College of Engineering, Pune
(Final Year B. Tech)- (Mechanical)
(Subject Code)- ME 405-4 (Energy Systems)

Open Book Examination **Timing: 3 hrs**
Academic Year: 2013- 14 **Max. Marks: 60**
End semester Examination

Instructions:
1. Attempt all questions
2. Figures to the right indicate full marks
3. Use of non-programmable calculator is permitted
4. Make suitable assumptions if necessary

<table>
<tr><td>Q. 1</td><td>A.</td><td>A certain effluent treatment plant at Pune requires 4000 liters of hot water at 60°C per day. The water consumption profile is as follows
10 am to 12 am –1500 liters
12 noon to 2 pm – 1500 liters
2 pm – 4 pm – 500 liters
4 pm to 5 pm – 500 liters
Characteristics of Flat plate Collector to be used are
i) Number of FPC panels used as per BIS : 23, Collector Efficiency Factor, $F_R (\tau\alpha) = 0.7$ and Collector loss coefficient factor $F_R U_L = 4.5$ W/m^2-K
ii) The system has cylindrical storage tank with diameter to height ratio of 0.75 Overall heat loss coefficient for insulated storage tank may be taken as 3.5 W/m^2-K
Take
a) Storage tank temperature at 10 am to be 38°C
b) Storage tank volume of 4000 liters
<table><tr><td>Solar Time</td><td>Average Solar Radiation on tilted surface, W/m^2 I_T</td><td>Ambient Temperature °C</td></tr><tr><td>10-12 noon</td><td>500</td><td>30</td></tr><tr><td>12 noon –2 p.m.</td><td>750</td><td>34</td></tr><tr><td>2 p.m. – 4 p.m.</td><td>600</td><td>38</td></tr><tr><td>4 p.m. to 5 p.m.</td><td>450</td><td>37</td></tr></table>
1) Write Energy Balance across the storage tank
2) Derive expression for final storage temperature for a time period of $\Delta\tau$
3) Draw water consumption profile (Temp. Vs. time of the day).</td><td>

2
5
3</td></tr>
<tr><td>Q2</td><td>A</td><td>In Continuation of Q. No. 1, with the above data
1) Determine final storage tank temperature at 12.00 noon, 2.00 pm, 4 pm, and 5 pm.
2) Super impose storage tank temperature profile on water consumption profile
3) Estimate Daily solar fraction.</td><td>
5

2

3</td></tr>
<tr><td>Q3.</td><td>A</td><td>Discuss different modes of tracking in Concentrating Collectors with respect to their arrangement, efficacy, technical feasibility and economic viability?</td><td>10</td></tr>
</table>

Q4.	A	Describe mechanisms of shading excess wind in horizontal axis wind machines	3
	B	A wind turbine with rotor diameter 8 m is installed at a certain location. The wind data for this location indicates Raleigh Winds with shape factor 2 and scale factor 8.Determine	
		i. Average wind speed	1
		ii. No. of hours, wind speed will be below cut in speed of 8 m/s over a year	1
		iii. No. of hours, wind speed will be above cut off speed of 18 m/s over a year	1
		iv. No. of hours wind speed will generate power?	1
		v. If rated wind speed is 11m/s., how much energy in kWh the wind turbine will generate? (Power Coefficient of the turbine is 75% of the Betz limit)	2
		vi. What is the capacity factor for the location?	1
Q5.	A	Design a complete solar photovoltaic system with an array of SPV modules, their configuration, lay out (parallel/ series), charge controller, battery type and size, inverter size, etc. to cater power requirement for an ATM room. 24 hours of autonomy per day is expected from the PV circuit Assume connected load of the ATM to be 1.3 kW with a diversity factor of 0.7. Take Inverter efficiency - 90% Battery efficiency - 80% Battery bank voltage – 48 V Nominal Battery voltage – 12 V Average solar radiation – 600 W/m^2 Average peak sunshine hours per day – 5.5 hrs. Average ambient temperature – 32°C Average values of solar data are applicable for 250 days in a year Nominal operating cell temperature – 45°C Select panels from Table 1.Make suitable assumptions if needed. Draw a neat lay out of the system Determine kWh generated by the array annually? What is SPP of the system if electricity rate is Rs. 12 per kWh and capital cost of SPV system with battery is 210Rs./Wp	10
Q6.	A	Explain briefly the routes of biomass energy conversion	3
	B	Describe with a neat sketch updraft gasifier. Compare the same with down draft gasifier.	4
	C	Explain with a neat sketch a biogas plant	3

Table 1. Solar photovoltaic panel specifications and Brands

	BP	Shell	Sharp	HHV solar
No. of Cells per module	72	42	72	72
Rated power at STC, W	150	40	165	265
Voc, V	42.8	23.3	43.1	43.7
Isc, A	4.75	2.68	5.46	8.08
Width x Length x height mm	1587x790x50	1293x329x54	1587x790x50	1425x652x52
Voltage at maximum power, V	34	16.6	34.6	35
Current at Rated power	4.45	2.41	4.77	7.58
Module cost Rs.	5000	1800	6000	12000

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