Mansoura University Faculty of Engineering BME & MTE Programs Course Title: Thermodynamics Course Code: MPE 172		Level: 100 Exam Type: Final Date: 17 /12/2017 Time: 2 Hours Full Mark: 50

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

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Question (1) [12 Marks]

0.5 m^3 of air at 300 K and 1 bar is heated at constant volume to 5 bar. It is then cooled at constant pressure and further expanded isothermally so as to reach the condition from where it started. Sketch the cycle on P-v diagram and determine :

(i) Temperature at the end of constant volume heating.

(ii) Heat, work and change in entropy for each process.

(iii) Net work done and heat transferred during the cycle.

Take C_p = 1005 J/kg.K and C_v = 718 J/kg.K.

Question (2) [10 Marks]

Steam flows steadily through an adiabatic nozzle. The inlet conditions of the steam are 10 bar , 250°C, and 80 m/s, and the exit conditions are 1.5 bar and dry saturated steam. The mass flow rate of the steam is 3 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.

Question (3) [10 Marks]

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.

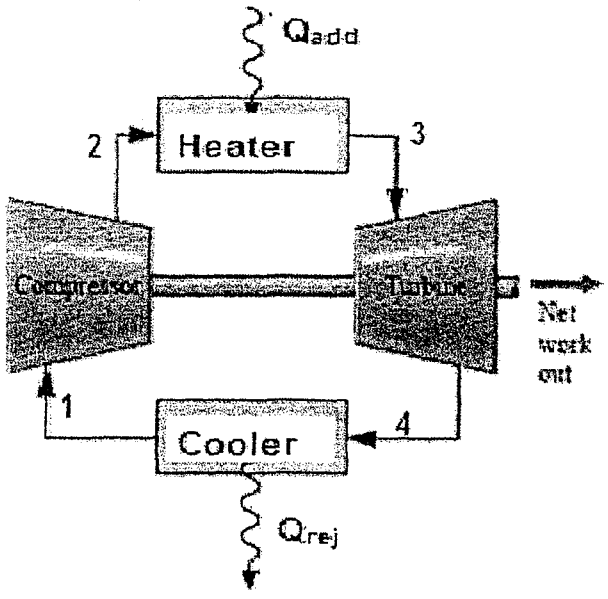
Question (4) [10 Marks]

In a gas turbine plant working on Brayton cycle, the air at inlet is 27 °C, 1 bar . The pressure ratio is 9 and the maximum temperature is 900 °C. Sketch the cycle on T-s diagram and determine:

i) The thermal efficiency of the cycle.

ii) The back work ratio.

iii) The required mass flow rate if the net output power is 100 MW.



Question (5) [8 Marks]

Moist air at the standard atmospheric pressure, has a temperature of 30 oC and a relative humidity 50% . Determine the following:

a)the partial pressure of dry air and the water vapor, b)the specific humidity, c)the degree of saturation, d)the dew point temperature, and e) the density of moist air.

Notes

Process	Q	W	P, v, T relation
Constant volume	m $C_v(T_2-T_1)$	0	$\frac{T_2}{T_1}=\frac{P_2}{P_1}$
Isothermal	$P_1 V_1 Ln(V_2/V_1)$	$P_1 V_1 Ln(V_2/V_1)$	$\frac{P_2}{P_1}=\frac{v_2}{v_1}$
Polytropic	$(\gamma-n)\, W/(\gamma-1)$	$(P_1V_1-P_2V_2)/(n-1)$	$(\frac{T_2}{T_1})^n=(\frac{P_2}{P_1})^{n-1}=(\frac{v_1}{v_2})^{n(n-1)}$

Entropy change during thermodynamic processes for ideal gas

$$\Delta S = m\left[c_v ln\left(\frac{T_2}{T_1}\right)+Rln\left(\frac{v_2}{v_1}\right)\right]=m\left[c_p ln\left(\frac{T_2}{T_1}\right)-Rln\left(\frac{p_2}{p_1}\right)\right]=m\left[c_p ln\left(\frac{v_2}{v_1}\right)+c_v ln\left(\frac{p_2}{p_1}\right)\right]$$

The enthalpy of the moist air is given by:

$$h = 1.005\,T+\omega(2500.9+1.88T\,)\,(\frac{kJ}{kg}dry\ air)$$

Good Luck

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