MECH545 - Hybrid Electric Vehicle Propulsion
Project 09 Battery Constant Current Discharge Model (Simulink)
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HEV Objective: The purpose of this project is to determine the operating characteristics of a lithium-ion battery pack undergoing constant current discharge.

Matlab/Simulink Objective: Learn to create a semi-log plot using `semilogx`

Assignment: Develop a battery model to be used in your conversion vehicle model.

Part 1: Develop a constant current discharge model for the lithium-ion battery pack provided, using the 'simple' battery model discussed in lecture. The data for the battery pack can be found in the file `ess_li_45_345_Chevrolet_Volt`, which is available on Blackboard.

- The battery pack consists of modules of 96 cells in series and 3 modules in parallel.
- The nominal (3 hour) capacity for each cell is 15.0 Ah, so the overall pack capacity is 45 Ah (nom).
- The nominal voltage for the cells is 3.60 V, so the overall pack voltage is 345 V (nom).
- The open circuit voltage as a function of the SOC is given as a lookup table.
- The nominal resistance of a cell is 0.0030 Ω, so the overall resistance of the pack is 0.0958 Ω (nom).
- The Peukert values for a cell are Cp 15.62 Ah and k =1.025, so the values for the pack are: C_P = 46.86 Ah and k = 1.025.

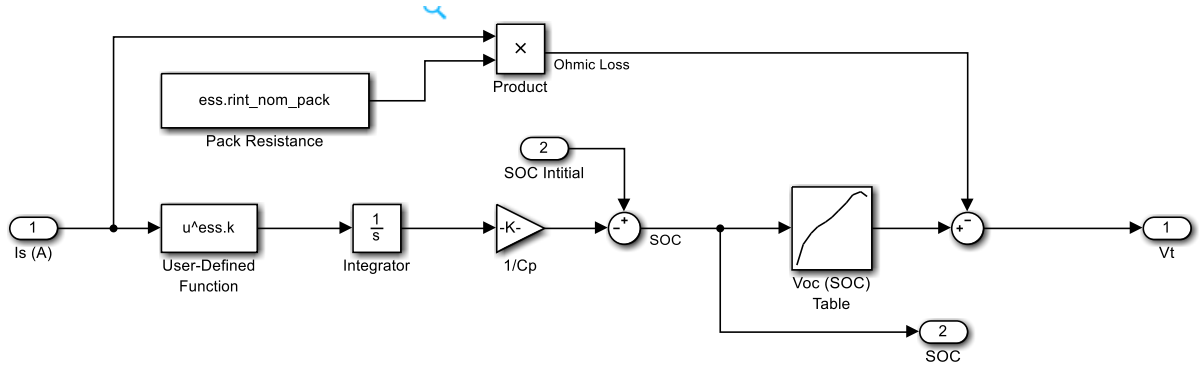

Figure 1 A simple battery capacity model

Note:

- Make certain that you **pay attention to your units**!!
- Make certain that you **use 'per pack' values** and not 'per cell' values. The important 'per pack' values are summarized at the bottom data file.

Part 2: Develop a Simulink model which uses the Battery Model developed in Step 1, to determine the discharge characteristics of the battery at the following discharge rate: 0.5C, 1.0C, and 2.0C (i.e. 22.5 A, 45.0 A, and 90 A). A starting point for the model is shown in Figure 2. Discharge the battery from SOC = 1 to SOC = 0[1], to determine

(a) the discharge time for the given loads (in hours),
(b) the actual charge capacity of the battery for the given loads (in Ah)
(c) the actual energy capacity of the battery for the given loads (in Wh).

Assume that the battery pack resistance is a constant and equal to the nominal value, which is given as `ess.rint_nom_pack`.

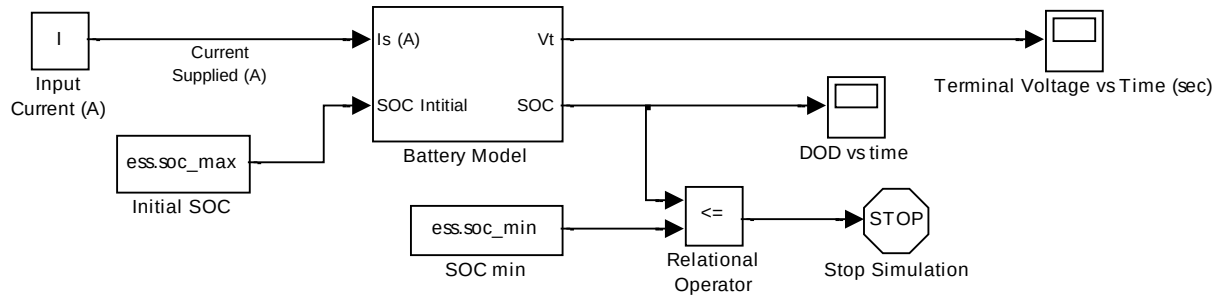

Figure 2 A Simulink model for constant current discharge of a battery

Results:

- Include a table of your discharge rate, time, charge capacity, and energy capacity
- Include a **semi-log** plot of terminal voltage vs. time, comparing each of the discharge rates
- Include a **linear** plot of terminal voltage vs. charge capacity, comparing each of the discharge rate
- Provide insights for your results

Table 1 Summary of Results for SOC_max = 1.0 and SOC_min = 0.0

Discharge Rate (C)	Discharge Rate (A)	Discharge Time (hr)	Current Capacity (Ah)	Energy Capacity (Wh)
0.5 C	22.5 A			
1.0 C	45.0 A			
2.0 C	90.0 A			

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Part 3: Modify your model to use a variable battery resistance. The SOC dependent data is given as a lookup table (`ess.rint_dis_map_pack`). How does this affect your answer?

[1] Do not do this in practice! It will destroy the battery very quickly!