**HOME WORK # 3**

**MENG 7891 Battery and Fuel Cells Fundamentals**

**Spring 2025**

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**\*\* Note that the calculations should be done using no. of electrons per one mole of fuel on the anode side and one mole of oxidizer on the cathode side**

***Objective***: Analysis of over potential losses

Due: March 31, 2025

A solid oxide fuel cell working on direct oxidation of methane (chemical equations given in class) is operated at 700 oC. The cell is supplied with air on cathode side and a mixture of methane, carbon dioxide and water vapor on the anode side. The average bulk concentrations inside the air and fuel channels are maintained at following values.

* 18 %  and 82 %  by volume in air channel
* 60 % , 20 % and 20 %  by volume on anode side.

Estimate the operating voltage for the fuel cell at average current densities of 1.0 A/cm2 and 2.5 A/cm2. Make use of the following data to calculate the over potentials.

* Anodic and cathodic charge transfer coefficients at anode and cathode may be taken as 0.5

Exchange current density at cathode and anode are given by the following empirical relations

Cathode: 

Anode: 

Where  is exchange current density in A/m2, T is temperature in K and C is concentration in mol/m3.

* The effective diffusivity of  in air inside the porous cathode is 3.66 x 10-7 m2/s and the diffusion layer thickness at cathode/electrolyte interface is 10 micron
* The effective diffusivity of  in fuel mixture inside the porous anode is 9.66 x 10-7 m2/s and the diffusion layer thickness at anode/electrolyte interface is 200 micron
* The area specific effective electrical resistance of the fuel cell is 0.1 Ω-cm2.at 700 oC.

Note that such data is either experimentally measured or determined empirically. Comment on the maximum average current density that can be produced by the cell under these conditions.