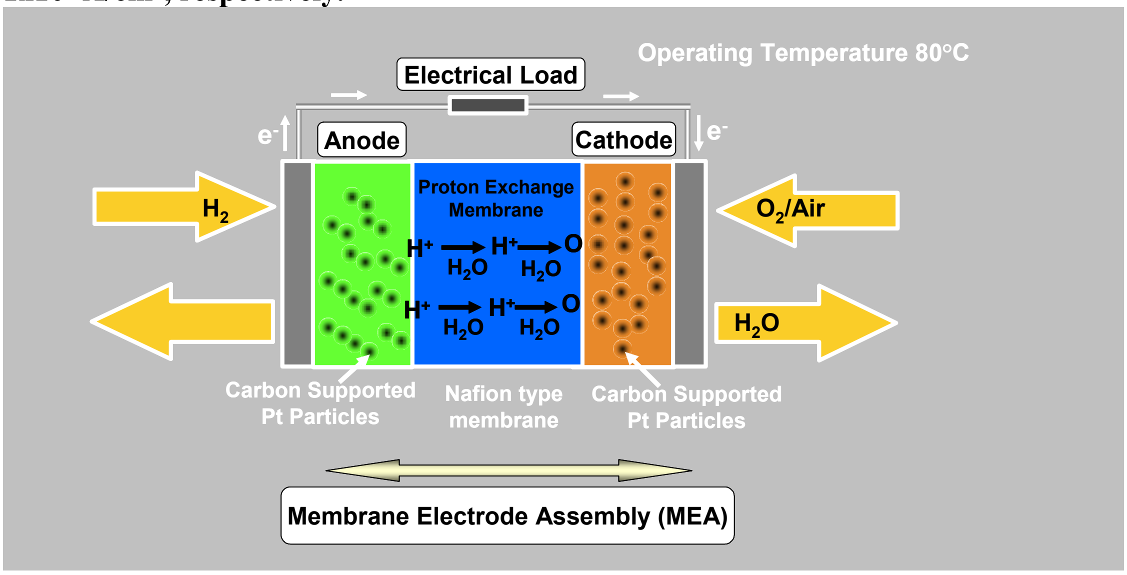
MASSACHESUTS ISNTITUTE OF TECHNOLOGY
FUNDAMNETALS OF ADVANCED ENEFRGY CONVERSION
SPRING 04
HOMEWORK VI
DUE DATE, April 5, 2004

Consider a single proton exchange membrane fuel cell operated at 80C with pure H_2 and pure O_2 inputs at 150kpa, in which Pt nanoparticles supported on carbon are used as the electrocatalyst for hydrogen oxidation and oxygen reduction. The anode and cathode electrode areas are 5cm^2. The ohmic resistance across the fuel cell is $5 \cdot 10^{-3}$ ohms. The exchange current densities for the rate determining steps of oxygen reduction and hydrogen oxidation on Pt nanoparticles are 5x10^{-11}A/cm^2 and 1x10^{-3}A/cm^2, respectively.



1) Calculate the equilibrium fuel cell voltage under the operating conditions.
2) Develop an analytical expression that relates the fuel cell operating voltage to the current density obtainable from the fuel cells by considering ohmic and activation overpotentials across the cell. Plot the effect of ohmic and activation overpotentials to the fuel cell voltage loss as a function of current density in mA/cm^2 in the range from 0 to 2A/cm^2.
3) Plot the second law efficiency of the fuel cell (see equation 2.7 in lecture note on electrochemical thermodynamics (electrochemLecturenote1.pdf)) and the power density in W/cm^2 as a function of current density in mA/cm^2.

Please state all assumptions clearly.