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MECA0527 EV, HEV, and FC vehicles

PERFORMANCE ASSESSMENT

ASSIGNMENT 1

Your first assignment delas with estimation of the performance of a battery electric vehicle. This year we are going to consider the following vehicle: ***Nissan Leaf II (model 2018)***

Data collected in the references [1,3] give:

ELECTRIC MOTOR: EM61

- P_{max} = 110 kW @ [3282-10 000] rpm
- C_{max} = 320 Nm @ [0 ; 3282] rpm
- N_{max} = 10300 rpm

BATTERY

- Lithium ion NMC
- Capacity: 40 kWh
- Voltage: 345 V
- Internal resistance model (see Ref [1])
- Peukert coefficient: k=1.03

- Power consumption of accessories: 200 W
- Power consumption of HVAC: 6 kW

VEHICLE DATA

- C_X = 0.29
- S = 2.19 m²
- Air density ρ=1,22 kg/m³
- Tire size: 205/55 R 16 91H

- Effective rolling radius R_e: 0,31 [m]
- Tire rolling resistance: f = 0.012 + 0.4*10-7 V² (with V in km/h)

TRANSMISSION

- Transmission to the front wheels
- Single reduction ratio: 7.9377
- Transmission efficiency η : 0.97 (Please validate this estimation given by [1] using the guidelines given in the lectures).

GEOMETRY AND MASS PROPERTIES

- Length/Width/height (mm): 4490/1788/1530
- Wheelbase (mm): 2700
- Curb weight: 1610 kg [1580 -1640 kg] +driver mass 75 kg = 1685 kg
- Weight distribution between front and rear axles: 50/50
- The elevation of the center of gravity as given by h= 20 inches = 508 mm

EXPECTED OUTCOMES

After estimating the missing parameters, you are asked to:

1. Plot the curves of the resistance **force** and **power** between 0 and 50 m/s. Consider three cases: slopes of 0, 3 and 10%.
2. Plot the tractive **force** and **power** at wheels against the road resistance forces in the force / speed diagram of the vehicle.
3. Plot the acceleration capability of the vehicle (me/Fnet) as a function the speed for slopes of 0, 3 and 10%.
4. Compute the theoretical greatest max speed of the vehicle, the related optimum transmission length and gear ratio if we keep the same wheel diameters. Compare with the actual gear ratio implemented in the car.
5. Compute the **maximum speed** on the actual gear ratio.
6. Compute the maximum speed on the actual gear ratio with a slope of 5%.
7. Compute the **maximum slope** with the actual gear ratio. Compute the maximum slope if the friction coefficients are respectively μ=0.8 and μ=0.2.
8. Compute the maximum slope at 100 km/h on dry road (μ=0.8).
9. Compute the **acceleration time** from 0 to 100 km/h.
10. Compute the acceleration time from 30-50 km/h and 90-120 km/h.

Terms of Duty:

The work will be in a group of two students. Each group will submit a report of 30 pages maximum. Reports are preferably submitted under pdf format. The report will include a description of the hypotheses made, the equations used, the complete results (possibly in appendix), a critical analysis of the results, a copy of the calculation codes used (possibly in appendix).

The report will be submitted by email to p.duysinx@uliege.be by Sunday, November 21, 2021 at 23:59 (Brussels time).

References:

[1] Paolo Iora and Laura Tribioli. *Effect of Ambient Temperature on Electric Vehicles' Energy Consumption and Range: Model Definition and Sensitivity Analysis Based on Nissan Leaf Data*. World Electric Vehicle Journal. 2019, 10, 2. doi:10.3390/wevj10010002.

[2] Li Gang and Yang Zhi. *Energy saving control based on motor efficiency map for electric vehicles with four-wheel independently driven in-wheel motor*s. Advances in Mechanical Engineering. 2018, Vol. 10(8) 1–18. DOI: 10.1177/1687814018793064

[3] https://en.wikipedia.org/wiki/Nissan_Leaf , visited on October 20, 2021.

