

Tallinn University of Technology, May 2025





# "Simulation session: Electric Vehicle »

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Based from presentation of Master "Electrical Engineering and Sustainable Development", University of Lille

#### **Reference vehicle**





Studied vehicle: **Renault Zoé** from PANDA H2020

Assumptions: •equivalent drive (chopper + DC machine) •mono-wheel equivalent model (only for straight lines) •NEDC driving cycle





Task: build the EMR of the powertrainl

# 1. Modelling



 $F_{res} = A + B v_{ev}^2$ 

#### Chopper model

i<sub>bat</sub>

$$\begin{cases} u_{ch} = m_{ch}u_{bat} \\ i_{bat} = m_{ch}i_m \\ u_{ch} = L_m \frac{d}{dt}i_m + R_m i_m \end{cases} \qquad \begin{array}{l} \text{Gearbox model} \\ \begin{cases} T_{gb} = k_{gb}T_m \\ \Omega_m = k_{gb}\Omega_{gb} \\ \\ \Omega_m = k_{gb}\Omega_{gb} \\ \end{cases} \\ \begin{cases} T_m = k_m i_m \\ e_m = k_m\Omega_m \end{array}$$

#### Chassis

$$F_{wh} - F_{res} = M_{ev} \frac{d}{dt} v_{ev}$$

Wheel model

$$\begin{cases} T_{bg} = R_{wh} F_{wh} \\ v_{ev} = R_{wh} \Omega_{gb} \end{cases}$$

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## 2. Model organisation (EMR)



# 3. Simulation (MATLAB-Simulink©)

# (1) EMR element selection





# 3. Simulation (MATLAB-Simulink©)

# (2) Model budling



 $\Box \times$ 

Simulink Library Browser

# 3. Simulation (MATLAB-Simulink©)

# (3) Model validation





#### Battery of 59 Ah

- Imposing 59 A during 1h
- SoC from 100% to 0% If not the model is false!



Any simple model MUST be validated by simple tests

## **Simulation session**

1) Model already given

all parameters in the "init" file (init\_EV\_dcm.m)

1) Organization (only source are given)

EMR of each element from library (emr\_library\_2025.slx) — EMR of the complete system

3) Simulation (only sources are given) (EV\_model\_v10.slx)

> Simulink of each model  $\rightarrow$  to check Simulink of the complete vehicle





Based from presentation of Master "Electrical Engineering and Sustainable Development", University of Lille

#### EMR (graphical description)

Organization of models of energy conversion systems

Systematic deduction of organization of control schemes and energy management





## Day 1: EMR of the reference vehicle





#### **Inversion-based control**



2. Tuning path



#### **Inversion-based control**



#### 3. Inversion step-by step

## **Example of inversion**



## Validation of inversion



# DAY 3: ENERGY MANAGEMENT

Based from presentation of Master "Electrical Engineering and Sustainable Development", University of Lille

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Bat

### EMR (graphical description)

Organization of models of energy conversion systems

Systematic deduction of organization of control schemes and energy management





### **Inversion-based control**



## Mechanical brake



## Coupling traction and mechanical braking forces



#### EMR summer schools

Since 2006, even year in France, odd year abroad

2014 Coimbra (Portugal), 2016 Montreal (Canada), 2018 Hanoi (Vietnam) 2022 Sion (Switzeland) 2024 Delhi (India)



118 attendeesEMR'23from 17 countries12-15(51 in presences, 61 on-line)3 lectures on concepts26 lectures on applications,4 simulation sessions (3 on-line).





EMR'23, Lille (France) 12-15 June 2023

origin of attendees

EMR'25, Lille (France), 8-11 July 2025, hybrid http://emerwebsite.org 23

Arts et Métiers Université de Lille

http://emrwebsite.org

#### EMR web site



## http://emerwebsite.org

- Summer schools
- Education
- Projects
- Publications
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Next Week: All documents and photos Available on EMR website