GANPAT UNIVERSITY

B. Tech. Semester: VIII (Mechanical Engineering)

CBCS Regular Examination April-June 2017

Subject: 2ME 801 ALTERNATIVE ENERGY SOURCES

Time: 3 Hours

Total Marks: 70

Instruction:
1. *Attempt all questions.*
2. *Don't write anything on the question paper.*
3. *Use of non- programmable scientific calculator is permitted.*
4. *Draw neat sketches and assume suitable additional data, if necessary.*
5. *Figures to the right indicate full marks of the question.*

SECTION I

Que. – 1 **(a)** Calculate the overall loss coefficient U_l for the receiver of a cylindrical parabolic concentrating collector system. The receiver consists of a selectively-coated absorber tubes with one glass cover around it .The following data is given: **6**

Absorber tube ,inner diameter (D_i) outer diameter (Do)	7.5 cm 8.1 cm
Glass cover, inner diameter (D_{ci}) outer diameter (D_{co})	14.4 cm 15.0 cm
Emissivity of absorber tube surface (ε_p)	0.15
Emissivity of glass (ε_c)	0.88
Mean temperature of absorber tube (T_{pm})	170°C
Ambient temperature (T_a)	25°C
Wind speed (V_∞)	4 m/s

(b) What are the types of Ocean Thermal Energy Conversion (OTEC) systems? Explain any one of them briefly. **6**

OR

Que. – 1 **(a)** Estimate the monthly average daily global radiation on a horizontal surface at Vadodara (22°00' N, 73°10' E) during the month of March if the average sunshine hours per day is 9.5. **6**

"Constant ***a*** and ***b*** for Indian cities"

Location	a	b	Mean error (%)
Ahmedabad	0.28	0.48	0.3
Bhavnagar	0.28	0.47	2.8

(b) Drive an expression for the total power of a wind stream. Discuss the following parameters used in rotor design : **6**

(i) Rotor (ii) solidity and (iii) tip speed ratio

Que. – 2 **(a)** What are the main advantages and disadvantages of sensible heat storage with water as storage media? Compare them with those of solid media storage. **5**

(b) Use the Gopinathan's correlation to calculate the value of H_g for Vadodara for the month of march. **6**

E_L	Ø	S	Smax	H_o
33 m	22.00°	8.5h	10.87 h	32206 KJ/m_2-day

OR

Que. – 2 **(a)** Explain how energy commodities can be economic substitutes for one another. **4**

(b) How are solar collectors classified? What are the important features of a solar collector? **4**

(c) Determine the sunset hour angle and day-length at a location latitude of 32° on March 30. **3**

Que. – 3 (a) Calculate the energy content of the wind per square meter for following situation:

Location:	Indore
Month:	June
Height above ground:	10.9 m
Take $\rho = 1.20$ kg/m^3	

(b) Explain briefly **any *two*** of the following: 6

(i) Horizontal axis wind machines. (ii) Darrieus type wind mill
(iii) Propeller type wind mill (iv) Savonius types wind mill

SECTION-II

Que. – 4 (a) A compound parabolic collector (CPC) 1.5 m long has an acceptance angle of 20°. The surface of the absorber is flat with a width of 15 cm. Evaluate the concentration ratio, the aperture height and the surface area of the concentrator. 6

(b) What do you understand by energy audit? Why is energy audit needed? 6

OR

Que. – 4 (a) What is the MHD generation? How does it work? 6

(b) Explain briefly ,with neat Sketches ,any two of the following concentrating collectors: 6

(i) Paraboloidal dish collectors (ii) Fresnel lens collectors
(iii) Flat-plate collector with adjustable mirrors (iv) Parabolic trough collector

Que. – 5 (a) Explain with a neat sketch the construction and working Janta model biogas plant. State also its advantage and disadvantages. 6

(b) Calculate Local Apparent time (LAT) and Declination at Mehsana (location longitude 77°30'; E, latitude 24° 20'N) corresponding to 12.30 IST on July 24. Equation of time correction (ETC =5'13'') 5

OR

Que. – 5 (a) Plot the variation of τ_r , τ_a and τ with the angle of incidence for the following cover system: 7

