ChE 498/599

Homework 3

Due on 04/21/2016, 2:30 pm

(You can slide it under the door if I am not in my office)

1. Re do all the steps involved (model development, dimensional analysis, analytical solution, plots) as given in the hand-out for the hypothetical thin film electrode battery given in the hand-out. (It is ok to not reproduce the 3D curves, but reproduce all other curves).

2. Imagine the same battery but in the opposite sense. Use this electrode to store energy and charge. Take initial concentration of reactant in the electrode to be zero (that will be the only change). Re do the model, derivation and analysis for this case. For this problem it is ok to use numerical solution instead of the analytical solution once you have set up the dimensionless equations

3. Practice numerical method of lines to solve PDEs. Solve the following PDEs and plot till t= 1 or whenever profiles become negative.

a.

$$\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$$
$$u(x,0) = 1$$
$$u(0,t) = 0; u(1,t) = 0$$

b

$$\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$$
$$u(x,0) = 1$$
$$\frac{\partial u}{\partial x}(0,t) = 0; \frac{\partial u}{\partial x}(1,t) = -1$$

c

$$\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2} + \frac{2}{x}\frac{\partial u}{\partial x} - u^2$$
$$u(x,0) = 1$$
$$\frac{\partial u}{\partial x}(0,t) = 0; u(1,t) = 0$$