ME 200 Thermodynamics – Spring 2020
PREPARING FOR EXAM 2

I. Class Notes, Examples and Quizzes

Review all class notes, examples and quizzes covering material up through the homework HW-21. Do you understand all of the concepts that were presented and discussed? Could you solve the examples and quizzes without looking at the solutions?

II. Homework Problems

Be able to solve all of the homework problems without having to look at the solutions! Note that solutions for the homework problems are posted.

III. Old Exams

The ME 200 website (https://engineering.purdue.edu/ME200/) has a previous exam (Exam 2). Try to solve the old exam in the time allotted which was 90-minutes.

IV. Some Additional Practice Problems

1. Answer the following short questions and provide appropriate justifications:

   A. Air treated as an ideal gas is expanded to a lower pressure in a closed piston cylinder device and heat transfer occurs from the surroundings so that temperature remains constant. What happens to the internal energy of the air as it is expanded? a) increases, b) decreases, c) remains the same, d) not enough information. **Justify using appropriate equations.**

   B. A steady flow of nitrogen gas in a constant diameter pipe experiences a decrease of temperature from 500 K to 400 K due to heat transfer and a decrease of pressure from 5 bar to 4.5 bar due to friction. What happens to the velocity of the nitrogen? **Show work.**
   a) increases, b) decreases, c) remains the same, d) can't tell

   C. Air treated as an ideal gas is flowing through a work producing turbine where the pressure is lowered at a constant temperature (isothermal process). If you neglect kinetic and potential energy changes, then what happens to the following quantities for the air flow stream between the inlet and outlet? **In each case, justify your answer with basic equations and/or property relations.**
   Enthalpy: a) increases, b) decreases, c) remains constant
   Density: a) increases, b) decreases, c) remains constant
   Heat Transfer: a) positive, b) negative, c) zero

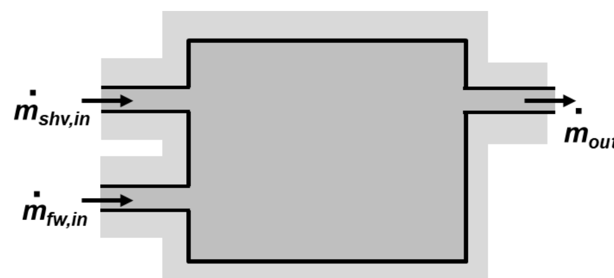
D. Water treated as an incompressible liquid is flowing through an adiabatic and horizontal nozzle and remains at a constant temperature (isothermal process). What happens to the following quantities for the water flowing through the device between the inlet and outlet? **In each case, justify your answer with basic equations and/or property relations.**

Velocity: a) increases, b) decreases, c) remains constant
Internal Energy: a) increases, b) decreases, c) remains constant
Enthalpy: a) increases, b) decreases, c) remains constant
Pressure: a) increases, b) decreases, c) remains constant

E. Fluid is flowing through an isenthalpic throttling device (i.e., no heat transfer, no work, and no changes in kinetic or potential energy). What happens to the temperature of the fluid assuming the following fluid types for both inlet and outlet? **In each case, justify your answer with basic equations and/or property relations.**

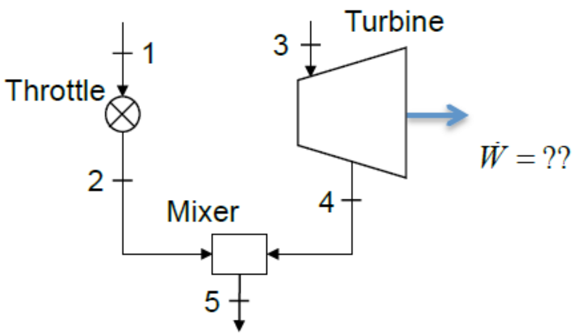
Ideal gas: a) increases, b) decreases, c) remains the same
Incompressible liquid: a) increases, b) decreases, c) remains the same
Saturated mixture: a) increases, b) decreases, c) remains the same

F. An open feedwater heater is used for heat recovery and operate by mixing superheated steam with liquid feedwater. Is it theoretically (thermodynamically) possible for this open feedwater heater to approach a thermodynamically reversible process? Explain why or why not? If yes, then show a system configuration that could be utilized to thermodynamically reverse the process.



