ME 501 Final Examination
Fall, 2001
Submission Deadline: December 6, 2001
(Submission in pdf Format through Digital Drop Box only)
Maximum Points: 100

1. Gaseous Propane is burned with 60% theoretical air in a steady flow process at 1 bar. Both fuel and air are supplied at 298 K. The products of combustion leave at 1500 K. The enthalpy of formation of propane is –103,847 J/gmol.

(a) If the products, which consist of CO_2, CO, H_2O, and N_2 are in equilibrium, determine the composition of the combustion products.
(b) Calculate the rate of heat transfer per kg of fuel.
(c) Calculate the maximum possible SSSF work and entropy generated per kg of fuel.

20 points

2. Liquid water at 50^oC and 7 bar and water vapor at 300^oC and 7 bar enter a mixing chamber and saturated liquid at 7 bar leaves the chamber. Ignore heat transfer with the surroundings and all changes in kinetic and potential energy. Calculate the ratio of flow rates of the two entering streams. Determine the specific flow availability of each stream. Also, calculate the entropy generated and irreversibility produced per unit mass of water at outlet. Assume steady state steady flow operation and ambient conditions of 298 K and 1 bar.

20 points

3. Derive an expression for the spinodal condition for a pure fluid following Peng-Robinson equation of state.

20 points

4. A binary fuel droplet has a molar composition 70% n-heptane and 30% n-dodecane. Determine the partial pressure of vapor of each species in air at 300K and 100 kPa total pressure. Assume that air is insoluble in the liquid phase and for each fuel component, Clausius-Clapeyron equation applies. The normal boiling points of heptane (molecular weight = 100.2)and dodecane (molecular weight = 170.3) are 371.4 K and 489.3 K and their enthalpies of vaporization at normal boiling points are 316 kJ/kg and 256 kJ/kg. respectively. Assume Raoult's law and Dalton's law to apply.

20 points

5. Obtain an expression for Joule-Thomson coefficient for a RK gas.

20 points