Mansoura University Faculty of Engineering Program of Biomedical Engineering. Course Title: Thermodynamics Course Code: MPE 172		Level: 100 Exam Type: Final Date: 8 June 2016 Time: 2 Hours Full Mark: 50

Answer all the following questions. Use of steam and gas tables are allowed

Question (1) [13 Marks]

a) Prove that , the change of entropy throught any process 1-2 and for ideal gas, is given by: *(4 marks)*

$$\Delta s = R \ln\left(\frac{v_2}{v_1}\right) + C_v \ln\left(\frac{T_2}{T_1}\right)$$

b) 0.2 m^3 of air at 500 K and 16 bar is expanded adiabatically to 4 bar and then cooled at constant volume to 290 K. Sketch the cycle on P-v diagram and determine :
(i) Pressure at the end of constant volume cooling.
(ii) Heat and work for each process.
(iii) Net entropy change.
Take for air : C_p = 1005 J/kg.K and C_v = 718 J/kg.K. *(9 marks)*

Question (2) [13 Marks]

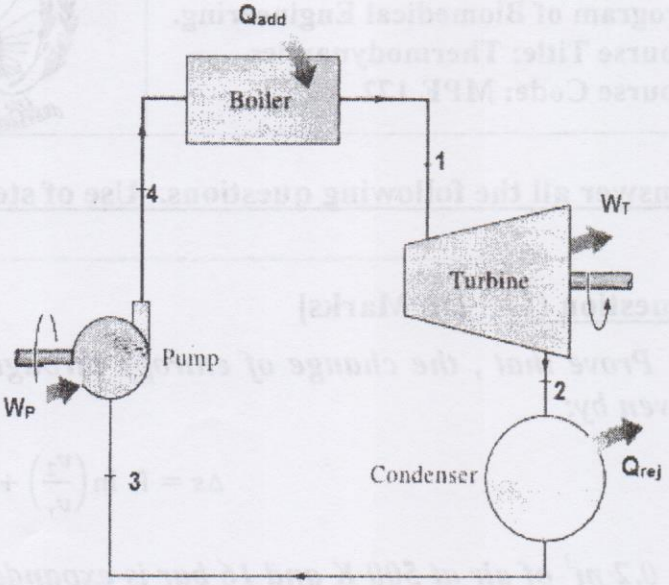
a) Steam flows steadily through an adiabatic nozzle. The inlet conditions of the steam are 10 bar , 220°C, and 60 m/s, and the exit conditions are 1.5 bar and dry saturated steam. The mass flow rate of the steam is 2 kg/s. Determine (i) the velocity of the steam leaving the nozzle , (ii) the exit area of the nozzle and (iii) the rate change in entropy. *(7 marks)*

b) Consider a building whose annual air-conditioning load is estimated to be 120,000 kWh in an area where the unit cost of electricity is $0.10/kWh. Two air conditioners are considered for the building. Air conditioner "A" has a seasonal average COP of 3.2 and costs $5500 to purchase and install. Air conditioner "B" has a seasonal average COP of 5.0 and costs $7000 to purchase and install. All else being equal, determine which air conditioner is a better buy. Assume the average life time of air conditioner is 10 years. *(6 marks)*

Question (3) **[12 Marks]**

Simple steam power cycle, the boiler pressure 60 bar and the condenser pressure is 0.1 bar. The steam enters the turbine at temperature of 500 °C. Assuming all processes to be ideal. Sketch the cycle on T-s diagram and determine for one kg:

i) The turbine work, ii) Heat added, iii) Heat rejected, iv) The pump work and v) The thermal efficiency of the cycle.



Question (4) **[12 Marks]**

Liquid octane (C_8H_{18}) enters a combustion chamber at 25°C at a rate of 0.06 kg/min where it is mixed and burned with 30 percent excess air that enters the combustion chamber at 25°C. If the exit temperature of the combustion gases is 1600 K, determine (i) the mass flow rate of air and (ii) the rate of heat transfer from the combustion chamber.

Good Luck

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