2. The figure below shows a portion of a cycle for producing power that utilizes water/steam as the working fluid. The components are a throttling device, a turbine, and a mixing device. For the data given and assuming adiabatic devices with negligible changes in potential and kinetic energy, do the following:

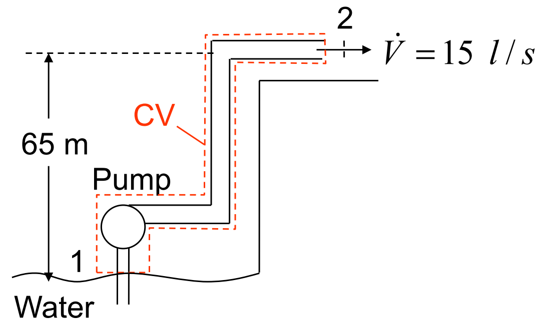
a) Fill in the unknown data within the table below.
b) Show the processes for water/steam on P-v and T-v diagrams with respect to saturation lines and including the state points with appropriate isotherms and isobars.
c) Determine the power output of the turbine, in MW.



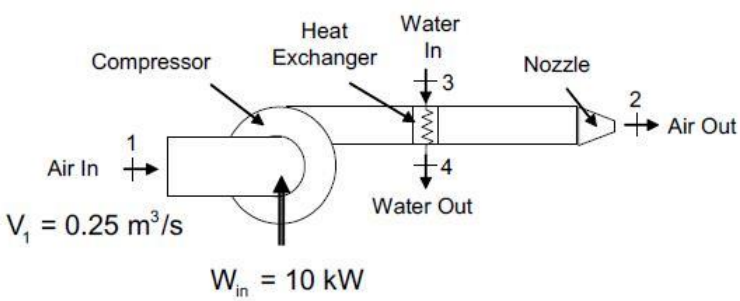
State	$\dot{m}$ (kg/s)	T (°C)	P (kPa)	h (kJ/kg)	x
1	100	130	1000		
2			6		
3	1000	320	1000		
4		80	6		
5			6		

3. Given: Steady state pumping of water as shown in figure with D_1 = 10 cm, D_2 = 15 cm; $T_2 = T_1 = T_{atm}$ = 20°C; $P_2 = P_1 = P_{atm}$ = 101.3 kPa. Assume adiabatic pump and piping.

   Find: Pump power (kW) required.



4. The system shown below draws air at negligible velocity from a room at 100 kPa and 21°C and produces a high velocity jet of air at 30 m/s and 21°C for cleaning of manufactured parts. The system includes a compressor for raising the air pressure, a heat exchanger for cooling the air, and a nozzle for producing the high velocity. In order to cool the air, liquid water enters the heat exchanger at 10°C and exits at 16°C and is at a constant pressure of 300 kPa. If the volumetric rate of air is 0.25 m^3/s at state 1 and the power input to the compressor is 10 kW, then find: a) mass flow rate of air, in kg/s, b) required water flow rate, in kg/s. **Hint: Choose the entire device as your system.**



state	T (C)	P (kPa)	V (m/s)
1	21	100	~0
2	21	100	30
3	10	300	-
4	16	300	-

5. A rigid tank with a volume of 1.0 m^3 initially contains H_2O at 0.07 MPa and 100°C. It is filled from a steam line at 0.70 MPa and 200°C. The tank is filled to a level of 90 % liquid on a volume basis. The tank is maintained at 100°C during the process. Evaluate the required heat transfer (kJ) to maintain the tank at the constant temperature.