Ae 330/708
Assignment 4
Due date: 13-10-2020 (11.59 pm)

1. Space Shuttle's main engine burns hydrogen and oxygen to generate the thrust. For simplicity, assume that the equivalence ratio is 1 and the reactants enter the chamber at 298 K. Determine the adiabatic flame temperature in the combustion chamber. (Standard heat of formation of H_2O = -241.997 kJ/mol, C_p of H_2O = 53.9 kJ/kmol-K).

2. The experimental data shows that the equilibrium products coming out of nozzle are as follows:

$$2H_2 + O_2 \rightarrow 1.83\ H_2O + 0.17\ H_2 + 0.085\ O_2$$

Determine the actual flame temperature corresponding to above equilibrium reaction. What is the c* value? (Cp values for H2, O2 and H2O are 35.811, 38.9, 53.9 kJ/kmolK respectively)

3. A semi-cryogenic engine burns liquid kerosene and oxygen in its combustor at φ=1. Kerosene can be approximated by $C_{12}H_{24}$. For simplicity, assume vapours of kerosene and gaseous oxygen are present at reference temperature of 298 K prior to combustion and combustion is complete. Determine the stoichiometric mixture ratio and adiabatic flame temperature. Standard heat of formation of octane is -159 kJ/mol.

	Heat of formation (kJ/mol)	Cp kJ/kmol.K
CO_2	-393.978	60.43
H_2O	-241.997	53.9

4. Estimate the adiabatic flame temperature of methane-air combustion with equivalence ratio of 1.2. The reactants are at reference state before combustion.

Species	CH4	CO2	H2O	N2
Heat of formation kJ/mol	-74.83	-393.978	-241.997	--
Cp kJ/molK	0.0358	0.0562	0.0439	0.0337