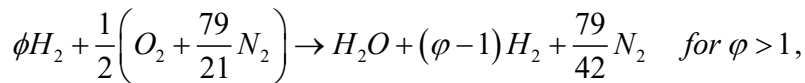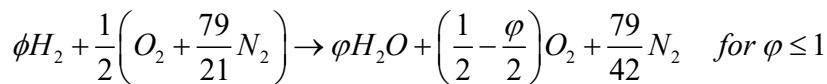Assignment - 4
Combustion Explosion and Detonation (AS 5640)
Department of aerospace Engineering, IIT Madras
Due date: **08/03/2019**
Assignment is to be submitted latest by 4pm on the above due date

1. Similar to the problem discussed in the class (solved example problem # 16.2 of book by Turns), estimate the steady state detonation wave velocity for the premixed gaseous mixture of hydrogen and air (assuming no dissociation of the product gases). The initial temperature and pressure of the reactants are $T_1=298.15K$ and $P_1=1atm$, respectively.

$$\phi H_2 + \frac{1}{2}\left(O_2 + \frac{79}{21}N_2\right) \rightarrow \varphi H_2O + \left(\frac{1}{2} - \frac{\varphi}{2}\right)O_2 + \frac{79}{42}N_2 \quad for\ \varphi \leq 1$$

$$\phi H_2 + \frac{1}{2}\left(O_2 + \frac{79}{21}N_2\right) \rightarrow H_2O + (\varphi - 1)H_2 + \frac{79}{42}N_2 \quad for\ \varphi > 1,$$

where φ *is the equivalence ratio* (take your value of φ from table overleaf)

You can guess flame temperature of burned products equal to adiabatic flame temperature at constant pressure plus 250K (at phi=0.1) to 800K on lean side and plus 800K to 650K (phi=2.5) on rich side. The specific heat of the product species have to be evaluated at this temperature. For example at stoichiometry adiabatic flame temperature is about 2400 K plus 800K is 3200K. Take heat of formation, $\Delta H_{f_{H_2O}}^0 = -241845kJ/kmol$ and constant specific heat. The specific heat capacity at this temperature for product gases (from Appendix A of Book by Turns) $C_{P(H_2O)} = 56kJ/kmolK, C_{P(O_2)} = 40kJ/kmolK,\ C_{P(H_2)} = 38kJ/kmolK,$ and $C_{P(N_2)} = 37kJ/kmolK$.

2. Use the CEA software to compute detonation velocity and plot its variation with φ . For a more realistic situation dissociation is to be considered. Take φ 0.1, 0.3, 0.5, 0.7, 0.9, 10, 1.1, 1.3, 1.5, 1.7, 2, 2.5, 3.0. Mark also on the plot detonation velocity from your calculation in Q1.

Sl. No	RollNo	First Name	φ
1	AE09B028	Vasireddy Saiashwin	0.1
2	AE14B041	Harshal Mankar	0.3
3	AE14B044	Pratik Sutar	0.5
4	AE15B008	APOORVA BANERJEE	0.7
5	AE15B031	RAJEEV KRISHNA S	0.9
6	AE15B055	RAPARTHI SAITEJA	1.0
7	AE16B109	RAKESH RAUSHAN	1.1
8	AE18D005	VIPIN KUMAR	1.3
9	AE18D012	SUMIT SARMA	1.5
10	AE18D014	ANUSAI R	1.7
11	AE18D409	CHAUN BRIJ JAYDEEPBHAI	2.0
12	AE18D410	GOMATHINAYAGAM N	2.5
13	AE18M007	VALLURI RAVI PRASAD	0.1
14	AE18M010	ADITYA WALIYA	0.3
15	AE18M011	ANKIT SAHAY	0.5
16	AE18M012	ARMAL NIKHIL DATTU	0.7
17	AE18M016	GAUTHAM KRISHNAN	0.9
18	AE18M027	SAURABH ROY	1.0
19	AE18M028	SIBANANDA PANIGRAHY	1.1
20	AE18M038	SHUBHAM KUMAR	1.3
21	AE18S021	ROHITH S K	1.5
22	AE18S025	KINGSHUK CHAKRABORTY	1.7
23	AE18S026	VISHAL SRIVASTAV	2.0
24	AE18S046	GAGANA S	2.5
25	ME16B067	RAGHAV KAKANI	1.2
26	AE19F001	Leo Coic	1.2
27	AE169F002	Marine Laumain	1.2