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Q5. a) Definitions - with diagram(1), 4*1=04 [5]

b) Refer Solution [5]

OR

Q6. a) Importance -01 What is required (i) electrically and (ii) mechanically to accommodate variable speed rotor (1.5*2=03) [5]

b) Refer Solution [5]

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Soln & Scheme of Marking :-

Renewable Energy System : [403143]

[30 marks]

location : (18°, 53'N, 73°, 50'E)

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5) On 13th August

$n = 31+28+31+30+31+30+31+13$

$= 225$ ——— (1)

$\therefore \delta = 23.45 \sin\frac{360}{365}(284+225)$ ——— (1)

$= 14.42°$

$\phi = 18 + \frac{53}{60} = 18.883°$

Sunrise hour angle

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

$= \cos^{-1}[-(0.342059)(0.257258)]$

$= 95.05°$ ——— (2)

Day length :

$S_{rise} = \frac{2}{15} * 95.05°$

$= 12.67$ hr. } ——— (1)

$= 12$ hr, 40 min.

Q2 (b) Locn (18°, 53'N, 73°, 50'E)

$LAT = ST \pm 4(Long_{std} \sim long_{place}) + E$

$E = 9.87 \sin 2B - 7.53 \cos B - 1.5 \sin B$

$B = \frac{360}{364}(n-81) = \frac{360}{364}(225-81) = 142.02$ ——— (1)

(13th day → n = 225) ——— (1).

$\therefore E = 9.87(-0.978) - 7.53(-0.788) - 1.5(0.61)$

$= -4.4325$ ——— (1)

$\therefore LAT = 12. - 4\left[82.5 - \left(73 + \frac{50}{60}\right)\right] - 4.5155$ min

$=$ (PTO) min ——— (1)

LAT = 12 hr − 34.67 min − 4.5455 min

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$= 12_{hr} - \frac{34.67}{60}\ hr - \frac{4.5455}{60}\ hr.$

$= 12_{hr} - 0.578_{hr} - 0.0752\ hr.$

$= 12 - 0.6532 = 11.3468\ hr.$ } — (2)

LAT = 11 hr., 20 min, 48 sec.

Q3 (b) $A = 1\ cm^2$, $P_{in} = 0.9\ mW/cm^2$, $\eta = 20\%$

$V_{oc} = 0.5\ V/cm^2$ $\quad I_{sc} = 10 \times 10^{-3}\ A/cm^2$

$I_m = 0.6 \times 10 \times 10^{-3}\ A/cm^2$

$= 6 \times 10^{-3}\ A/cm^2$ — (1)

(1) Max Volt. $\quad \eta = \frac{V_m I_m}{P_{in}}$

$\therefore V_m = \eta \cdot P_{in}/I_m = \frac{0.2 \times 0.9 \times 10^{-3}}{6 \times 10^{-3}}$

$V_m = 0.03\ V/cm^2$ — (2)

(2) $F.F. = \frac{V_m I_m}{V_{oc} \cdot I_{sc}} = \frac{0.03 \times 6 \times 10^{-3}}{0.5 \times 10 \times 10^{-3}} = 0.036 = 3.6\%$ — (2)

Q4 (b) (3) AM = 1.5 $\Rightarrow \frac{1}{\cos\theta} = 1.5 \Rightarrow \theta = 48.18°$

$\cos\theta = 0.6667$ — (2)

(II) Extra terrestrial Rad^n = 1367 W/m^2

$\therefore$ Normal Rad^n from surface.

$= 1367 \times \cos\theta$

$= 1367 \times .6667$

$= 911.38\ W/m^2$ — (2)

(III) Standard Sol. Rad^n = 1000 W/m^2 ≈ 911.38 — (1)

$\therefore \eta_{\text{standard Radiation}} = \frac{150}{1000} \times 100 = 15\%$ — (1)

(P.T.O)

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Q5

(b) Given wind speed = 10 m/s

$P = 1 \text{ atm} = 1.01325 \times 10^5 \text{ Pa}$

Temp = 15°C (= 273+15 = 288 K) R = gas const = 287 J/kg°K atm

(1) air density $\rho = \frac{P}{RT} = \frac{1.01325 \times 10^5}{287 \times 288 \ (273+15)} = 1.226 \text{ kg/m}^3$

$= 1.226 \text{ kg/m}^3$ — (3)

(2) Total power $P_{tot} = P$

$\frac{P_{tot}}{A} = \frac{1}{2} \rho V_i^3 = \frac{1}{2} \times 1.226 \times 10^3$

$= 613 \text{ W/m}^2$ — (4)

(3) Max^m possible power

$\frac{P_{max}}{A} = \frac{8}{27} \rho V_i^3 = \frac{1}{2} \times 1.226 \times 10^3 = 363 \text{ W/m}^2$ — (1)

(4) $\eta = 0.42$

$\frac{P}{A} = 0.42 \left(\frac{P_{tot}}{A}\right) = 0.42 \times 613$

$= 257 \text{ W/m}^2$ — (1)

(5) Total power

$P = 0.257 \times \frac{\pi D^2}{4} = 0.257 \times \frac{\pi \times 120^2}{4}$ — (5)

$= 2956 \text{ kW}$

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Q6 (b) Change in wind speed (Ratio) = 40/10 = 4 times. — (1)

$\because P \propto (\text{Wind speed})^3$ — (1)

$\therefore$ P will increased by $4^3 = 64$ — (1)

$\because$ 10 mph wind give 120 watts.

$\therefore$ 40 mph wind will give 64 times more

$= 64 \times 120$

$= 7680$ watts. — (2)

$= 7.680$ kW.

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Scheme of Marking

Term-I : In-Semester Examination **Subject Code : Elective-I 403143**

Renewable Energy Systems

Instructions: Solve total Three questions. Solve any one question from Q.1 and Q.2, Q.3 and Q.4 and Q.5 and Q.6

Given:

(1) Equation of incident angle

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

(where Φ –latitude, δ- the declination, ω- hour angle, β- slope)

(2) Equation of time correction (Minutes)

$$E = 9.87\sin 2B - 7.53\cos B - 1.5\sin B$$
$$where, B = (n-81)(360/364)$$

where n is the day of the year

Q1. a) Domestic hot water system –(04) Types of solar thermal collectors-(01) [5]

b) Refer Solution [5]

OR

Q2. a) Explain any one type of CSP. [4]

b) Refer Solution [6]

Q3. a) Illustrative example + **Four** steps involve in designing

(Assume the size of the home is 3 rooms consist of each light and fan load only) [5]

b) Refer Solution [5]

OR

Q4 a) Comparison 4 point –1*4 [4]

b) Refer Solution [6]