The University of Jordan – Faculty of Engineering and Technology-
Mechanical Engineering Department
ME 0904341: Thermodynamics I
Fall, 2009 - Instructor: Dr. Jamil Al Asfar
Makeup Final Exam (11-1): January 17th, 2010

Name: ..... ID #:..... . Seat #: ... (50 points)

Q1) (12 points) A three (3) kg of Oxygen undergoes the following **three** successive processes as a **closed** system:
1 to 2 Polytropic process from 300 K and 250 kPa to 750 kPa (with $n = 1.3$)
2 to 3 isobaric process.
3 to 1 isothermal process.
Show the cycle on a ***P-v*** and ***T-s*** diagrams, and find the net work done, the entropy change and heat transfer during this cycle, assuming ideal gas behavior of Nitrogen. Find also the **exergy destructed*** in first process assuming the environment conditions to be 22 °C and 90 kPa. Is it acceptable to assume ideal gas behavior of Nitrogen in above processes? Justify your answer.

Q2) (12 points) Refrigerant-134a enters an adiabatic compressor at 100 kPa. and -7°C with a volume flow rate of 0.3 m^3/s, and leaves at 700 kPa. **Determine** the mass flow rate of the refrigerant, the power input to the compressor, the generated entropy, the exergy change* and the exit temperature if the compressor efficiency is 80%. What is the minimum work input that needs to be supplied to the compressor per unit mass of the refrigerant*? Take the environment conditions to be 15 °C and 100 kPa.

Q3) (12 points) A mass of 10 kg of saturated liquid–vapor mixture of water is contained in a piston cylinder device at 125 kPa. Initially 6 kg of water is in the vapor phase and the rest in liquid phase. Heat is transferred to system until the piston starts to move up when the pressure inside reaches 300 kPa. Heat continues until the final volume increased by 20%. **Find:** The temperature at the **three** states, mass of vapor when piston starts moving up, total work done, total entropy change and total heat transfer. **Show** the processes on a ***P-v*** and a ***T-s*** diagram.

Q4) (14 points) A steam power plant operating on **Carnot** cycle has a **net output** power of 150 kW. Steam enters the boiler as saturated liquid, and enters the turbine at 1.4 MPa. and 350°C. The condenser pressure is 19.94 kPa. The steam is cooled in the condenser by cooling water from a nearby river at 16°C initial temperature, and the exit temperature of the cooling water is 28°C. Find:

a) The thermal efficiency of the cycle.
b) The net output work in kJ/kg unit.
c) The mass flow rate of steam in the cycle.
d) The flowing rate of the cooling water in kg/s.
e) The dryness factor (quality, x) of steam at both turbine and condenser exit.
f) The amount of heat absorbed by steam in the boiler.
g) The **exergy** change* during the steam expansion process in the turbine.

Draw a schematic diagram of the cycle, and **show** it on a ***T-s*** diagram. Assume C_p for **cooling water** is 4.18 kJ/kg.K, and the environment conditions to be 25 °C and 110 kPa.

- Good Luck-