BITS,Pilani-Dubai
Dubai International Academic City, Dubai
Second Semester 2008-09
BITS C462 RENEWABLE ENERGY
Comprehensive Examination

Max. .Marks:80 **Date: 26.05.09**
Weightage: 40 % **Time: 3 Hour**

Note:
(i) Answer all Questions sequentially
(ii) Assume suitable value if required
(iii) Draw the sketch wherever required

---

1. (a) Define the following terms:
(i)Global Radiation and (ii) Beam Radiation (2M)

(b) Calculate the average value of solar radiation on a horizontal surface located in Ahmadabad (22^0 00' N, 73^0 10' E) for April 15. Average daily hours of bright sunshine is 10 hours. Assume the constants **a**=0.28 and **b**=0.48. (8M)

2 (a) A WECS maintains a tip speed ratio of 8 at all wind speeds. At which wind speed will the blade tip exceed the speed of sound? (3M)

(b) A wind mill with multi blade rotors lifts 3.03 m^3/hour of water through a head of 28 m when the wind speed is 3.3 m/s. Calculate the power coefficient for a rotor diameter of 4.5 m. Assume the transmission efficiency as 95 % and pump efficiency as 70%, specific gravity of water as 0.996 and specific gravity of air as $1.2x10^{-3}$. (7M)

3.(a) Discuss the advantageous and limitations of OTEC power plants (4M)

(b) In gulf of Cambay, which is being considered for possible tidal power generation, during the tide cycle, the observed difference between the high and low water of the tide was 10.8 m. It has been estimated that this estuary having an area of 10 km^2 can generate power for 3 hours in each cycle. Assuming the average available head to be 10 m and the total efficiency of generation system to be 75 %.

Calculate :

(i) the power in HP at any instant

(ii) (ii) the total energy generated in the year

Take the specific gravity of sea water as 1.025 (6M)

4(a) Compare the following systems: (2M)

(i) Hydrothermal system

(ii) Petro thermal system

(b) A 100 MW vapor dominated system uses saturated steam from a well with a shut-off pressure of 28 bar. Steam enters the turbine at 5.5 bar and condenses at 0.15 bar. The polytrophic efficiency is 0.82 and turbine-generator combined mechanical efficiency is 0.9. The cooling water exists is at 20^0C. Calculate the necessary steam flow, the cooling eater flow and plant efficiency and heat rate if reinjection occurs prior to cooling water. (8M)

5(a) Water are the different fuels that can be derived from the bio mass? How are they differing in terms of energy contents? (4M)

(b) Calculate: (i) the volume of a biogas digester and

(ii) the efficiency of burner

for a family biogas digester suitable for the output of four cows with following data:

The power available from the digester = 300W

Retention time = 20 days

Temperature = 30^0 C

Dry matter consumed =2 kg/day

Density of dry material = 50 kg/m^3

Biogas yield = 0.24 m^3 per kg

Methane proportion = 0.8

Heat of combustion of Methane = 28 MJ/m^3 at STP (6M)

6 (a) What are the different types of Fuel Cells? Describe the principle of working of Ion Exchange Membrane Fuel Cell. (5M)

(b) Explain the materials and their purpose of various components in the operation of solar distillation plant. (5M)

BITS,Pilani-Dubai
International Academic City, Dubai
Second Semester 2008-09
BITS C462 RENEWABLE ENERGY
TEST– 2 (Open Book)

Max.Marks :40 **Date:30.04.09**
Weightage: 20 % **Time: 50 min**

Note:
(i)Answer all Questions (ii) Assume suitable value if required
(iii) Draw the sketch wherever required (iv)Steam tables are allowed

---

1. A wind turbine with solidity 0.5 which has much higher power coefficient and maximum efficiency of 60 %. The mean chord length of each blade is 1 meter. The turbine operates at 40 rpm. Wind at 1 standard atmospheric pressure and 20^0C has velocity of 18 m/s. Calculate (i) maximum obtainable power density, (ii) torque at maximum efficiency and (iii) maximum axial thrust. (10M)

2 A hot water geothermal plant with capacity 20MW, of the total flow type receives water at 225° C. The hot water flow rate is 8.82×10^5 kg/hour. The plant uses a direct contact condenser that operates at 0.5 bar. The turbine has polytrophic efficiency of 85%. Calculate the pressure in bar at turbine inlet. (10M)

