Karlsruhe Institute of Technology

Electromagnetics and Numerical Calculation of Fields

Dr.-Ing. Mario Pauli

INSTITUT FÜR HOCHFREQUENZTECHNIK UND ELEKTRONIK

KIT – University of the State of Baden-Wuerttemberg and
National Research Center of the Helmholtz Association

www.ihe.kit.edu

Lecture Announcement I

- Lectures: in Presence
  - starting Thursday 31.10.2024 17:30
- Tutorials: in Presence
  - starting Tuesday 19.11.2024 17:30 (preliminary)
- Lectures and exercise base on the former lecture given by Prof. Dössel
  - content is not changed to ensure continuity
  - slight changes may be possible in the next semesters
  - no “disruptive” changes in exam, old exams/tutorials still useful for preparation
- Information regarding Lectures or Tutorials…
  - can be found in ILIAS (also FAQs, videos, exams, lecture dates …)
  - announced during lectures/tutorials
  - prerecorded videos from last semester

Lecture

Mario Pauli
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Room 3.30
Phone 0721 608 46259
Email: mario.pauli@kit.edu

- Senior Researcher and Permanent Lecturer at IHE since 2011
- lecturer Microwave Engineering, Mikrowellenmesstechnik, 2 RF labs (Bachelor and Master)
- Model Advisor of Study Models 11, 16/17, 19 and 25

Tutorials

Xueyun Long
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Mario Faliero
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Lectures and Tutorials WS 2022/23

Lectures / Masch.bau, mittlerer HS
Thursdays 17:30 – 19:00

- 31.10.2024
- 07.11.2024
- 14.11.2024
- 21.11.2024
- 28.11.2024
- 05.12.2024
- 12.12.2024
- 19.12.2024
- 09.01.2025
- 14.01.2025 Tuesday
- 16.01.2025
- ~~23.01.2025~~
- 04.02.2025 Tuesday
- 06.02.2025
- 13.02.2025

Exercise / LTI
Tuesdays 17:30 - 19:00

- preliminary dates

- 19.11.2024
- 03.12.2024
- 17.12.2024
- 07.01.2025
- 21.01.2025
- 30.01.2025 Thursday

- Information about lecture and exercise on ILIAS
- https://ilias.studium.kit.edu/
- Password: **ihe_emfields**

Electrodynamics - Question and Answers

- > 100 Q&A made available by Prof. Dössel
- helpful to prepare for exam in addition to former exams and tutorials

Electrodynamics - Questions and Answers

Olaf Dössel
IBT Karlsruhe

1	Write down Maxwell's equations in differential and integral form.
	$\text{div}\ \vec{D} = \rho \leftrightarrow \oint \vec{D} d\vec{f} = \int \rho dv$ $\text{rot}\ \vec{H} = \vec{J} + \dot{\vec{D}} \leftrightarrow \oint \vec{H} d\vec{s} = \int \left(\vec{J} + \dot{\vec{D}}\right) d\vec{f}$ $\text{rot}\ \vec{E} = -\dot{\vec{B}} \leftrightarrow \oint \vec{E} d\vec{s} = -\frac{d}{dt} \int \vec{B} d\vec{f}$ $\text{div}\vec{B} = 0 \leftrightarrow \oint \vec{B} d\vec{f} = 0$
2	Write down the names and units of E, D, P, J, B, H, M (in terms of m, kg, s, A and V).
	E: Electric Field Strength in V/m D: Electric Flux Density in As/m^2 P: Electric Polarization in As/m^2 J: (free) Electric Current Density in A/m^2 B: Magnetic Flux Density or Magnetic Induction in Tesla = Vs/m^2 H: Magnetic Field Strength in A/m M: Magnetization in A/m

Exam WS 2024/25

Electromagnetics and Numerical Calculation of Fields

06.03.2024 16:30 – 18:30

Carl-Benz- Hörsaal (10.21)

Depending on number of participants both lecture halls might be required.
Assignment to lecture halls is by name and will be announced in a timely manner.
No aids allowed, formula sheet will be provided.

Content of the Lecture

- Mathematical basics
- Maxwell equations
- Green's functions
- Magnetostatics
- Law of induction
- Wave equation, wave propagation in different media
- Introduction to numerical field calculation
- Finite Difference Time Domain
- Finite Integration Technique
- Finite Element Method
- Boundary Element Method
- Transmission Line Matrix Method

Literature / References I

- David Pozar, Microwave Engineering, John Wiley & Sons
- Constantine A. Balanis, Advanced Engineering Electromagnetics, John Wiley & Sons, 1989
- Matthew Sadiku, Numerical Techniques in Electromagnetics, CRC Press, Boca Raton, 0-8493-1395-3, 2001
- Allen Taflove and Susan Hagness, Computational electrodynamics: the finite-difference time-domain method, Artech House, Boston, 1-58053-076-1, 2000
- Nathan Ida and Joao Bastos, Electromagnetics and calculation of fields, Springer Verlag, New York, 0-387-994877-5, 1997
- Z. Haznadar and Z. Stih, Electromagnetci Fields, Wave and Numerical Methods, IOS Press, Ohmsha, 1-58603-064-7, 2000
- MVK Chari and S.J. Salon, Numerical Methods in Electromagnetism, Academiuc Press, 0-12-615760-X
- http://farside.ph.utexas.edu/teaching/em/lectures/lectures.html

Literature / References II

- John B. Schneider, Understanding the Finite-Difference Time-Domain Method, www.eecs.wsu.edu/~schneidj/ufdtd, 2010
- Dean G. Duffy, Green's Functions with Applications, Chapman & Hall/CRC, 2001
- David B. Davidson, Computational Electromagnetcis for RF and Microwave Engineering, Cambridge University Press, 9780511778117, 2005
- Matthew Sadiku, Computational Electromagnetics with MATLAB, CRC Press, 9781032339030, 2022

Lectures at IHE

Circuit Design and RF-Components

Microwave Engineering
Radio Frequency Electronics
Mikrowellenmesstechnik
Radio Frequency Integrated Circuits and Systems
Semiconductor Process Technologies
Hochleistungsmikrowellentechnik

Wave Propagation and Communication

Antennen und Mehrantennensysteme

Radar, Remote Sensing and Systems

Modern Radio Systems Engineering
Radar Systems Engineering
Space-borne Microwave Radiometry
Space-borne Radar Remote Sensing

Laboratories

Microwave Engineering Lab
Mixed Signal IC Design
MMIC Design Lab