École Polytechnique Fédérale de Lausanne
Distributed Electrical Systems Laboratory
EPFL-STI-DESL-ELL, Station 11, CH-1015 Lausanne

http://desl-pwrs.epfl.ch

# Student project proposal

*Project title*

**Finite Element Analysis of 3D Effects in Linear Electric Motors**

*Project type* ☒ MSc thesis ☐ BA semester project ☒ MSc semester project

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*Project description*

The proposed project is part of the epfloop team's research into the electrification of transport, and more specifically into the propulsion of high-speed levitated vehicles. The purpose of the project is to study specific electromagnetic effects in linear electric motors using finite element method (FEM).
A linear electric motor can be considered as the "flat counterpart" of a rotary electric motor. It converts electrical energy into linear movement and levitation force through magnetic field.
Some specific effects that can impact the performance of the motor take place in the plane transverse to the direction of motion. Most existing FEM-based models use a simple 2D representation that cannot take these effects into account.
As a first step, the project will involve developing a 3D FEM model of the motor using COMSOL Multiphysics. The latter could be time-dependent and/or stationary and include non-linearities such as the B-H curve or the losses in the materials. The student working on the project will be able to draw inspiration from existing models developed within the DESL.
The model will then be validated by comparing the results of a given configuration with data from measurements.
Finally, the model will be used to study and characterise these effects on the various performance indicators of electric motors (efficiency, power factor, force generated, etc).
This project is a good opportunity to develop skills in FEM modelling and electromagnetism that are easily transferable to another field.

*Tasks of the student*

- Get familiar with COMSOL.
- Develop a 3D FEM model of a linear electric motor:
  - Geometry.
  - Mesh.
  - Physic definition.
  - Study definition.
  - Solver configuration.
  - Result processing.
- Validate the model by comparing the results with measurements.
- Study and characterise the impact of 3D effects on motor performance.

*Requirements*

- Basic knowledge in FEM.
- Basic knowledge in electrical machines.

*Literature*

[1] https://www.comsol.com/acdc-module

[2] S. Rametti, L. Pierrejean, A. Hodder, and M. Paolone, "Pseudo-Three-Dimensional Analytical Model of Linear Induction Motors for High-Speed Applications," *IEEE Trans. Transp. Electrific.*, pp. 1–1, 2024, doi: 10.1109/TTE.2023.3348655.