Assignment 1 (EN 315, due date: 9th August, 10:30 AM)

1. Determine the viscosity, conductivity and the binary diffusivity of methane-O_2 mixture at equivalent ratio $\emptyset = 0.5$ at 50 °C and 0.5 MPa pressure.

	C_0	C_1	C_2	C_3	C_4
O_2	1.3708 e-3	9.2262 e-5	-2.8054e-8	6.3322 e-12	-2.299 e-16
CH_4 (~)	2.6101 e-3	1.5101 e-4	-5.2050e-8	1.2601 e-12	-2.601 e-16

Table1. Constant for the calculation of thermal conductivity (W/m . K)

Diameter of methane and oxygen molecule are 0.380 e-9 m and 0.354 e-9 m respectively.

μ_{CH_4}=1.19 e-5 Pa.s and μ_{O_2} =2.18 e-5 Pa.s.

2. In a combustor, hydrogen fuel is reacted with oxygen to produce water. The hydrogen enter through a 2 cm diameter tube with velocity 3 m/s at 100 kPa and 500 K, and the oxygen enter through 4 cm diameter tube with velocity 5 m/sec at 100 kPa and 500 K. Find out the steady state velocity of product passing through an outlet of 4 cm diameter pipe.

3. Determine the gas mixture conductivity and viscosity at 700 K and 0.1 MPa. Assuming the relation between viscosity and temperature as fallow:

$$\mu = \mu_o \left(\frac{T}{T_o}\right)^{0.7}$$

	% composition	Viscosity at 293K
CO_2	15 %	1.47 e-5 Pa.s
H_2O	5 %	1.299 e-3 Pa.s
O_2	5 %	2.04 e-5 Pa.s
N_2	75 %	1.76 e-5 Pa.s

Table2. Gas mixture composition and their viscosity at 293 K

	C_0	C_1	C_2	C_3	C_4
O_2	1.3708 e-3	9.2262 e-5	-2.8054e-8	6.3322 e-12	-2.299 e-16
CO_2	1.2528 e-3	1.8145 e-5	1.4728 e-7	-1.3644 e-10	3.7908 e-14
N_2	3.7894 e-3	8.1514 e-5	-2.339 e-8	-3.2294 e-12	4.3092 e-15

H_2O	2.0878 e-2	-9.4108 e-5	3.6958 e-7	-2.7724 e-10	6.7850 e-14

Table3. Constant for the calculation of thermal conductivity (W/m . K)

4. Determine the air-fuel ratio for aviation turbine fuel (ATF, C_8H_{18}) for an equivalence ratio of $\emptyset = 0.6$. The higher heating value for the aviation fuel (ATF) is 48000 KJ/Kg at 298 K. The heat of vaporisation of this liquid fuel (C_8H_{18}) is 375 KJ/Kg. Determine the heat of reaction at 298 K for the ATF vapour.
   Enthalpy of formation at 298 K and 1 atm is given by,

   $h_{fC_8H_{18}}$ = -208.447 KJ/kmol, h_{fH_2O} = -241.826 KJ/kmol, h_{fCO_2} = -393.522 KJ/kmol

5. Determine the adiabatic flame temperature of the stoichiometric methane-air mixture at 298 K and 0.1 MPa ; Under constant volume condition assuming no dissociation of the the product. Enthalpy of formation at 298 K and 1 atm is given by,
   h_{fCH_4} = -74.873 KJ/kmol, h_{fH_2O} = -241.826 KJ/kmol, h_{fCO_2} = -393.522 KJ/kmol

6. A heat recirculating burner for LPG (70 % C_3H_8 + 30 % C_4H_{10}) air is being operated with equivalence ratio of 1.0 , preheated air temperature of 1000 K and pressure 0.1 Mpa. Estimate the adiabatic temperature under this condition. What will be fuel saving due to preheating of air? Enthalpy of formation at 298 K and 1 atm is given by,
   $h_{fC_3H_8}$ = -103.847 KJ/kmol, $h_{fC_4H_{10}}$ = -124.733 KJ/kmol
   The Specific heat at 20 and 1 atm is given by,

O_2	0.919 KJ/kg.K	H_2O	35.550 KJ/kg.K
CO_2	0.844 KJ/kg.K	C_3H_8	1.67 KJ/kg.K
N_2	1.04 KJ/kg.K	C_4H_{10}	1.67 KJ/kg.K

7. In a closed vessel, the oxygen molecules at 2000 K and 0.1 Mpa is dissociated to oxygen , by the following reaction,
   $O_2 \leftrightarrow 2\,O$
   I. Estimate equilibrium Composition.

II. If the vessel pressure is increased to 0.5 MPa, Determine its composition.

8. In a closed vessel, 2 moles of hydrogen are reacted with one mole of oxygen at ambient temperature and pressure. Estimate the equilibrium products assuming adiabatic condition at constant pressure.