Welcome in the Netherlands and in Delft

Welcome to our Finite Element Course!

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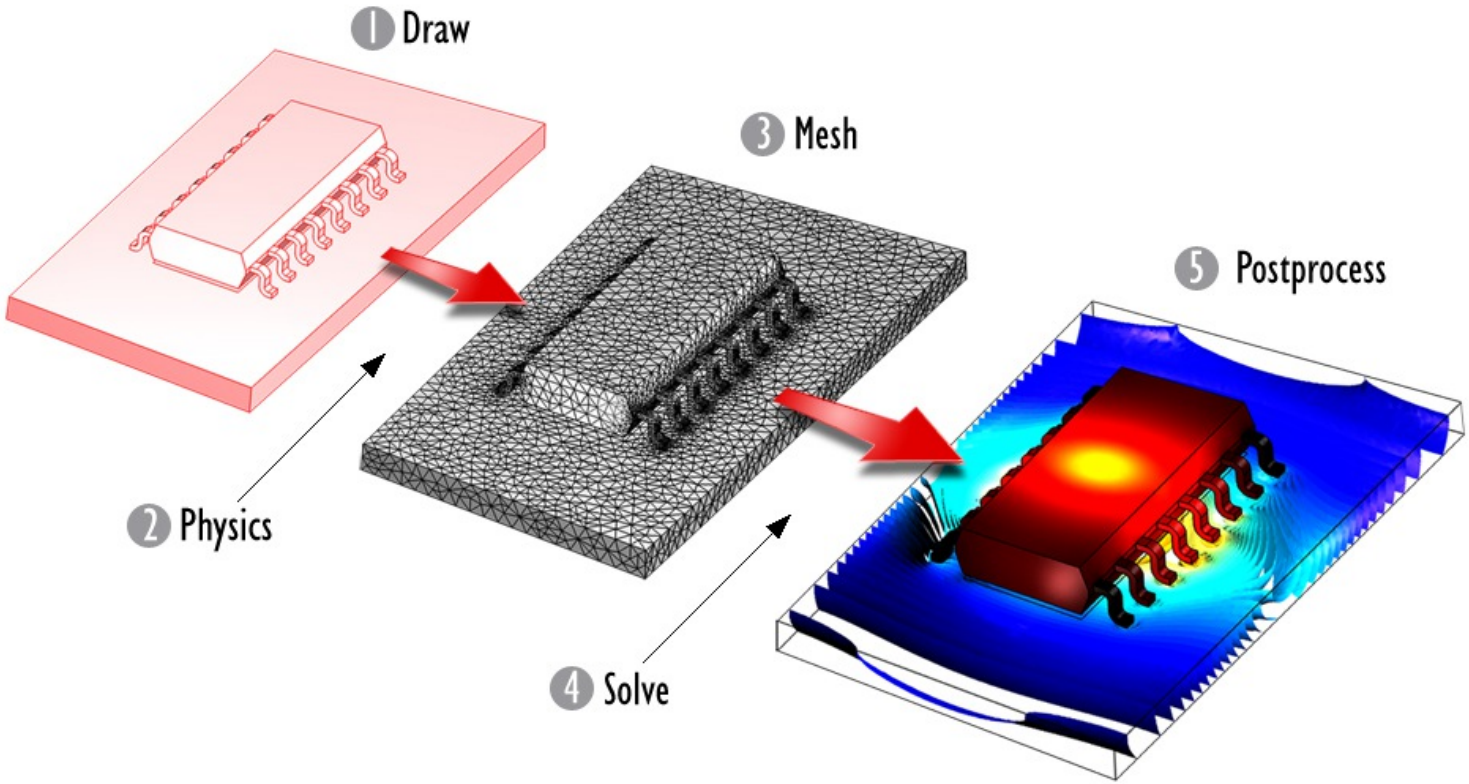
Why Finite Elements?
FE = An Old Guy in Good Shape!

What is Finite Elements?



What is our Course About?

- algorithmic aspects
- simple model problems
- spatial and temporal variation

What is this Course Not?

- mathematical foundations
- advanced engineering applications

Teaching Goals

- build your own finite element code
- for elliptic and parabolic differential equations
- acquire know-how to extend the code to more complex cases

How is this course organized (1/4): Lectures

- Day 1: Motivation, Model problems and Tools
- Day 2: Theory and Algorithms for Spatial Discretization
- Day 3: Theory and Algorithms for Time Discretization
- Day 4: Convection/Diffusion - Two Dimensinal Problem
- Day 5: The Quest for Accurary - Extensions

How is this course organized (2/4): Lab Sessions

- Day 1: Introduction to Matlab (or Python)
- Day 2: Implementation of Spatial Discretization in Matlab/Python
- Day 3: Implementation of Temporal Discretization
- Day 4: Extension to 2D
- Day 5: Convection/Diffusion

