AME 513	**Assigned: Tuesday 12/4/2012**
Problem Set #4	• **"Due" Friday 12/7/12 but no late penalty until Friday 12/14/12 at 12:00 noon. NO LATE HOMEWORK WILL BE ACCEPTED! Solutions will be available at the time and place homework is due.** • **Email to the grader (Thada Suksila) at ame513_fall2012@yahoo.com or fax to 213-740-8071 if you're off campus** • **DEN students submit through the usual channels**

Textbook problems:

9.5 (Non-reacting laminar jet)

9.8 (Laminar jet flame)

10.1 (Droplet evaporation without combustion)

10.5 and 10.6 (Droplet combustion)

Other problems:

PDR1. (Stoichiometry of non-premixed flames)

a) Determine the stoichiometric mixture ratio (S in my notation) and stoichiometric mixture fraction $Z_{st} = 1/(1+S)$ fraction for
   - CH_4 - air
   - C_2H_5OH – air
   - C_6H_{14} - air

b) Determine the stoichiometric mixture ratio (S) and stoichiometric mixture fraction $Z_{st} = 1/(1+S)$ fraction for the mixtures of part (a) where all of the N_2 from the air side has been moved to the fuel side, i.e. fuel + N_2 against pure O_2

c) For the mixtures of part (a), what mole fraction of N_2 would be required on the fuel side and on the O_2 side so that S = 1 ($Z_{st} = 0.5$)?

PDR2. (Droplet combustion)

For the conditions of the textbook problem 10.5 and 10.6, determine the flame temperature T_f and the fuel mass fraction at the droplet surface ($Y_{F,d}$).

PDR3. (Temperatures of non-premixed flames)

a) Calculate the temperature profile (T vs. x) for a planar 1D methane-air non-premixed flame with both reactants at 298K for no flow and L = 1 cm

b) Repeat (a) for a flow u(L) = -1 m/s (that is, flow from right to left)

c) Calculate the temperature profile (T vs. x) for a counterflow methane-air non-premixed flame with both reactants at 298K and a stretch rate a = 100 s^{-1}. (Notice the similarity to part (b) where you had u/L = (1 m/s)/(0.01 m) = 100 s^{-1}).
d) Calculate the temperature profile in the hexane droplet of problem 10.5, from $r = r_d$ to $r = \infty$.

PDR4. (Jet flames)

a) Determine the flame length scaling for a turbulent, buoyant, round-jet flame
b) Determine the flame length scaling for a turbulent, buoyant, slot-jet flame.

PDR5. (Extinction)

a) Using Liñán's formula, estimate the extinction stretch rate for a methane-air flame in a counterflow.
b) Repeat (a) if the N_2 is moved from the oxidizer to the fuel side, as in problem PDR 1b. (Note that the stoichiometric parameter S appears in several places in the extinction formula!)