Technical University of Denmark

Course 31778 – Assignment 1 – Cell modelling and control

- **The assignment is individual and shall be completed by Thursday 27/02 – 12:00**
- **TO BE UPLOADED**: one Simulink file and a short (approx. 2-3 pages) narrative document
- **Starting conditions**: read (carefully) the instructions below

Given the characteristics of the following Lithium Nickel Manganese Cobalt Oxide (NMC) cylindrical cell, complete the following objectives.

- C_{cell} = 3.0 Ah; v_{nom} = 3.6 V; R_{cell} = 0.035 Ω
- m_{cell} = 48 g; C_{th} = 1000 J/(kg*K); R_{th} = 50 K/W
- v_{oc} = f(SOC) as follows (interpolate linearly between values)

SOC (pu)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
V_{oc} (V)	2.85	3.19	3.39	3.52	3.65	3.73	3.82	3.92	4.01	4.07	4.19

OBJECTIVES:

1) Implement the cell model in Simulink (based on the model analyzed in the class). Include: SOC dynamic, the 1st order electrical circuit and 1st order thermal dynamic. Note that the open circuit voltage is function of the SOC.

2) Start with SOC(0) = 60%, T_{cell}(0)=20 C and T_{out}(0)=20 C. Set a discharge equal to 20 W for 10 minutes, start the discharge at t = 10 s. Run the simulation for 15 minutes.

3) 3.1. In the narrative document, discuss and plot v_{cell} in order to discharge the 20 W for 10 minutes. Is the value constant? If not, why? Plot the joule losses during the 15 minutes of simulation and assess the total amount of energy lost during the period of time.
   3.2 In the narrative document, report and shortly discuss the temperature behavior during the 15 minutes of simulation. Calculate the thermal time constant and comment the value and its meaning.

4) Based on the same previous conditions and assuming a measurement delay of cell power equal 0.1 s, create a second model (in the same Simulink file) where the cell voltage is controlled by a PI controller instead of the explicit calculation. PI parameters have to be chosen so that the response is stable and is settling within 3 seconds. In the narrative document, describe how the PI parameters have been derived in few lines.

Note for the Simulink file:
- the block diagram has to be clearly designed (use tags where convenient)
- Joule losses and cell temperature should be displayed in both plot and display
- clearly plot input and output of the PI controller