How is this course organized (3/4): Location

- Location of the lectures: daily 10:00 - 13:00
  - Tuesday: Drebbelweg Zaal 2
  - Wednesday: EWI Lecture Hall Ampere
  - Thursday: EWI Lecture Hall L (tricky to find)
  - Friday: IO Joost van Grinten

How is this course organized (4/4): Location

- Location of the lab sessions: daily 10:00 - 13:00
  - Monday, Tuesday, Wednesday: TBM Computer Room B
  - Thursday, Friday: LR Computer Room 007

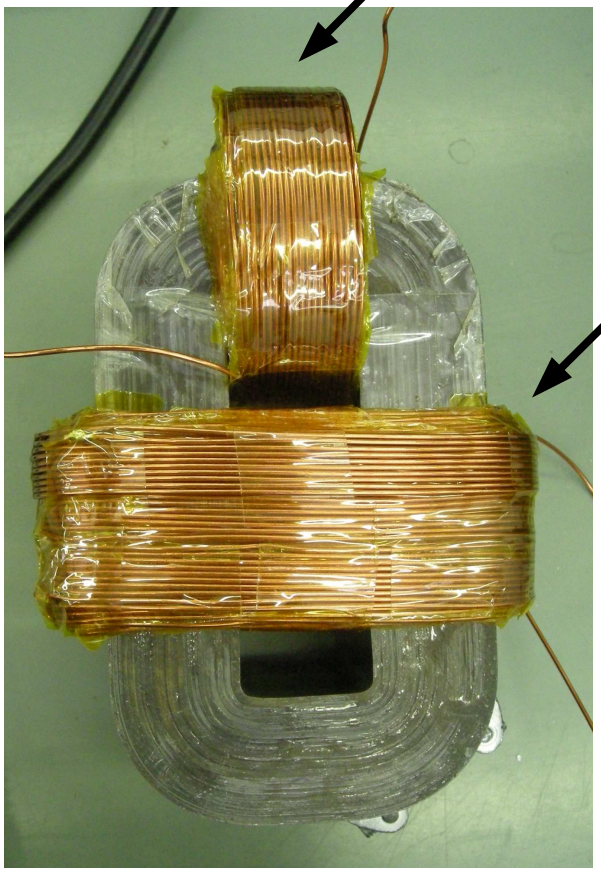
Course Assesment

- no exam as such
- active participation during the lectures
- completion of the programming exercises
- increase δ!