3.(a) Discuss the merits and demerits of wave energy plants. (4M)

(b) Enumerate the factors to be considered for effective ocean thermal energy conversion process and explain. (6M)

4 (a) State the present status of tidal power plants in the world and in India (4M)

(b) Discuss the classification of geothermal power plants on the basis of geothermal fluids, thermodynamic cycle and type of turbine (6M)

TABLE B.1.1 (*continued*)
Saturated Water

		ENTHALPY, kJ/kg			ENTROPY, kJ/kg-K		
Temp. (°C)	**Press. (kPa)**	**Sat. Liquid h_f**	**Evap. h_{fg}**	**Sat. Vapor h_g**	**Sat. Liquid s_f**	**Evap. s_{fg}**	**Sat. Vapor s_g**
0.01	0.6113	0.00	2501.35	2501.35	0	9.1562	9.1562
5	0.8721	20.98	2489.57	2510.54	0.0761	8.9496	9.0257
10	1.2276	41.99	2477.75	2519.74	0.1510	8.7498	8.9007
15	1.705	62.98	2465.93	2528.91	0.2245	8.5569	8.7813
20	2.339	83.94	2454.12	2538.06	0.2966	8.3706	8.6671
25	3.169	104.87	2442.30	2547.17	0.3673	8.1905	8.5579
30	4.246	125.77	2430.48	2556.25	0.4369	8.0164	8.4533
35	5.628	146.66	2418.62	2565.28	0.5052	7.8478	8.3530
40	7.384	167.54	2406.72	2574.26	0.5724	7.6845	8.2569
45	9.593	188.42	2394.77	2583.19	0.6386	7.5261	8.1647
50	12.350	209.31	2382.75	2592.06	0.7037	7.3725	8.0762
55	15.758	230.20	2370.66	2600.86	0.7679	7.2234	7.9912
60	19.941	251.11	2358.48	2609.59	0.8311	7.0784	7.9095
65	25.03	272.03	2346.21	2618.24	0.8934	6.9375	7.8309
70	31.19	292.96	2333.85	2626.80	0.9548	6.8004	7.7552
75	38.58	313.91	2321.37	2635.28	1.0154	6.6670	7.6824
80	47.39	334.88	2308.77	2643.66	1.0752	6.5369	7.6121
85	57.83	355.88	2296.05	2651.93	1.1342	6.4102	7.5444
90	70.14	376.90	2283.19	2660.09	1.1924	6.2866	7.4790
95	84.55	397.94	2270.19	2668.13	1.2500	6.1659	7.4158
100	101.3	419.02	2257.03	2676.05	1.3068	6.0480	7.3548
105	120.8	440.13	2243.70	2683.83	1.3629	5.9328	7.2958
110	143.3	461.27	2230.20	2691.47	1.4184	5.8202	7.2386
115	169.1	482.46	2216.50	2698.96	1.4733	5.7100	7.1832
120	198.5	503.69	2202.61	2706.30	1.5275	5.6020	7.1295
125	232.1	524.96	2188.50	2713.46	1.5812	5.4962	7.0774
130	270.1	546.29	2174.16	2720.46	1.6343	5.3925	7.0269
135	313.0	567.67	2159.59	2727.26	1.6869	5.2907	6.9777
140	361.3	589.11	2144.75	2733.87	1.7390	5.1908	6.9298
145	415.4	610.61	2129.65	2740.26	1.7906	5.0926	6.8832
150	475.9	632.18	2114.26	2746.44	1.8417	4.9960	6.8378
155	543.1	653.82	2098.56	2752.39	1.8924	4.9010	6.7934
160	617.8	675.53	2082.55	2758.09	1.9426	4.8075	6.7501
165	700.5	697.32	2066.20	2763.53	1.9924	4.7153	6.7078
170	791.7	719.20	2049.50	2768.70	2.0418	4.6244	6.6663
175	892.0	741.16	2032.42	2773.58	2.0909	4.5347	6.6256
180	1002.2	763.21	2014.96	2778.16	2.1395	4.4461	6.5857
185	1122.7	785.36	1997.07	2782.43	2.1878	4.3586	6.5464
190	1254.4	807.61	1978.76	2786.37	2.2358	4.2720	6.5078

