METU EE 7566

Spring 2019

Homework 1: Vehicle Dynamics and Electrified Vehicle Powertrains

This is the first part of your HW1 that will have in total 5 parts. I expect you to develop a Matlab script with the parts explained below. Homework 1 will be collected once all parts are completed, but I highly recommend you to start working on it as the assignments are posted.

Part 1: Week 2 → Speed and torque calculations + maximum power required (EM and Battery)

Part 2: Week 3 → Acceleration Performance

Part 3: Week 4 → Drive Cycle Calculation

Part 4: Week 6 → Matlab Assignment EV

Part 5: Week 7 → Matlab Assignment Range Extender

Part 2: You are asked to redesign a midsize internal combustion engine vehicle (characteristics of the car is given below) as a battery electric vehicle with following requirements:

- 0-100 km/h acceleration time in 7.5 sec

Find the following quantities:

a. Electric machine maximum torque (you calculated power and maximum speed in part1)

Assume following constant efficiency values for the energy converters.

Efficiency of electric machine + inverter	*92%*
Efficiency of gearbox + differential	*97%*
Efficiency of battery pack	*95%*

Vehicle and component characteristics:

Mass of body without powertrain	1000 kg
Increase in mass due to acceleration of rotating masses	1.05
Gravitational acceleration	9.8 m/s^2
Frontal area	2.57 m^2
Aerodynamic drag coefficient	0.26
Density of air	1.25 kg/m^3
Friction coefficient of tires	0.006
Radius of wheels	0.3 m
Gear ratio (electric motor to wheels	9.0478
Accessories consumption (fixed)	750 W
Adhesive coefficient of tires to ground surface	0.9
Front wheel drive with equally distributed load on wheels	0.5 (Acceleration)
Load distribution during braking, W_{front}/W_{total}	0.65 (Braking)
Specific cost of electric machine + inverter	$30/kWh
Specific mass of electric machine + inverter	1.1 kW/kg
Specific volume of electric machine + inverter	2.6 kW/l
Battery pack specific cost, P_{batt}/E_{batt}: power-to-energy ratio	**$(200 + 13 x P_{batt}/E_{batt})/kWh**
Battery pack specific mass	**(200 - 3 x P_{batt}/E_{batt}) Wh/kg +120 kg**
Specific cost of internal combustion engine	$50/kW
Specific mass of internal combustion engine	0.55 kW/kg
Charger mass and cost (fixed)	10 kg and $300
Fuel tank mass and cost (fixed)	5 kg and $150