ME 211 Thermodynamics Name _____

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Second Hour Exam

Education does not mean teaching students what they do not know,
it means teaching them to behave as they do not behave. -Julius Ruskin

Short Answer (10 pts each).

1. Air at 200 kPa and 27 C flows through a 0.25 m diameter pipe at 200 m/s. Calculate the mass flow rate in kg/s (R_{air} = 0.287 kJ/kg K, $A = \pi r^2$).

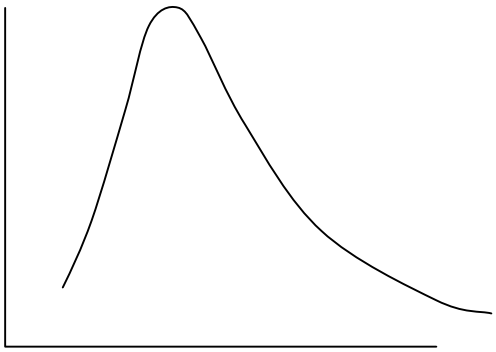
2. For 1 above, calculate the kinetic energy of the air in kJ/s.

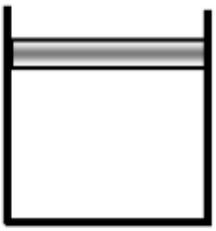
3. Helium (R= 2.077 kJ/kg K, c_v = 3.116 kJ/kg K) is heated from 100 C to 300 C in a steady-state steady-flow process. Neglect velocities and change in potential energy. Determine the heat added to the helium in kJ/kg.

Problems (25 pts each)

4. A mass of 5 kg of water at 300 kPa with a quality of x = 0.60 is heated at constant pressure until the temperature reaches 200C.

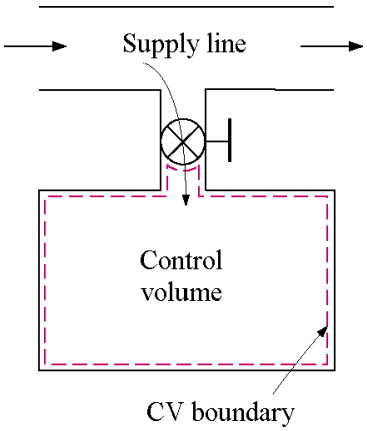
a) Draw the pV diagram
b) Determine the initial temperature of the water in degrees C
c) Indicate the work done on the pV diagram with shading
d) Calculate the work done in kJ by the steam during this process.





5. A rigid 0.4 cubic meter tank, is initially evacuated, and is connected through a valve to a supply line that carries air at 1 MPa and 27 deg. C. The valve is opened and air is allowed to flow into the tank until the pressure reaches 1 MPa. The surroundings are at 20 deg. C and 100 kPa. The valve is now closed. (Note for air R = 0.287 kJ/kg K, c_p = 1.0035 kJ/kg K, c_v = 0.718 kJ/kg K.)

a. Determine the final mass of the air in the tank, kg
b. Determine the final temperature of the air in the tank, deg. C.
c. Determine the final pressure in the tank after the tank reaches thermal equilibrium with the surroundings.



6. Air enters an adiabatic air compressor at 120 kPa and 20 C with a volumetric flow rate of 10 l/s and exits at 1000 kPa and 300 C. Neglect kinetic and potential energy changes. (Note: R = 0.287 kJ/kg K, c_p = 1.0035 kJ/kg K, c_v = 0.718 kJ/kg K, and 1 m^3 = 1000 l.)

Determine a) the work required by the compressor in kJ/kg, and b) the power required to drive the air compressor in kW. Draw the pV diagram.