TABLE B.1
Thermodynamic Properties of Water

TABLE B.1.1
Saturated Water

		SPECIFIC VOLUME, m^3/kg			INTERNAL ENERGY, kJ/kg		
Temp. (°C)	**Press. (kPa)**	**Sat. Liquid v_f**	**Evap. v_{fg}**	**Sat. Vapor v_g**	**Sat. Liquid u_f**	**Evap. u_{fg}**	**Sat. Vapor u_g**
0.01	0.6113	0.001000	206.131	206.132	0	2375.33	2375.33
5	0.8721	0.001000	147.117	147.118	20.97	2361.27	2382.24
10	1.2276	0.001000	106.376	106.377	41.99	2347.16	2389.15
15	1.705	0.001001	77.924	77.925	62.98	2333.06	2396.04
20	2.339	0.001002	57.7887	57.7897	83.94	2318.98	2402.91
25	3.169	0.001003	43.3583	43.3593	104.86	2304.90	2409.76
30	4.246	0.001004	32.8922	32.8932	125.77	2290.81	2416.58
35	5.628	0.001006	25.2148	25.2158	146.65	2276.71	2423.36
40	7.384	0.001008	19.5219	19.5229	167.53	2262.57	2430.11
45	9.593	0.001010	15.2571	15.2581	188.41	2248.40	2436.81
50	12.350	0.001012	12.0308	12.0318	209.30	2234.17	2443.47
55	15.758	0.001015	9.56734	9.56835	230.19	2219.89	2450.08
60	19.941	0.001017	7.66969	7.67071	251.09	2205.54	2456.63
65	25.03	0.001020	6.19554	6.19656	272.00	2191.12	2463.12
70	31.19	0.001023	5.04114	5.04217	292.93	2176.62	2469.55
75	38.58	0.001026	4.13021	4.13123	313.87	2162.03	2475.91
80	47.39	0.001029	3.40612	3.40715	334.84	2147.36	2482.19
85	57.83	0.001032	2.82654	2.82757	355.82	2132.58	2488.40
90	70.14	0.001036	2.35953	2.36056	376.82	2117.70	2494.52
95	84.55	0.001040	1.98082	1.98186	397.86	2102.70	2500.56
100	101.3	0.001044	1.67185	1.67290	418.91	2087.58	2506.50
105	120.8	0.001047	1.41831	1.41936	440.00	2072.34	2512.34
110	143.3	0.001052	1.20909	1.21014	461.12	2056.96	2518.09
115	169.1	0.001056	1.03552	1.03658	482.28	2041.44	2523.72
120	198.5	0.001060	0.89080	0.89186	503.48	2025.76	2529.24
125	232.1	0.001065	0.76953	0.77059	524.72	2009.91	2534.63
130	270.1	0.001070	0.66744	0.66850	546.00	1993.90	2539.90
135	313.0	0.001075	0.58110	0.58217	567.34	1977.69	2545.03
140	361.3	0.001080	0.50777	0.50885	588.72	1961.30	2550.02
145	415.4	0.001085	0.44524	0.44632	610.16	1944.69	2554.86
150	475.9	0.001090	0.39169	0.39278	631.66	1927.87	2559.54
155	543.1	0.001096	0.34566	0.34676	653.23	1910.82	2564.04
160	617.8	0.001102	0.30596	0.30706	674.85	1893.52	2568.37
165	700.5	0.001108	0.27158	0.27269	696.55	1875.97	2572.51
170	791.7	0.001114	0.24171	0.24283	718.31	1858.14	2576.46
175	892.0	0.001121	0.21568	0.21680	740.16	1840.03	2580.19
180	1002.2	0.001127	0.19292	0.19405	762.08	1821.62	2583.70
185	1122.7	0.001134	0.17295	0.17409	784.08	1802.90	2586.98
190	1254.4	0.001141	0.15539	0.15654	806.17	1783.84	2590.01

BITS,Pilani-Dubai
International Academic City, Dubai
Second Semester 2008-09
BITS C462 RENEWABLE ENERGY
TEST– 1 (Closed Book)

Max.Marks :25 **Date:22.03.09**
Weightage: 25 % **Time: 50 min**

Note: ***(i) Answer all Questions***
(ii) Assume: 1J = 0.277 x 10^{-6} kWh
Specific heat of water = 4186 J/kg ^{0}C
(iii) Draw the sketch wherever required

