MEMS 0051
Spring 2018
Midterm #1
2/16/2018

Name (Print): _____

This exam contains 2 pages (including this cover page) and 4 problems. Check to see if any pages are missing. Enter all requested information on the top of this page, and put your initials on the top of every page, in case the pages become separated.

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	30	
3	30	
4	30	
Total:	100	

BONUS (5 pts):

This date, February 16$^{\text{th}}$, 1923, marks the opening of this pharaoh's tomb by archaeologist Howard Carter.

Written Problem #1
1. (10 points) Determine the polytropic index for a process where air, initially in a piston cylinder with a pressure of 1,000 [kPa] and a volume of $8 \cdot 10^{-5}$ [m^3], is expanded to a pressure of 350 [kPa] and a volume of $8 \cdot 10^{-4}$ [m^3].

Written Problem #2

2. (30 points) Water vapor at 3,000 [kPa] and 300°C is contained within a piston-cylinder. The water is cooled in a constant volume process until the temperature reaches 200°C. The water is then compressed in a constant temperature process until the pressure is 2,500 [kPa]. **Determine the following**:

    1. The specific volumes at States 1, 2 and 3.

    2. The quality at State 2.

Written Problem #3

3. (30 points) One kilogram of air undergoes a thermodynamic cycle consisting of three processes:

    1. From the initial state, it proceeds to State 2 via a constant volume process

    2. From State 2, it proceeds to State 3 via a constant temperature process

    3. From State 3, it proceeds back to the initial state via a constant pressure process

At State 1, the temperature 300 [K] and the pressure is 100 [kPa]. At State 2, the pressure is 200 [kPa]. The critical pressure of air is 3.786 [MPa] and the critical temperature of air is 132.63 [K]. Using the Ideal Gas law, **determine the following**:

    1. The temperature at State 2.

    2. The specific volume at State 3.

    3. If this process satisfies the requirements to treat air as an Ideal Gas.

Written Problem #4

4. (30 points) Water is contained within a piston-cylinder device and undergoes a series of processes from an initial state with a pressure of 1,000 [kPa] and a temperature of 400°C, to a final state. The processes are as follows:

    1. The water vapor is cooled in a constant pressure process to saturated vapor.

    2. The water is then cooled in a constant volume process to $150°C$.

Determine the following:

    1. Determine the work into the system, in [kJ/kg].

    2. Determine the heat out of the system, in [kJ/kg].