Menofia University Faculty of Engineering, Shebin El-Kom Mechanical Power Engineering Department First Semester Examination, 2015-2016 Date of Exam: 24/1/2016	Course Title: Thermodynamics II Course Code: MPE 211 Year: Second Year Time Allowed: 3 hours Total Marks: 100 marks

Remarks: **No. of pages: 2** **No. of questions: 6**
Allowed Tables and Charts: (Steam, Pure substance, Atmospheric Air, Refrigerants, Ideal Gases, Real Gases, Fuels)

Answer ALL the Following Questions (Assume any missing data)

(Question 1): (17 Marks)

1-a) (5 marks)

50-kg iron block (C=0.45 kJ/kg.C) and a 20-kg copper block (C=0.386 kJ/kg.C), both initially at 80 °C, are dropped into a large lake at 15 °C. Thermal equilibrium is established after a while as a result of heat transfer between the blocks and the lake water. Determine the total entropy change for this process

1-b) (12 marks)

An insulated 5-m^3 rigid tank contains air at 500 kPa and 57 °C. A valve connected to the tank is now opened, and air is allowed to escape until the pressure inside drops to 200 kPa. The air temperature during this process is maintained constant by an electric resistance heater placed in the tank. If the environment is at 25 °C and 100 kPa determine

(a) the electrical energy supplied during this process,
(b) the maximum work potential of the air at the initial state,
(c) the total entropy generation, and
(d) the exergy destroyed during this process.

(Question 2): (18 Marks)

2-a) (5 marks)

Explain how the adiabatic saturation process is used for determining the absolute or relative humidity of air at a known dry bulb temperature. Use sketches and equations whenever possible.

2-b) (13 marks)

An air-conditioning system operates at a total pressure of 96 kPa and consists of a heating section and a humidifying section. Air enters the heating section at 10 °C and 70 percent relative humidity at a rate of 30 m^3/min, and it leaves the humidifier at 20 °C and 60 percent relatively humidity. Saturated vapor at 100 °C is used in the humidifier. Without using the psychrometric chart, determine (a) the rate of heat transfer in the heating section, (b) the rate of water added to air in the humidifying section, and (c) the temperature and relative humidity of the air when it leaves the heating section.

(Question 3): (20 Marks)

Methane gas (CH_4) at 25 °C is burned steadily with dry air that enters the combustion chamber at 17 °C. The volumetric analysis of the products on a dry basis is 5.20 percent CO_2, 0.33 percent CO, 11.24 percent O_2, and 83.23 percent N_2. The combustion products leave at 700 K and the entire process takes place at 1 atm. Determine:

(a) the percentage of theoretical air used,
(b) the mass fraction of each constituent in the wet products,
(c) the partial pressure of N_2 in the products,
(d) the dew point temperature of the products, and
(e) the heat transfer from the combustion chamber per unit mass of CH_4

(Question 4): (18 Marks)

1. How does regeneration affect the efficiency of a Brayton cycle, and how does it accomplish it? **(3 mark)**
2. Why is the combined gas–steam cycle more efficient than either of the cycles operated alone? **(3 mark)**
3. Why is excessive moisture in steam undesirable in steam turbines? What is the highest moisture content allowed? **(3 mark)**
4. For a specified pressure ratio, why does multistage compression with inter-cooling decrease the compressor work, and multistage expansion with reheating increase the turbine work? **(3 mark)**
5. Why are the back work ratios relatively high in gas turbine engines? **(2 mark)**
6. What is the effect of turbine and compressor irreversibilities of a turbojet engine on the following: (*a*) the network, (*b*) the thrust, or (*c*) the fuel consumption rate? **(2 mark)**
7. In an ideal regenerator, is the air leaving the compressor heated to the temperature at (*a*) turbine inlet, (*b*) turbine exit, (*c*) slightly above turbine exit? **(1 mark)**
8. Might the thermal efficiency of a vapor power plant be different in the winter than in the summer? **(1 mark)**

(Question 5): (15 Marks)

A steam power system contains a reheating and regenerative produces 80 MW. The steam is supplied to the high pressure turbine at 85 bar and 600 °C. It is expanded to 6.5 bar where an amount of steam is bled out to an open feed water heater while the rest is reheated to 450 °C. Farther expansion takes place to 0.06 bar where it is condensate in the condenser.

Draw the layout diagram of this plant and show the cycle on a T-s diagram with respect to saturation lines, and determine:

a) The mass flow rate of steam generated in the boiler.
b) The thermal efficiency of the plant.
c) The back work ratio, and
d) The amount of mass flow rate of water required in the condenser for condensation for a temperature difference of 13 °C

(Question 6): (12 Marks)

An ideal gas-turbine cycle with two stages of compression and two stages of expansion has an overall pressure ratio of 8. Air enters each stage of the compressor at 300 K and each stage of the turbine at 1300 K. Determine the back work ratio and the thermal efficiency of this gas-turbine cycle, for the following: (a) no regenerators and; (b) an ideal regenerator with 100 percent Effectiveness is used.

For Quality Management's Use Only (Students May Ignore This Section)

This exam measures the following ILOs										
Q.#	2A	3	4	1A,1B	2A,2B,3	3	4,5,6	2B,5,6	3	1B
ILO	a13-1	a14-1	a14-2	b2-1	b2-2	b2-3	c1-1	c1-2	c5-1	c5-2
Skills	K&U Skills			Intellectual Skills			Professional Skills			