Chapter 4 Examples

1. Air enters a nozzle at 200 ^oC and a speed of 100 m/s and exits with a speed of 200 m/s. Determine the exit temperature. Take the c_p of air as 1.005 kJ/kg.K
2. Steam enters a nozzle at 40 bar, 400 ^oC with a speed of 10 m/s and exits at 16 bar and a speed of 665 m/s. Heat loss and potential energy changes can be neglected. Steam mass flow rate is 2 kg/s. Determine the exit cross sectional area.

1. For a compressor operating at steady state, air enters at 1 bar, 290 K with a speed of 6 m/s by an inlet with a cross sectional area of 0.1 m^2. At the outlet, pressure is 7 bar, temperature 450 K and the speed is 2 m/s. Heat loss is at a rate of 180 kJ/min. Find the compressor power input in kW. (R=0.287 kJ/kg.K, c_p=1.005 kJ/kg.K)
2. A mixing chamber operates at steady state. Steam at 8 bar, 200 ^oC with a mass flow rate of 40 kg/s mixes with liquid water at 8 bar, 40 ^oC. The mixture exits as saturated liquid at 8 bar. Assuming perfect insulation and negligible KE and PE, determine;
   - Mass flow rate of water entering
   - Mass flow rate of saturated liquid exiting
   - Speed of incoming water if the cross sectional area is 25 cm^2.

1. Steam enters a condenser at 0.1 bar with a quality of 0.95 and exits at 0.1 bar, 40 ^{o}C. Cooling water enters the condenser via a different inlet at 20 ^{o}C and exits at 35 ^{o}C without any change of pressure (P_{atm}). Heat loss, changes in KE and PE can be neglected. For steady flow conditions, determine

   - Ratio of cooling water mass flow rate to steam mass flow rate
   - Heat transfer from steam to the cooling water [in kJ for each kg steam that is flowing]