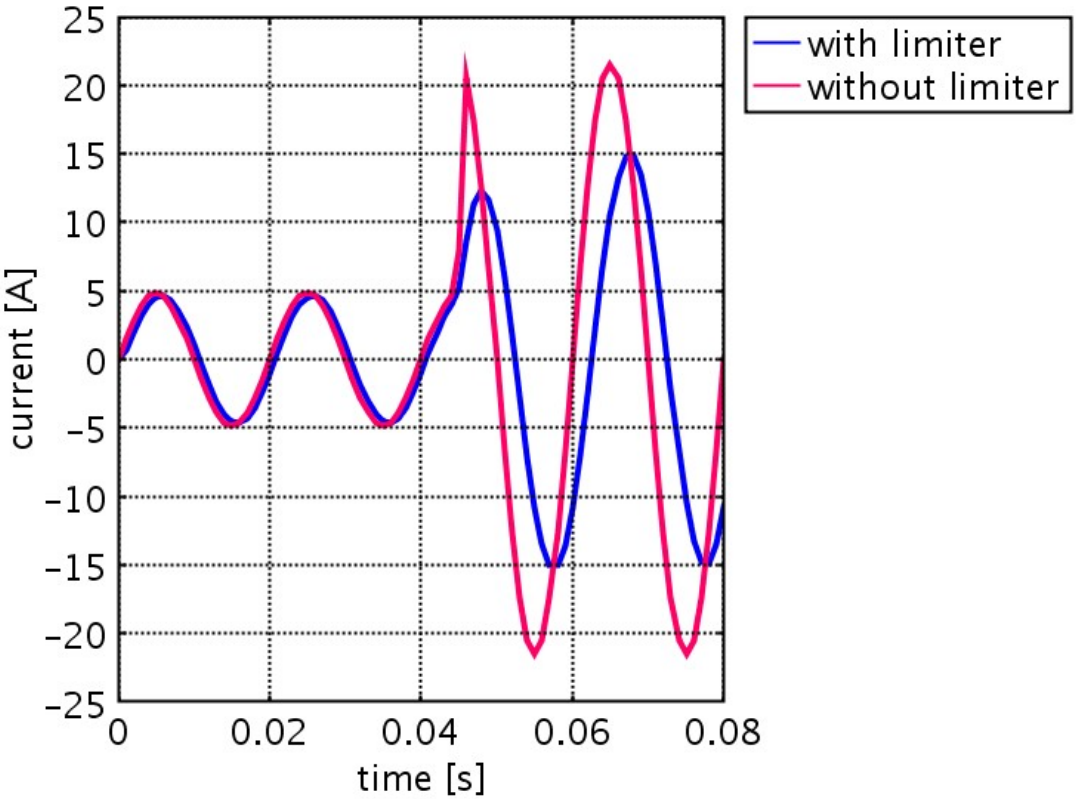
Check Presence

1 Day 1
- Introduction
- An Example from Computational Electromagnetics
- Humble beginnings

Motivating Example
Inductive Fault Current Limiter



Motivating Example
Current through AC winding - Line current

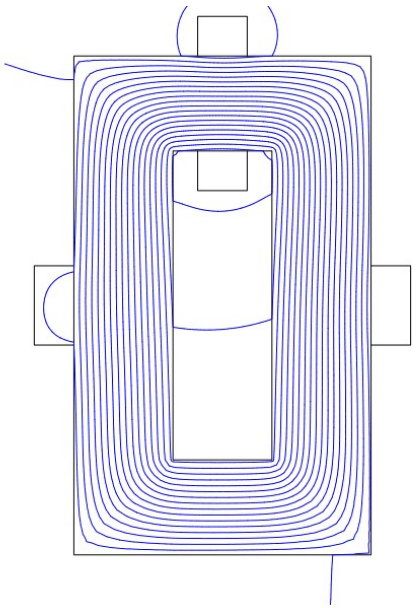


transparant
before fault

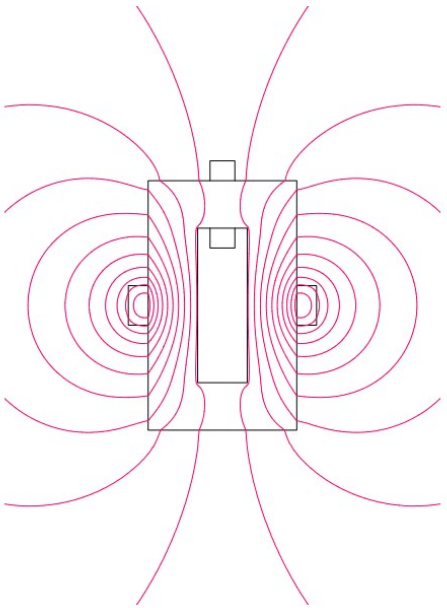
limiting after fault

Motivating Example
Magnetic Flux Contributions

DC Flux

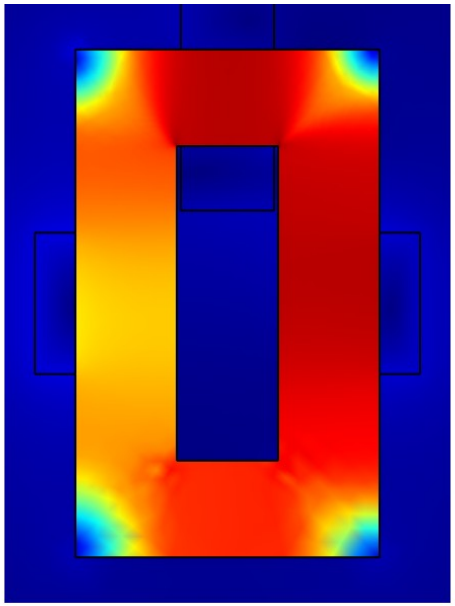


AC Flux

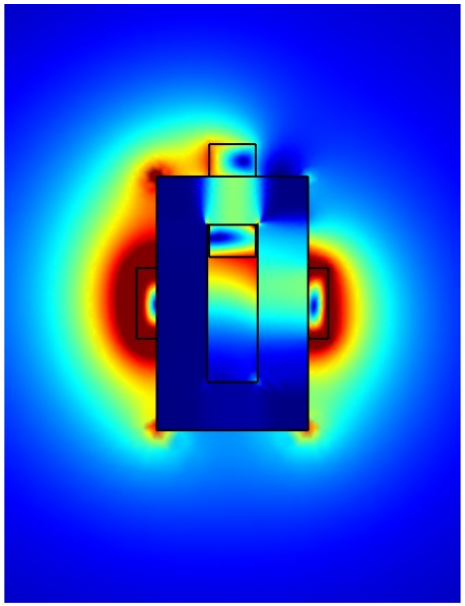


Motivating Example
Total Magnetic Flux and Field

Magnetic Flux



Magnetic Field



Motivating Example

Mathematical Model

- $\sigma \dfrac{\partial u}{\partial t} + \nabla(\mu \nabla u) = f$

  u: magnetic potential f: current

  σ and μ: material parameters

- $\nabla(\mu \nabla u) = f$ $(\sigma = 0)$

Motivating Example
Three Reoccuring Themes

- theme 1: discontinuous coefficients
- theme 2: singular domains
- theme 3: time evolution

1 Day 1
- Introduction
- An Example from Computational Electromagnetics
- Humble beginnings

Humble Beginnings

Study Goals

- classify partial differential equations
- apply integration theorems
- (Become acquanted with variational calculus)