Homework 2 on Prof. Krein’s Lecture on EV Design & Operation

Date due: Friday, February 11, 2022

1. Consider the Nissan Leaf EV we have been exploring in Lecture 3 with the following technical data: $C_d = 0.28$; $A_f = 2.28 \ m^2$; 40-kWh battery pack; final drive ratio 8.193:1; motor with a continuous rating of 110 kW (3,283 to 9,795 r.p.m.); and, a torque rating of 320 N-m (0 to 3,283 r.p.m.). You may assume a 90-% efficiency and 1-kW hotel load in your analysis.
   a. Estimate and compare range based on loaded masses of 1,800 kg, 1900 kg and 2000 kg, respectively, at 70 mph continuous cruise. Compare these three estimates and comment about the impacts of mass on the vehicle range.
   b. For the 2,000-kg mass, estimate the range based on continuous speeds of 60 mph, 70 mph and 80 mph, respectively. Compare these three estimates and comment about the impacts of speed on the vehicle range.

2. Some experts suggest that values such as 100-kW continuous rating, 200-kW peak, 400-N-m torque are excessively high for passenger car motor specifications. As an alternative, consider a car such as the Nissan Leaf EV, loaded to 2,000 kg, with a motor rated for 60-kW continuous, 120-kW peak, and 200-N-m torque.
   a. Estimate the final drive ratio required to support a 30-% gradability for this car.
   b. Determine the attainable acceleration at 50 mph with the 120-kW limit.
   c. Estimate the top speed under the assumption of no limit on motor rotational speed.

Additional Study Activities:

A. Learn about some of the Worldwide Harmonized Light Vehicles Test Procedure (WLTP) classes and meanings. Suggested resources:
c. [http://www.wltpfacts.eu/what-is-wltp-how-will-it-work/](http://www.wltpfacts.eu/what-is-wltp-how-will-it-work/)

B. Pick a vehicle platform of particular interest to you. It can be either an existing or near-future electric vehicle, or a fuel-driven vehicle for which you will prepare an electric version. Please choose an on-road passenger, transport, or cargo vehicle rather than a “supercar,” racecar, or off-road application. It need not be a passenger car, if you wish to analyze a bus, truck, or other road vehicle.

a. For an *EV*, gather enough data to model it (you are welcome to estimate the tire loss coefficient, published by tire vendors rather than vehicle vendors). This needs drag coefficient, empty and loaded weights, frontal area, and any specifications about force, power, motor speeds, final drive ratio(s), etc.

b. For an *ICEV*, gather data about weight, drag, frontal area, and engine-based performance. Pick an electric motor (and single-speed final drive ratio) that can provide similar torque and other performance attributes. Pick a lithium-ion pack, based on 180 kW/kg, that can provide about 150 miles of range.

The data you gather will be useful for future problems and analysis. You may refer to this data collection as “your primary vehicle” for models.