MEMS 0051
Summer 2017
Midterm #1
6/26/2017
75 Minutes

Name (Print): _____

This exam contains 2 pages (including this cover page) and 5 problems. Check to see if any pages are missing. Enter all requested information on the top of this page. Please do all of your work in the provided blue examination book.

You may *not* use your books or notes. Calculators are permitted on this exam.

The following rules apply:

- All work must be done in the blue testing book. Any work done on the exam question sheet will not be graded.

- All work must be substantiated. A result with no methodology and mathematics will not be graded.

- Do not write in the table to the right.

Problem	Points	Score
1	10	
2	10	
3	20	
4	25	
5	35	
Total:	100	

BONUS:

5 pts: June 26$^{\text{th}}$, 1945, marked the signing of what charter that established the Statute of the International Court of Justice?

Basic Properties

1. (a) (5 points) Determine the quality of 2.0 [kg] of water having a volume of 0.5 [m^3] existing at 25 °C and a pressure of 3.169 [kPa].

   (b) (5 points) Determine the mass of saturated water vapor at 155 °C in a 40 [m^3] rigid tank.

Polytropic Process

2. (10 points) A piston-cylinder contains water at 500 °C and 3 [MPa]. It is cooled in a polytropic process to 200 °C and 1 [MPa]. Determine:

   - the polytropic index n,
   - the specific work in the process.

Formulation of Work

3. (20 points) Water contained in a piston-cylinder assembly has an initial temperature of 150 °C, a quality of 50% and an initial volume of 0.05 m^3. The pressure of the process is given as a function of volume such that P($\forall$)=100 + C$\forall^{0.5}$ [kPa]. Heat is transferred to the piston-cylinder until the final pressure reaches 600 kPa. Determine:

   - the heat input.

   Hint: Solve for the constant C based upon givens at State 1.

Ideal Gas

4. (25 points) A frictionless piston-cylinder device contains 0.1 [kg] of air at 300 K at 100 [kPa]. The air is slowly compressed from its initial state in an isothermal process to a final pressure of 250 [kPa].

   - Show the process on the P-v diagram,
   - determine the work into the system,
   - determine the heat rejected from the system.

Multistep Process

5. (35 points) A frictionless piston-cylinder device has two sets of stops that constrain the piston. When the piston is at rest on the lower set of stops, the enclosed volume is 0.4 [m^3]. When the piston reaches the uppers tops, the enclosed volume is 0.6 [m^3]. The cylinder initially contains water at 100 [kPa] and a quality of 20%. It is heated until the water eventually exists as a saturated vapor. The mass of the piston is such that is requires 300 [kPa] generated within the piston-clyinder device to move. Determine:

   1. the final pressure in cylinder,
   2. the heat transfer during this process,
   3. the work for this process.

   Hint: There are three processes going between 4 states.