FACULTY OF ENGINEERING AND COMPUTER SCIENCE
DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING

COURSE		NUMBER	SECTION
Thermodynamics I		ENGR 251	M
EXAMINATION	DATE	TIME & PLACE Room:	# OF PAGES
Final	December 12, 2008	14:00 – 17:00 H-509; H-520; H-521	4

PROFESSORS: L. Kadem

LAB INSTRUCTOR:

MATERIALS ALLOWED ❑ NO ❑ YES (PLEASE SPECIFY)

CALCULATORS ALLOWED ❑ NO ❑ YES (non programmable)

SPECIAL INSTRUCTIONS:

Answer the following four questions.
State clearly any assumptions you make.
Draw a clear sketch of the problem.
Return the Exam paper with the answers' book.

X

x

Name: ______________________________ **I.D.:** ______________________
Surname, given names

Question no. 1 (20 Marks)

An ideal steam power plant operates between the pressure limits of 3 MPa and 50 kPa. The temperature of the steam at the turbine inlet is 400°C, and the mass flow rate of steam through the cycle is 60 kg/s.

- a) Show the cycle on a T-s diagram with respect to saturation lines.
- b) Compute the thermal efficiency of the cycle.
- c) Compute the net power output of the power plant.

Thermal efficiency	
Power output	

Question no. 2 (20Marks)

Air is used as the working fluid in a simple ideal Brayton cycle that has a pressure ratio of 12, a compressor inlet temperature of 300 K, and a turbine inlet temperature of 1000 K. Determine the required mass flow rate of air for a net power output of 90 MW, assuming both the compressor and the turbine have an isentropic efficiency of: (a) 100% and (b) 80%.

Assume constant specific heats at room temperature.

Mass flow rate (100 %)	
Mass flow rate (80 %)	

Question no. 3 (20 Marks)

The compression ratio of an ideal Otto cycle is 8. At the onset of the compression stroke, the pressure is 0.1 MPa and the temperature is 15°C.
The heat supplied to air, per cycle, is 1800 kJ/kg. Determine:

-a) The pressure, the specific volume and the temperature at each state.
-b) The thermal efficiency.

Assume constant specific heats at room temperature.

	T	P	v
Point 1			
Point 2			
Point 3			
Point 4			
Thermal efficiency			

<u>Question no. 4 (20 Marks)</u>

An insulated 0.08 m^3 tank contains helium at 2 MPa and 80°C. A valve is now opened, allowing some helium to escape. The valve is closed when one-half of the initial mass has escaped. Determine:

-a) The final temperature in the tank.
-b) The final pressure in the tank.

Final temperature	
Final pressure	

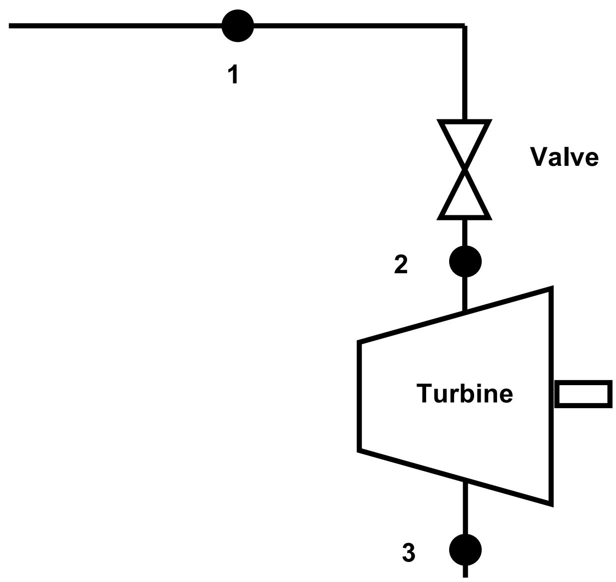
<u>NOTES:</u>

The enthalpy of helium exiting the tank can be approximated by: $C_p\ T_{avg}$
The internal energy at each state can be approximated by: $C_v\ T$

Question no. 5 (20 Marks)

The conditions at the inlet of a steam turbine can be controlled using a valve (see figure below). The pressure before the valve is 1.4 MPa and the temperature 300°C. The pressure at the turbine exit is fixed at 10 kPa. Assuming the expansion through the turbine is adiabatic and reversible, determine:

- The pressure at point (2) to produce 75% of the maximal work.



Pressure (2)	

Formulae and Constants
For Air: k= 1.4; C_p = 1.005 kJ/kg K; R=0.287 kJ/kg K
For Helium: k= 1.667

$$\left(\frac{T_2}{T_1}\right)_{s=cte} = \left(\frac{v_1}{v_2}\right)^{k-1}$$

$$\left(\frac{T_2}{T_1}\right)_{s=cte} = \left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}}$$

$$\left(\frac{P_2}{P_1}\right)_{s=cte} = \left(\frac{v_1}{v_2}\right)^{k}$$