Material	Glass	θ_1=18
Number of cover	5	
Thickness of each cover	4 mm	
Refractive index of glass relative to air	1.55	
Extinction coefficient of glass	16 m^{-1}	

(b) Write a note on "utilization of geothermal resources in India." 4

Que. – 6 (a) Calculate hour angle for the local apparent time given by 4

(i) 6 AM (ii) 9 AM (iii) 12 noon (iv) 3PM (v) 6PM (vi) 9 PM

(b) Define the following angles: 8

(i) Latitude angle (ii) Hour angle (iii) Zenith angle (iv) Surface azimuth angle

END OF PAPER

Wind Data

Percentage frequency distribution of hourly wind speed

Location: Kandla Port

Interval (kmph)	J	F	M	A	M	J	J	A	S	O	N	D	Annual
00	1.2	2.8	3.1	3.6	2.2	4.2	1.7	2	3.9	7.1	4.6	2.2	3.2
00-02	2	2.2	2.6	2.1	0.7	1.8	0.9	0.6	1.2	4.3	4.4	2.4	2.1
02-04	2.4	2.3	2.9	2.3	0.6	1.5	1	0.9	2.3	3.9	4.8	2.7	2.3
04-06	3.1	2.5	3	2.1	1.1	1.9	1.6	1.1	2.2	4.2	4.5	3	2.5
06-08	3.2	3.5	3.7	2.5	1.4	1.7	1.3	1.6	3.1	5.8	6.5	4.4	3.2
08-10	5.2	4.4	5	4	1.4	2.2	2.1	2.5	4.5	7.3	7.6	6.5	4.3
10-12	6.5	5.6	5.3	4.4	1.7	2.2	2.2	2.6	4.7	7.8	8.1	7.5	4.8
12-14	8.2	6.8	6.4	5	2.4	2.6	2.6	3.9	5.6	8.7	9.7	8.4	5.8
14-16	9.2	9.5	8.1	6.4	3.2	3.6	3.4	5.5	7.6	10.3	10.2	10.3	7.2
16-18	10.9	9.1	8.2	6.6	3.4	1	3.9	4.7	7.6	9.1	9	11.2	7.3
18-20	12.2	11	9.3	7.1	4.7	4.6	4.4	6.5	8.9	8.7	9.3	11.5	8.1
20-22	9.6	8.8	7.8	6.6	4.6	3.7	4.4	4.8	6.7	5.8	6	9	6.5
22-24	8.5	9.1	8.2	7.3	5.2	4	4.4	5.4	5.9	4.9	6.1	7.8	6.4
24-26	6.5	6.8	7.5	7.5	6.9	5.6	6.2	7.8	8.3	3.8	4.2	5.4	6.4
26-28	4.5	5	5.3	5.5	5.4	5.3	5.5	7.4	5.7	2.1	2.5	3.2	4.8
28-30	2.8	4.1	3.8	6.1	6.4	5.8	6.4	7.1	5	1.8	1.3	2.5	4.5
30-32	1.8	2.4	2.8	4.9	5.8	5.2	7.1	6.9	4.2	1.1	0.6	1.2	3.7
32-34	0.8	1.1	1.8	3.2	5.1	4.7	5.6	4.8	2.5	0.7	0.3	0.3	2.6
34-36	0.7	1.2	1.5	3.5	6.4	5.2	7.3	5.2	2.3	0.8	0.3	0.4	3
36-38	0.2	0.5	1	2.4	5.3	4.6	5.6	3.9	2.1	0.4		0.1	2.2
38-40	0.2	0.6	1.1	2.7	6	5.9	7.6	5.4	2.8	0.2			2.8
40-42		0.3	0.6	1.5	3.9	3.6	4.4	2.9	1	0.3			1.6
42-44	0.3	0.2	0.4	1.1	3.2	2.9	2.6	1.7	0.5	0.1			1.1
44-46		0.2	0.3	0.9	3	3	2.8	1.9	0.7	0.2			1.1
46-48			0.1	0.4	2.6	2.6	1.7	1	0.5	0.1			0.8
48-50			0.2	0.2	2.7	1.8	1.4	0.8		0.5			0.7
50-52					1.9	1.4	0.7	0.4					0.4
52-54					1	1.5	0.5	0.3					0.3
54-56					1.1	0.9	0.5	0.2					0.2
56-58					0.4	0.6	0.1	0.1					0.1
58-60					0.3	0.6	0.1	0.1					
60-62						0.3							
62-64						0.2							

