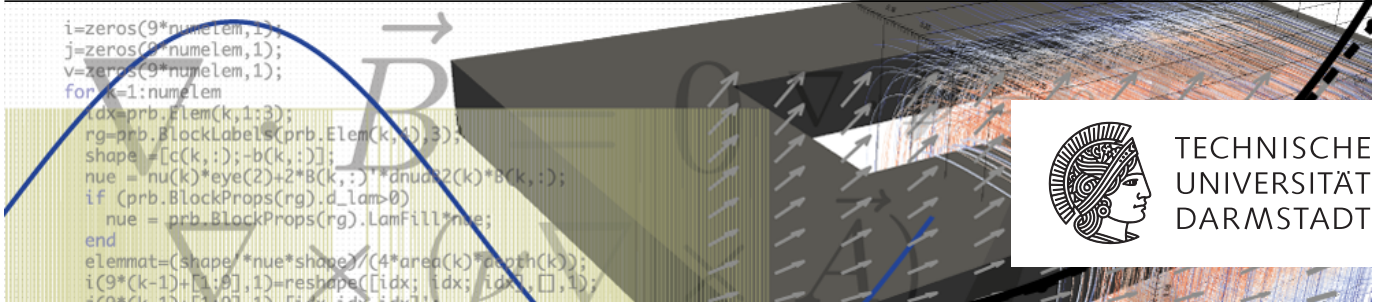


Efficient simulation of power converters using multirate partial differential equations

Project Seminar Electromagnetic CAD

Computational Engineering / Electrical Engineering / Numerics

Start: Immediately

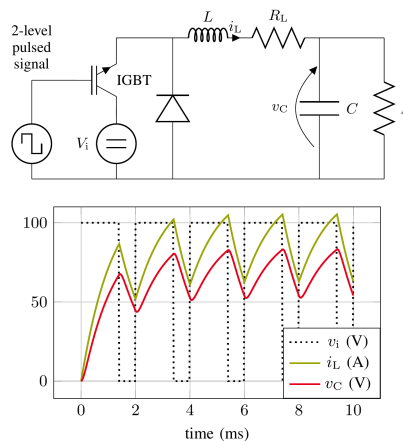


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Motivation

Multiscale and multirate problems occur naturally in many applications from electrical engineering. Consider the buck converter depicted in the figure, which uses a transistor (IGBT) to periodically switch on and off the power supply to achieve a conversion of the voltage level at the load. Its solution consists of a slowly varying envelope and fast periodically varying ripples.

Solving this problem using classical time discretization is highly inefficient since steep transients occur inside the converter due to the transistor switching. These force adaptive methods to use a very high number of time steps to properly resolve the solution. An efficient simulation can be achieved using the concept of Multirate Partial Differential Equations (MPDEs), which allows to split the solution into separate components depending on different time scales. The MPDEs can be efficiently solved using a Galerkin approach and time discretization. A disadvantage of the resulting method is the increasing size of equation systems leading to higher computational effort.



The focus of this work is on investigating possibilities to decouple the degrees of freedom in the equation systems and thus enable a more efficient solving process, e.g., by parallelization.

Tasks

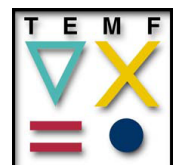
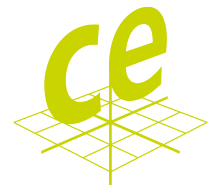
- Literature study on Multirate Partial Differential Equations, Finite Element Methods (Galerkin approach) and fundamentals about time discretization and circuit simulation.
- Investigation of different approaches to obtain decoupled equation systems.
- Replacement of parts of the circuit by a field model, i.e., field-circuit coupling.

Prerequisites

Basic knowledge of electrical circuit simulation and Finite Element Methods, experience with MATLAB and/or Octave, interest in numerical methods.

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