---

1. a)What is mean by Solar constant. How is the intensity of solar radiation for a particular day of the year calculated ? (3 Marks)

   b) What are heliostats and its main losses? (2 Marks)
   c) Enumerate the advantages and limitations of solar furnace. (2 Marks)

2. Define the terms (6Marks)
   a) Zenith angle
   b) Day length
   c) Solar azimuth angle
   d) CPC in solar collectors
   e) Tilt factor for beam radiation
   f) Sunshine Recorder

3. a) Calculate the angle of incidence for a flat plate collector is installed on the roof of a building in Delhi (latitude Φ = 28.35 ^{0} N). The collector surface is pointing towards south with an angle of 30 ^{0} with horizontal on December 1 at 9 AM.
   b) With power intensity of 0.6 kW/m^2, what is the power collection at that time?
   c) The water tank of the thermal system contains 1000 kg of water initially at 30 ^{0} C. What will be the temperature of water after 60 minutes assuming constant power collection of (b) (7 Marks)

4. Describe the construction and working of flat plate and concentrating type of solar collector. Discuss materials used (5 Marks)

BITS,Pilani-Dubai
Dubai International Academic City, Dubai
Second Semester 2008-09
BITS C462 Renewable Energy
Quiz – 3

DURATION: 15 MIMUTES **MAXIMUM MARKS: 10**

Name: **ID Number:**

---

1. In binary cycle, the working fluids are_____,_____
2. Hydrothermal systems are sub classified as_____,_____
3. Kinetic energy and heat energy by steam – liquid mixture produced by flashing the geothermal brine is utilized in _____
4. For a depth of 3 Km, the total stored energy of known fields is approximately $8x10^{21}$ J and for a depth of 10 km the total energy stored is estimated to be $4x10^{n}$, n=?
5. HDR stands for_____
6. Semi thermal area having a temperature gradient of X° C per km depth, X= ?
7. Two phase mixture of low quality substance requires_____ in total flow concept system to get power.
8. Till now one pilot plant is in operation in Puga Valley in Jammu Kasmir, having _____ MW capacity
9. Geothermal steam originating from ground water heated by magma is called _____
10. Geothermal steam originating from magma is called _____

BITS,Pilani-Dubai
International Academic City, Dubai
Second Semester 2008-09
BITS C462 RENEWABLE ENERGY
Quiz – 2

DURATION: 15 MIMUTES Weightage 5% MAXIMUM MARKS: 10

Name: **ID Number:**

1. The sail type wind mill blade made up of ----------
2. ----------rotor consists of two-half cylinders facing opposite directions in such away as to have almost an S-shaped cross section.
3. ----------type machine has two or three thin, curved blade with aerofoil cross section and constant chord length
4. ----------rotors are found to attain a maximum power coefficient
5. Aero generator consists of ----------
6. Maximum available wind power is proportional to----------wind speed
7. Power coefficient is for wind mill is given by----------
8. Maximum axial force on wind blade is given by
a) $\mu/9\ \rho D^2 V_i^2$ b) $\mu/9\ \rho D^2 V_i^3$ c) $\mu/8\ \rho D^3 V_i^3$ d) $\mu/8\ \rho D^3 V_i^2$
9. WECS stands for----------
10. Density of air at 1 atmospheric pressure and 15^0 C is ----------

BITS,Pilani-Dubai
Dubai International Academic City, Dubai
Second Semester 2008-09
BITS C462 Renewable Energy
Quiz – 1

DURATION: 15 MIMUTES MAXIMUM MARKS: 10

Name: **ID Number:**

1. In roof storage of solar heat, heat is transferred from the heated water to the rooms below by conduction through----------

2. In passive solar heating system to absorbs solar radiation and stores heat in thermal storage wall is called ----------

3. A large paraboloid reflector consists of number of mirrors and each mirror is called ----------

4. As viewed from the earth, the radiation coming from the sun appears to be essentially equivalent to that coming from a black surface at ----------

5. As solar radiation passes through the earth's atmosphere, the short wave ---------- ---------- rays are absorbed by the ozone in the atmosphere.

6. The angle made by the plane surface with the horizontal is called----------

7. Fluids can be heated to temperature of 500^0 C or more in ---------- ---------- collector.

8. The length of the day is a function of latitude and ----------

9. A serious of arrangement of thermocouples in Eppley Pyrheliometer is called ---- ----------

10. Wien's law which relates ----------