Appendix 1: Nissan Leaf electric machine maps

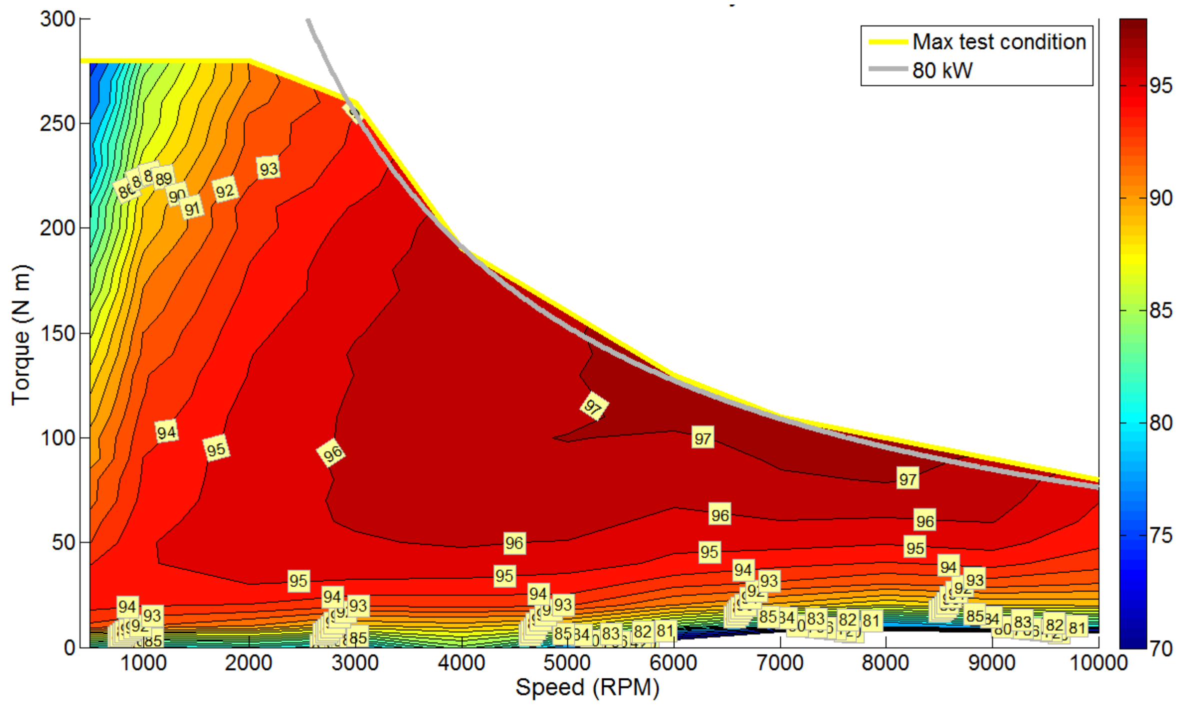

Figure 1 Efficiency map for the Nissan Leaf electric (model 2012) machine 80 kW

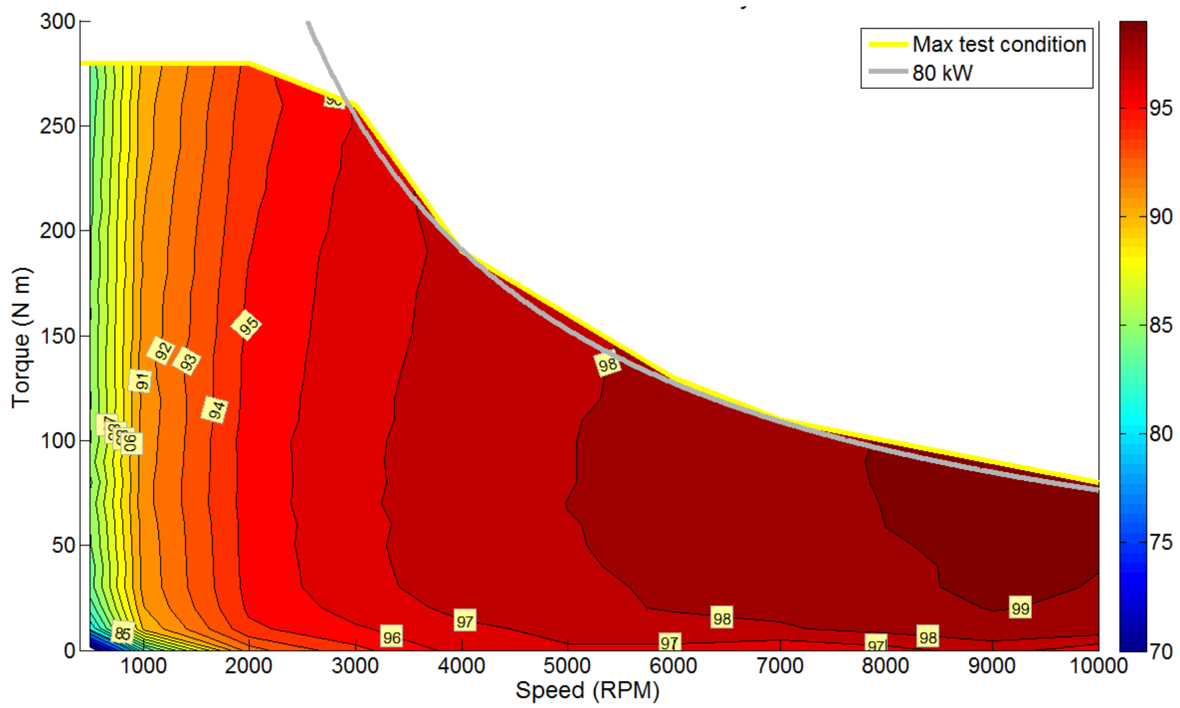

Figure 2 Efficiency map for the Nissan Leaf inverter (model 2012) 80 kW

