Assignment - 3

Combustion Explosion and Detonation (AS 5640)

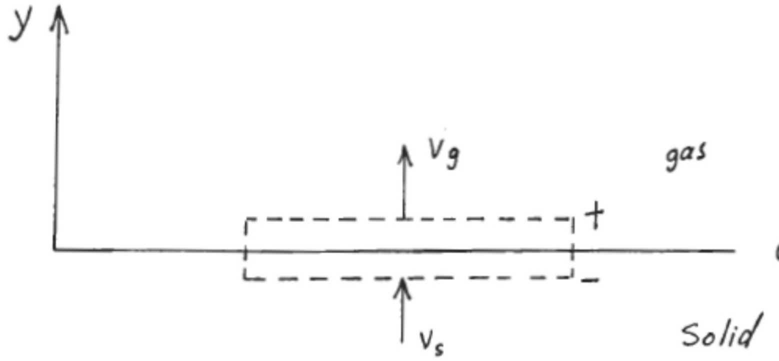
Department of aerospace Engineering, IIT Madras

Due date: **27/02/2019**

Assignment is to be submitted latest by 5 PM on the above due date

1. Derive the species conservation differential equation in one dimension (r-direction) from first principles using a control volume of a cylindrical shell with thickness Δr.

2. If a solid fuel is gasifying at a fixed surface. The fuel mass fraction in the solid fuel is Y_{fs} and remaining is component say 'a' *i.e.* $Y_{as} = 1 - Y_{fs}$. Write down the interface conditions for 1) the mass flux and 2) for balance of individual components (fuel: 'f' and 'a' and non-fuel: 'i').



3. Simplify energy boundary condition at an interface to write energy boundary condition at an interface of a single component evaporating liquid.

4. Compute the binary diffusivity of a) Hydrogen in Oxygen and Methane in Oxygen at 300K. The pressure is 1 atmosphere. The relevant data and equations are provided below.

$$D_{AB} = \frac{0.0266T^{3/2}}{P(MW_{AB})^{1/2}\sigma_{AB}^2\Omega_D} \quad \textit{where } D_{AB}\,(m^2/s),\ T(K),\ P(Pa),\ \sigma_{AB}(\mathring{A})$$

$$(MW_{AB}) = 2\left[\frac{1}{MW_A} + \frac{1}{MW_A}\right]^{-1} \text{ and } \sigma_{AB} = \frac{[\sigma_A + \sigma_B]}{2}$$

$$\Omega_D = \frac{A}{(T^*)^B} + \frac{C}{\exp(DT^*)} + \frac{E}{\exp(FT^*)} + \frac{G}{\exp(HT^*)}$$

Where A=1.06036, B=0.15610, C=0.19300, D=0.47365, E=1.03587, F=1.52996, G=1.76474 and H=3.89411

$$T^* = \frac{\kappa_B T}{\varepsilon_{AB}} = \frac{\kappa_B T}{(\varepsilon_A \varepsilon_B)^{1/2}}$$

Use appendix D of book by Turns to obtain values of σ_i $(\mathring{A})$ and $\frac{\varepsilon_i}{\kappa_B}$(K)