MECH545 - Hybrid Electric Vehicle Propulsion
Project 10 – EREV Range Model (Simulink)
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<u>HEV Objective:</u> The purpose of this project is to determine the range (in **charge-depleting mode**) for the EREV conversion of a 2017 Audi Q7, using the electric machine(s) from Project 8 and the lithium ion battery pack from Project 9.

<u>MATLAB Objective:</u> Learning how to avoid an "algebraic loop" error.

Part 1: Modify your battery capacity model from Project 9 to be appropriate for a ***variable-current*** discharge rate. More specifically, you need to remove the Peukert capacity references and replace them with a nominal (3 hour) capacity reference.

- First, remove the I^k calculation (or set k = 1)
- Then replace the Peukert capacity of the pack (C_p = ess.cp_pack = 46.86 Ah) with the **nominal** (3-hour capacity) of the pack (C_{3hr} = ess.cap_pack = 45.0 Ah).

You model will be like Figure 1.

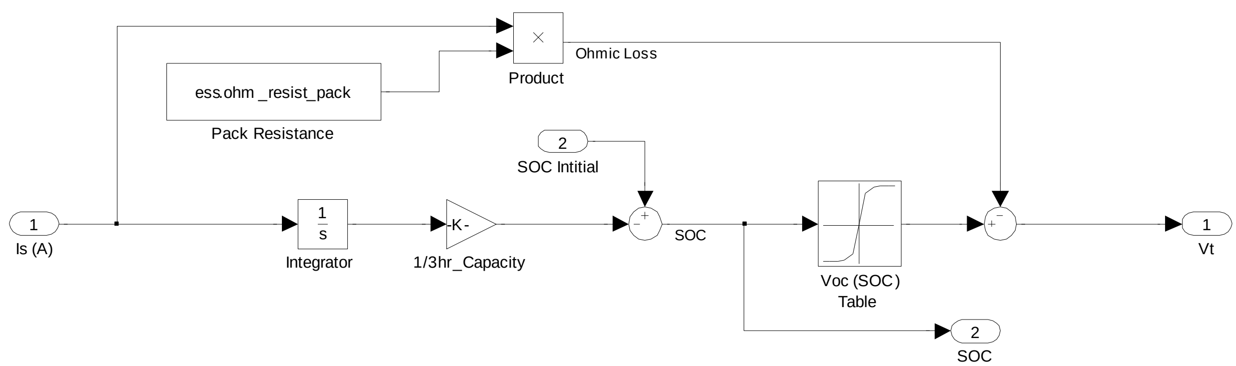

Figure 1 Modified battery capacity model for EV Range model

Part 2: Modify your Fuel Energy Model from Project 7 to use the modified battery model. Your result will be like Figure 2.

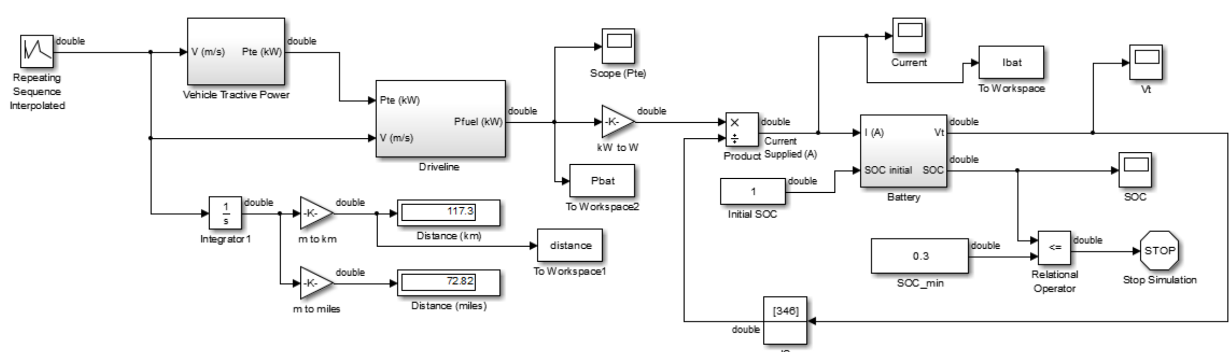

Figure 2 A Simulink model for predicting EV range.

Note:

- Pay attention to your units!!
- The calculation for battery current (P_bat/Vt) will result in an "Algebraic Loop" warning. Ignore it or turn off the warning in the simulation configuration dialog box.
- A 'Memory' block or better yet an 'Initial Condition' block is needed for the first time step, since the value for V_t is not known until the loop runs once. Set the initial value to the nominal pack voltage.
- The 'Repeating Sequence Interpolated' box used to provide the drive cycle data. It is similar to the 1-D Lookup table the you've used previously, however this block will continue repeating the sequence of values in the table until the program is stopped (by the 'Relational Operator'). Make sure you set the 'Sample Time' to match the time step for the simulation (i.e. set it to 1). Remember to set the final time for the simulation to be very high. Hint: check the SOC output to be sure that the program was stopped by the 'Relational Operator' and not by reaching the set final time.

Part 3: Evaluate the range of this vehicle on each of the three drive cycles (City, Highway, Aggressive) for the case where the initial SOC = 0.80 and the final SOC = 0.2. (In other words, allow ΔSOC = 60%.) This battery usage pattern will limit the vehicle range, but significantly increase the battery life[1].

Note: For this model, use the "best" options from your previous projects, i.e.

- Use the single-speed gear box with $R_t = 3.5$, $\eta_t = 0.95$ (from Projects 7 & 8)
- Use the 1.50 x stronger motor from Project 8. To do this multiply the mc.trq_cont_map, mc.trq_max_map, and mc.trq_eff_index values by the 1.50 factor.

Results:

- Include a table of your range values for each driving cycle, the average electrical current for the cycle and the peak electrical current for the cycle.
- Include a plots of V_t vs time, I vs. time and any other you feel are useful
- Provide insights for your results

Due: One week.

MECH-691Students (MECH-545 Students for Extra Credit)

Part 4: None for this assignment. Work on your Final Project.

[1] The battery usage pattern used here, is based on measured data for the 2103 Chevrolet Volt by Argonne National Lab. http://www.anl.gov/energy-systems/group/downloadable-dynamometer-database/plug-hybrid-electric-vehicles/2013-chevrolet See also: https://energy.gov/sites/prod/files/2014/02/f7/2013_chevrolet_volt_fs.pdf