



ENGR 225: Fall 2024

Homework #3: Open systems

Due: September 19

1. [Chapter 6] Water enters the constant 150-mm inside diameter tubes of a boiler at 5 MPa and 60°C and leaves the tubes at 4 MPa and 400°C with a velocity of 75 m/s. Calculate the velocity of the water at the tube inlet and the inlet volumetric flow rate.
2. [Chapter 6] Air at 600 kPa and 500 K enters an adiabatic nozzle that has an inlet-to-exit ratio of 2:1 with a velocity of 100 m/s and leaves with a velocity of 400 m/s. Determine: (a) the exit temperature and (b) the exit pressure of the air. [Assume ideal gas behavior and use c_p at 500 K]
3. [Chapter 6] Steam enters an adiabatic turbine at 8 MPa and 400°C and leaves at 100 kPa with a quality of 90%. Neglecting the changes in potential and kinetic energies, determine the mass flow rate required for a power output of 5 MW.
4. [Chapter 6] Refrigerant R134a enters an adiabatic compressor as saturated vapor at -20°C and leaves at 1 MPa and 60°C. The mass flow rate of the refrigerant is 1.2 kg/s. Determine (a) the power input to the compressor and (b) the volumetric flow rate of the refrigerant at the compressor inlet.
5. [Chapter 6] A well-insulated valve is used to throttle steam from 5 MPa and 400°C to 1 MPa. Determine the final temperature of the steam.

1. 1.04 m/s , $0.0183 \text{ m}^3/\text{s}$
2. (a) 427 K , (b) 256 kPa
3. 7.24 kg/s
4. (a) 65.96 kW , (b) $0.177 \text{ m}^3/\text{s}$
5. 368°C