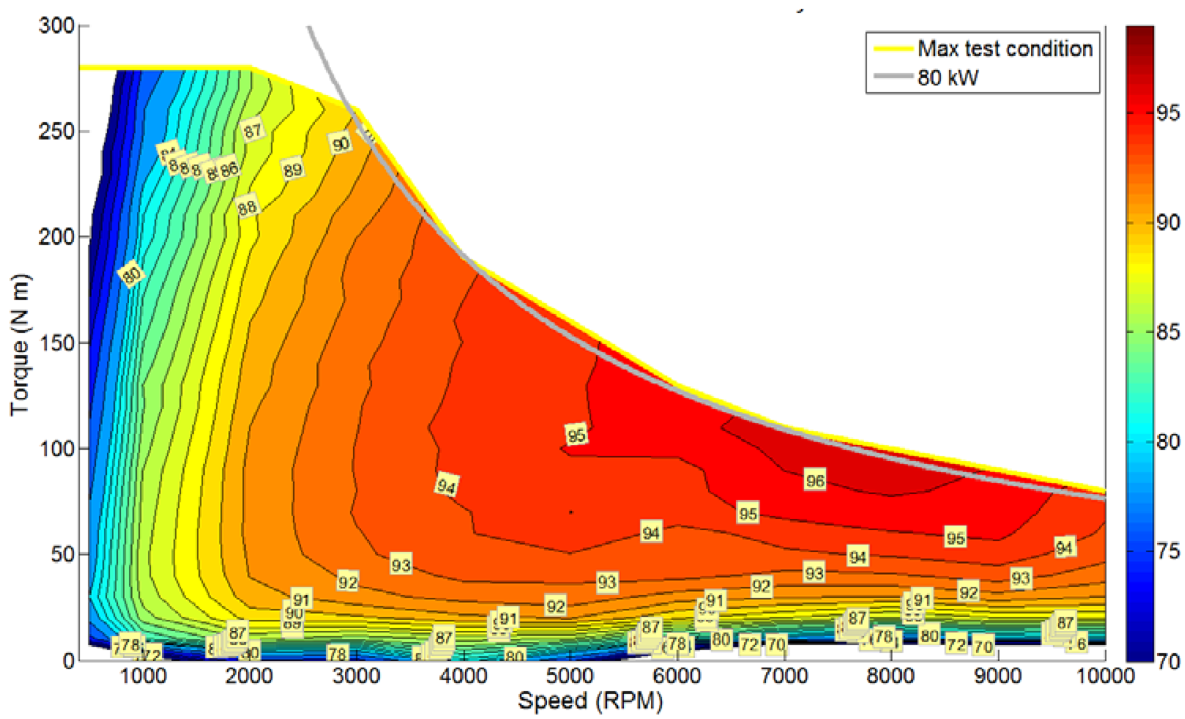

Figure 3 Efficiency map for the Nissan Leaf e-motor + inverter (model 2012) 80 kW

Appendix 2: Nissan Leaf battery curves

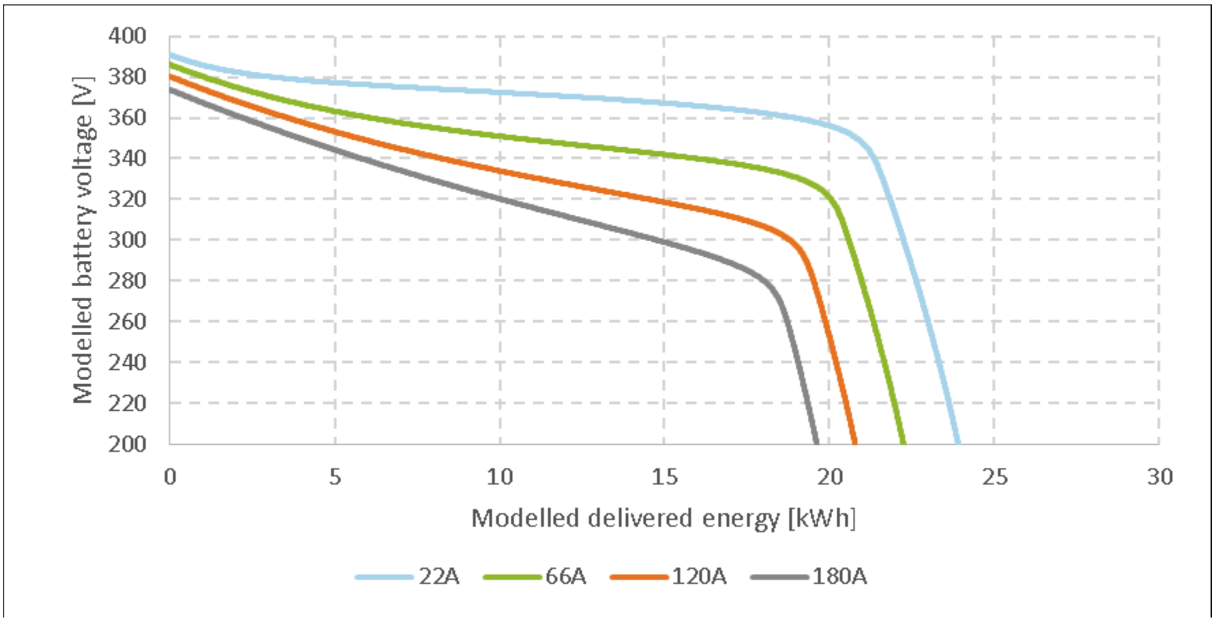

Figure 4: Discharge performance shown in energy, for Nissan Leaf