MEMS 0051
Spring 2019
Midterm #2
3/22/2018

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	16	
2	21	
3	28	
4	35	
Total:	100	

BONUS (5 pts):

This date, March 22$^{\text{rd}}$, 1920, marked the signing of which treaty between Germany and the opposition of Germany ending WWI.

Written Problem #1

1. (16 points) 1 [kg] of liquid water is heated from 20 to 95 °C. Determine:

   (a) (8 pts) The change of entropy assuming constant specific heat;

   (b) (8 pts) The change of entropy using the steam tables.

Written Problem #2

2. (21 points) A piston-cylinder device contains 0.001 [m^3] of saturated liquid R-12 at 20 °C. The piston is expanded isothermally, in a reversible process, until the final pressure reaches 400 [kPa]. Determine:

   (a) (7 pts) The change of entropy, in [kJ/K], between the final and initial state;

   (b) (7 pts) The heat supplied to the system, in [kJ];

   (c) (7 pts) The work done by the piston-cylinder, in [kJ].

Written Problem #3

3. (28 points) A process involves the heating of oxygen from 300 to 3,000 [K], in which the pressure decreases from 200 to 150 [kPa]. Calculate the change of entropy via:

   (a) (7 pts) Using the Ideal Gas tables (A.7.1 or A.8)

   (b) (7 pts) Using the integral-average constant-pressure specific heat from Table A.6;

   (c) (7 pts) Using a constant constant-pressure specific heat evaluated at the average temperature from Table A.6;

   (d) (7 pts) Using a constant constant-pressure specific heat from Table A.5.

Written Problem #4

4. (35 points) A heat engine receives heat at the rate of 1,000 [kW] from a high-temperature reservoir with a temperature of 550 °C. The rejected energy is to a low-temperature reservoir with a temperature of 25 °C. If work is produced at a rate of 450 [kW], determine:

   (a) (7 pts) The quantity of energy discarded to the low-temperature reservoir;

   (b) (7 pts) The efficiency of the heat engine;

   (c) (7 pts) If the engine were a Carnot engine, what would be the efficiency;

   (d) (7 pts) If the engine were a Carnot engine, what is the rate of work;

   (e) (7 pts) If the engine were a Carnot engine, what is the rate of heat rejection.