Sensor 33.3 m above ground

Weibull Distribution Table

Coefficient of variation $\frac{\sigma}{\bar{V}}$ of the Weibull distribution, as a function of k alone

	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	---	---	15.84298	5.40769	3.14086	2.23607	1.75807	1.46242	1.26051	1.11303
1	1.00000	0.91022	0.83690	0.77572	0.72375	0.67897	0.63991	0.60548	0.57487	0.54745
2	0.52272	0.50029	0.47983	0.46108	0.44384	0.42791	0.41314	0.39942	0.38662	0.37466
3	0.36345	0.35292	0.34300	0.33365	0.32482	0.31646	0.30853	0.30101	0.29385	0.28704
4	0.28054	0.27435	0.26842	0.26276	0.25733	0.25213	0.24714	0.24235	0.23775	0.23332
5	0.22905	0.22495	0.22099	0.21717	0.21348	0.20991	0.20647	0.20314	0.19992	0.19680
6	0.19377	0.19084	0.18800	0.18524	0.18257	0.17997	0.17744	0.17499	0.17260	0.17028
7	0.16802	0.16582	0.16368	0.16159	0.15956	0.15758	0.15565	0.15376	0.15192	0.15012
8	0.14837	0.14666	0.14498	0.14335	0.14175	0.14018	0.13866	0.13716	0.13570	0.13427
9	0.13286	0.13149	0.13015	0.12883	0.12754	0.12627	0.12503	0.12382	0.12263	0.12146

The following tables may be used to evaluate the Gamma function at values required to

Table 1. $\Gamma\left(1+\frac{1}{k}\right)$

	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	∞	362880.	120.000	9.26053	3.32335	2.00000	1.50458	1.26582	1.13300	1.05218
1	1.00000	0.96491	0.94066	0.92358	0.91142	0.90275	0.89657	0.89224	0.88929	0.88736
2	0.88623	0.88569	0.88562	0.88591	0.88648	0.88726	0.88821	0.88928	0.89045	0.89169
3	0.89298	0.89431	0.89565	0.89702	0.89838	0.89975	0.90111	0.90245	0.90379	0.90510
4	0.90640	0.90768	0.90894	0.91017	0.91138	0.91257	0.91374	0.91488	0.91600	0.91710
5	0.91817	0.91922	0.92025	0.92125	0.92224	0.92320	0.92414	0.92507	0.92597	0.92685
6	0.92772	0.92857	0.92940	0.93021	0.93100	0.93178	0.93254	0.93329	0.93402	0.93474
7	0.93544	0.93613	0.93680	0.93746	0.93811	0.93874	0.93937	0.93998	0.94058	0.94117
8	0.94174	0.94231	0.94286	0.94341	0.94395	0.94447	0.94499	0.94550	0.94599	0.94648
9	0.94697	0.94744	0.94790	0.94836	0.94881	0.94925	0.94968	0.95011	0.95053	0.95094

For example, when k=2.5, we can read (3rd row, 6th column),

$$\Gamma\left(1+\frac{1}{2.5}\right)=\Gamma(1.4)=0.88726$$

evaluate the mean and variance of the Weibull distribution

Correlations& some important formula

Gopinathan Correlations	$a_1=-0.309+0.539\cos\emptyset-0.0693\ E_L+0.290(\bar{S}/\bar{S}_{max})$ $b1=-1.527-1.027\cos\emptyset+0.0926\ E_L-0.359\ (\bar{S}/\bar{S}_{max})$
Overall Loss Coefficient and Heat transfer correlation	$\frac{q_l}{L}=h_{p-c}(T_{pm}-T_c)\pi D_o+\frac{\sigma\pi D_o(T_{pm}^4-T_c^4)}{\left\{\frac{1}{\varepsilon_p}+\frac{D_o}{D_{ci}}\left(\frac{1}{\varepsilon_c}-1\right)\right\}}$ $=h_w(T_c-T_a)\pi D_{co}+\sigma\pi D_{co}\varepsilon_c(T_c^4-T_{sky}^4)$