23 October 2014

CHE 260 – Thermodynamics and Heat Transfer

Mid-Term Exam – 2014

You have 110 minutes to do the following five problems. You may use your textbook, notes and any type of non-communicating calculator. All questions are worth equal marks.

1) Helium gas initially at 1 bar, 200 K undergoes a polytropic process with Pv^{γ} =constant, where $\gamma = c_p/c_v$, to a final pressure of 14 bar. Determine the work done during the process per kilogram of helium.

2) An isolated system initially contains two equal masses of water, one at temperature T_1 and the other at temperature T_2. The two masses are mixed and allowed to come to equilibrium. If the total mass of water in the system is m and its specific heat is c, show that the entropy generated by mixing is:

$$S_{gen} = mc \ln\left[\frac{T_1 + T_2}{2\sqrt{T_1 T_2}}\right]$$

3) A piston-cylinder device with 2 kg of water at 1 MPa and 250°C is cooled with a constant load on the piston. This isobaric process ends when the water has reached a state of saturated liquid. Sketch the process on both *P-v* and *T-s* diagrams on which the vapour dome is marked. Find the work and heat transfer.

4) Air enters a nozzle steadily at 280 kPa and 77°C with a velocity of 50 m/s and exits at 85 kPa and 320 m/s. The heat losses from the nozzle to the surrounding medium at 20°C are estimated to be 3.2 kJ/kg. Determine (*a*) the exit temperature and (*b*) the total entropy change for this process.

5) Steam enters an adiabatic turbine steadily at 7 MPa, 500°C and leaves at 100 kPa. If the power output of the turbine is 5 MW and the isentropic efficiency is 77%, determine the mass flow rate of steam through the turbine.