<u>Chapter 5 Assignment</u>
<u>(Answers are in parenthesis)</u>

1. Steam expands isentropically in a converging-diverging nozzle from inlet conditions of 1400 kPa, 598K, and negligible velocity to a discharge pressure of 140 kPa. At the throat the cross-sectional area is 6 cm^2. Determine the mass flow rate of the steam and the state of the steam at the exit of the nozzle. **(1.08kg/s, 0.966)**
2. Steam expands adiabatically in a nozzle from inlet conditions of 9 bar, 488K, and a velocity of 70m/s to a discharge pressure of 2.4bar where its velocity is 609.6 m/s. What is the state of the steam at the nozzle exit? **(0.987)**
3. Carbon dioxide at upstream conditions T_1 = 350 K and P_1 = 80 bar is throttled to a downstream pressure of 1.2 bar. Estimate the downstream temperature and ΔS of the gas. **(280K, 31.5J/molK)**
4. A steam turbine operates adiabatically at a power level of 3500 kW. Steam enters the turbine at 2400 kPa and 500°C and exhausts from the turbine as saturated vapor at 20 kPa. What is the steam rate through the turbine, and what is the turbine efficiency? **(4.1kg/s, 0.819)**
5. Isobutane expands adiabatically in a turbine from 5000 kPa and 250°C to 500 kPa at the rate of 0.7 kmol/s. If the turbine efficiency is 0.80, what is the power output of the turbine and what is the temperature of the isobutane leaving the turbine? (**4663kW, 458K**)
6. Saturated steam at 125 kPa is compressed adiabatically in a centrifugal compressor to 700 kPa at the rate of 2.5 kg/s. The compressor efficiency is 78%. What is the power requirement of the compressor and what are the enthalpy and entropy of the steam in its final state? **(3156.6kJ/kg, 7.45kJ/kgK, 1173kW).**
7. Derive an expression for enthalpy change of a gas during an isothermal process assuming that: $\left(P+\frac{a}{TV^2}\right)(V-b)=RT$ **[** $Ans:(3a)(\frac{1}{V_1}-\frac{1}{V_2})+RTb(\frac{1}{V_2-b}-\frac{1}{V_1-b})$ **]**