Menoufia University	**Renewable Energy and Environment**
Faculty of Eng., Shebin El-Kom	**Code: *MPE 314B***
Mechanical Power Eng. Dept.	**Year : *3rd Year***
First Semester Exam.,2013-2014	**Time Allowed : 3 hours**
Date of Exam: 20 /01 / 2014	**Total Marks : 85 marks**

Notes: a) Exam in two parts, time for part one is 2 hrs and for part two is 1 hrs
b) Answer each part in separate section

Part one

Question (1) *(16 Marks)*

1.1 Explain global ozone problem. What are its reasons? (3 Marks)

1.2 Explain with sketches the operation of a closed cycle *ocean thermal energy conversion* power plant? (3 Marks)

1.3 Wind energy is an indirect form of solar energy. Discuss this expression? (2 Marks)

1.4 Are the following sentences correct or not and why: (3 Marks)

a) American multi blade wind turbine is used mainly for pumping water.

b) In Eolian method the wind direction is measured by the direction of moving trees and vegetations.

c) In pressure tube anemometer two parallel tubes are located parallel to main wind direction.

1.5 Explain why anemometer with ac generators would not be used for wind speeds below 5 m/s? (2 Marks)

1.6 An anemometer mounted on the tower head of an operating downwind propeller-type turbine measures an average wind speed of 10 m/s. Estimate the undisturbed wind speed. (3 Marks)

Question (2) *(17 Marks)*

2.1 How can sonic anemometer be used for measuring wind speed? (2 Marks)

2.2 Explain with sketch how can the rotational movement of wind vane be transformed to digital output? (2 Marks)

2.3 How can the wind turbines be classified according to wind direction? (2 Marks)

2.4 Explain with sketches the operation of Darrieus wind turbine? What are the main advantages and disadvantages of this wind turbine? (3 Marks)

2.5 Are the following sentences correct or not: (3 Marks)

a) The Savonius turbine holds promise in applications where low rotation torque is required.

b) Larger generators are of course less efficient than smaller generators.

c) Sites with low mean wind speeds tend to have lower values of Weibull shape parameter k than sites with greater mean wind speeds.

2.6 A wind farm location is characterized by the Weibull parameters $c = 9$ m/s and $k = 2.3$. You work for a wind farm company that plans to build wind machines of the same size as the MOD-2 (rotor diameter 91.5 m) but optimized for this site, if necessary. You know that the MOD-2 has a rated power of 2500 kW at a rated wind speed of 12.4 m/s at hub height. You may estimate that $u_c = 0.5\,u_R$ and $u_f = 2u_R$
Taking the ratio u_R/c for maximum power and for minimum cost conditions as 1.6 and 1.1 respectively, what are the rated wind speed, capacity factor, average power and yearly energy production in the following cases:

a) Using the MOD-2 on this site without modification.

b) Modify the MOD-2 to operate at maximum power condition.

c) Modify the MOD-2 to operate at minimum cost condition.

d) Which operating case should you recommend? (5 Marks)

Question (3) *(17 Marks)*

3.1 Describe the different arrangements of solar turbines in solar chimney systems? (2 Marks)

3.2 Drive an expression to determine the air velocity at the inlet of chimney in solar chimney system? (3 Marks)

3.3 Describe with sketch the forces acting on a movable wind turbine blade? What are the role of each force in the wind turbine operation and design? (2 Marks)

3.4 Drive an expression to calculate the average power of a wind turbine in a certain location? (4 Marks)

3.5 Explain why is the blade without twist less efficient than a blade with proper twist? (2 Marks)

3.6 A MOD-2 wind turbine is delivering mechanical power $P_m = 2000$ kW at 17.5 r/min to a gearbox with an output speed of 1800 r/min. The gearbox is 92 percent efficient at this power level.

a) What is the average torque in the low-speed shaft?

b) What is the average torque in the high-speed shaft?

c) Find the diameter of both low speed and high speed shaft if they are made of steel which having maximum allowable shear stress of 55 Mpa. (4 Marks)

End of part one, with best wishes **Dr. A. A. El-Haroun**

Part:--Two

1)- Define the following:-

A) The photovoltaic conversion of solar radiation. And estimate its max. efficiency. (5Marks)

B) Explain With sketch the methods of the solar refrigeration systems and solar irrigation system. (7 Marks)

c) Compare between the solar wind power plant and the high temperature Rankin cycle, using suitable sketch. (8 Marks)

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2)-Calculate:- The zenith angle and the top heat loss coefficient for a flat plate collector having one glass cover is installed in Tanta at 11:00 on 20/9/2013.,with the following data:

Azimuth angle	- 30 °	, Collector tilt angle	45 °
Plate to cover spacing	3 Cm	, Ambient air and sky temperature	35 C°
Wind speed	6 m/sec	, Back insulation thickness	4 Cm
Insulation conductivity	0.07W/m.c	, Mean plate temperature	96 C°
Cover temperature	53 C°	, Plate emittance	94 %
Latitude angle for Tanta		30.48°	

(15 Marks)

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

$$\delta = 23.45 \sin\left[360 \frac{284+n}{365}\right]$$

$$\cos\theta_z = (\sin\delta \sin\phi) + (\cos\delta \cos\phi \cos\omega)$$

$$\epsilon_c = 0.8$$

$$\epsilon_p = 0.95$$

$$h_{r,p-c} = \frac{\sigma \cdot (T_p^2 + T_c^2)(T_p + T_c)}{(1/\epsilon_p) + (1/\epsilon_c) - 1}$$

$$h_{r\,c-s} = \epsilon_c \cdot \sigma \cdot (T_c^2 + T_s^2)(T_c + T_s)$$

$$h_{p-c} = \frac{1.14 \, \Delta t^{0.31}}{L^{0.7}}$$

$$h_w = 5.7 + 3.8 \, v_w$$

$$U_t = \left(\frac{1}{h_{p-c} + h_{r-p-c}} + \frac{1}{h_w + h_{rc-s}}\right)^{-1}$$