Plate Solar Collectors. What are their advantages and limitations? **10**

Q.4 a) State and explain the factors affecting angle of incidence. **10**

b) A solar pond 1.5 m deep is built in Pondicherry (11° 56' N). the following values of global and diffuse radiation are measured by a horizontal Pyranometer placed beside the pond on April 20 at 1300 h(LAT) **10**

I_g 0.964 kW/m^2
I_d 0.210 kW/m^2

Calculate the variation of the solar radiation flux as it penetrates through the pond.

Q.5 a) Discuss Standard Procedure and code of conduct for Testing of Solar Water Heaters. **10**

b) Calculate the angle of incidence of beam radiation on a flat plate collector for the following situation **10**

Location	Mangaon (18°12' N, 73°20' E)
Date	6 October
Time	0900 h (IST)
Slope of collector	31°
Surface Azimuth angle	15°

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

I. PV generators
II. Pyranometer
III. Evaporative Cooling
IV. F- chart method
V. Thermal Stratification
VI. Concentrating collectors

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Annexure:1 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)

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

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*

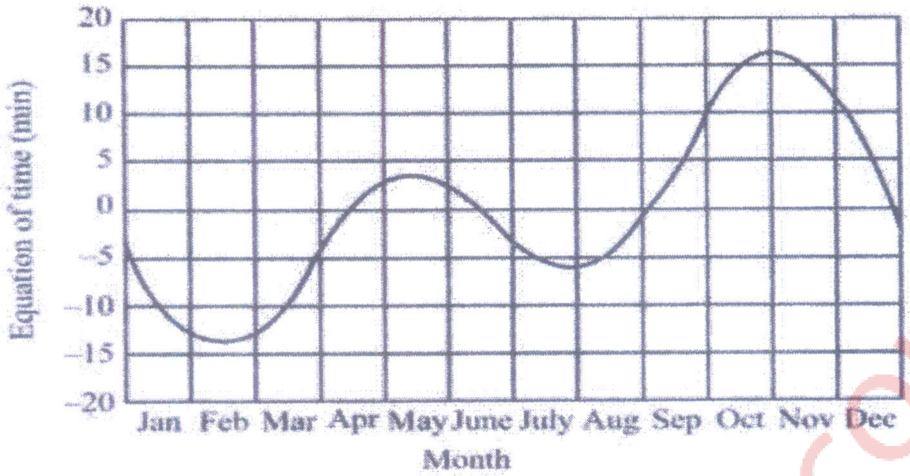

Fig. 3.14 *Equation of time correction*

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

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