

# Bachelorthesis / Masterthesis

## Validation of Finite Element Formulations considering Ferro-magnetic Materials and Permanent Magnets

### Motivation

Relevant magnetic materials for electric machines are subdivided into ferromagnetic materials and permanent magnets. Our in-house finite element software is capable of simulating phenomena occurring in both categories. However, it lacks concrete validation of the implementations in the transient and static case. In this work, validation examples should be established and its results discussed. This involves accuracy, limitations, run-time, etc. to evaluate the performance. Working on this thesis gives an opportunity to gain experience in the use of finite element simulations and to deepen the understanding regarding Maxwell's equations and magnetic materials.

**Overall Question:** How to validate finite element software that solves Maxwell's equations considering ferromagnetic materials and permanent magnets.

**Learning Goals:** Get in touch with various popular software and methods:

- Git, C++, Coreform Cubit, Paraview and openCFS to implement efficient code.
- Solve partial differential equations (e.g. Maxwells equations).
- Learn about magnetic materials.

### Tasks

- Literature research (Ferromagnetic/permanent material laws, Finite element method, Methods to solve nonlinear systems of equations)
- Validation of the software considering ferromagnetic materials, permanent magnets and combinations of both cases.

### Organisation

- Language: English
- Start: Immediately possible

### Contact/Supervisor

Lukas Domenig  
Inffeldgasse 18/I  
lukas.domenig@tugraz.at  
HS 01 106

