**ME 322 – Mechanical Engineering Thermodynamics (Exam 1)**

Spring 2022

**THIS IS A TAKE-HOME EXAM. YOU HAVE SEVERAL DAYS TO WORK ON THIS EXAM, AND SEVERAL CLASS PERIODS WHERE YOU CAN ASK QUESTIONS. THE WORK PRESENTED ON THIS EXAM NEEDS TO BE YOURS, AND YOURS ALONE. PRESENTING SOLUTIONS FROM SOMEONE ELSE WILL RESULT IN A GRADE OF F IN THE COURSE.**

Please read the following statement:

Article II, Section 1 of the University of Idaho Student Code of Conduct states,

> *Cheating on classroom or outside assignments, examinations, or tests is a violation of this code. Plagiarism, falsification of academic records, and the acquisition or use of test materials without faculty authorization are considered forms of academic dishonesty and, as such, are violations of this code. Because academic honesty and integrity are core values at a university, the faculty finds that even one incident of academic dishonesty seriously and critically endangers the essential operation of the university and may merit expulsion.*

Passing on exam information to someone who has not taken the exam constitutes cheating on an examination. Such action is a violation of the University of Idaho Student Code of Conduct.

I have read and understand the above statement.

_____ _____

Signature Date

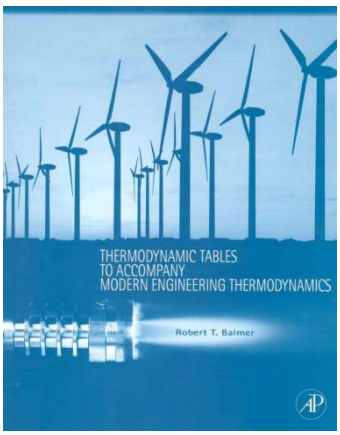
_____

Printed Name

## EXAM INSTRUCTIONS – PLEASE READ THIS CAREFULLY

**You need to show your work for each of the problems to get credit. If values from a table are cited, you need to indicate which table was used, and what inputs were used to find the value. Equations used should be written down, and the numbers used in those equations should also be shown. You should include units in your calculations, as many times there will be unit conversions necessary. You may work your problems on these pages, or work them on separate pages. You will scan and upload a PDF of your submission to BbLearn.**

**If you have questions about problems on the exam you should ask those of the instructor. You are not allowed to work with other people (in person, or online) on this exam. However, many problems on this exam are similar to past homework problems. You can certainly work with other students to make sure you know how to solve past homework problems.**



# Part 1: Short Calculations – 50 Points

1. You have a rigid tank with a divider inside. When the divider is in place one side of the tank has 5 kg of an ideal gas inside, and the volume is 2.4 $m^3$. The other side has 7.8 kg of an ideal gas, and its volume is 1.9 $m^3$. Once the divider is removed, calculate the specific volume of the mixture.

2. You have 2.4 lb of Nitrogen gas in a rigid, sealed container. The temperature is initially -10 °F and it is heated up until it reaches 260 °F. Calculate the change in Total Enthalpy [Btu] of the gas.

3. You have 6.3 lb of superheated steam that is initially at 400 °F and 100 psia. This gas is compressed at constant temperature until it reaches 225 psia. Calculate the work input [ft*lbf] required to do this.
   **Hints:** What is $v_1$? What is $v_2$? What is the polytropic exponent for an isothermal process?

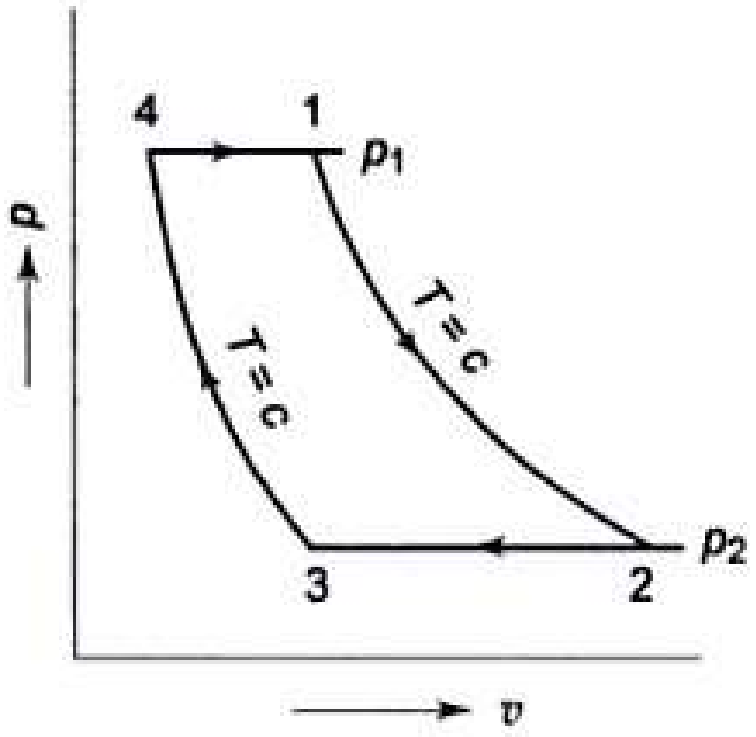
4. The little boiler unit in Dr. Dan's Rancilio espresso machine creates liquid water that is at 220 °F. What is the minimum pressure above atmospheric pressure that the boiler needs to be at? i.e. find the minimum $p_{boiler}$ [psig] for making an espresso shot.

5. While preparing to use the steam wand the little boiler unit in Dr. Dan's Rancilio espresso machine creates 2-phase water that is at 280 °F. What is the minimum pressure above atmospheric pressure that the boiler needs to be at? i.e. find the minimum $p_{boiler}$ [psig] for making steamed milk

## Part 2: Conceptual Problems – 20 Points

6. You have liquid water in a clear, rigid, sealed container. It starts out at room temperature and pressure (68 °F and 14.7 psia). You put it on your stovetop and add heat – hoping to watch it boil. Your container has a pressure relief valve that will open when the pressure gets to 200 psia. Explain if you will or won't see the water boil before it reaches 200 psi.

7. The figure below shows an engineering cycle on a P-v diagram. The cycle operates as a Closed System. Determine the following:
    a. Shade and label the Net Work for the cycle
    b. Label the Net Heat Transfer for the cycle
    c. Determine if the Net Work is positive (work out) or negative (work in)



## Part 3: Property Tables – 30 Points

8. Use the Balmer thermodynamic tables to determine the specific internal energy [Btu/lbm] of water that is at a pressure of 1324 psia, and a quality of 0.667.

9. Use the Balmer thermodynamic tables to determine the specific enthalpy of saturated ammonia when the temperature is 0 °F, and the specific volume is 2.25 $ft^3$/lbm.

10. You have water that is at 200 psia and 212 °F. Determine what phase this water is in, then use your supplemental tables to give your best approximation for the value of specific internal energy [Btu/lbm] **Note:** You can also check your answer in EES, but for your actual answer you're going to need to get your specific volume from the tables.