

Electromagnetic Field Theory - Course Map

1. Einführung in die mathematischen Grundlagen

Learning Objectives:

- Understand vector algebra and calculus tools for field theory.
- Gain familiarity with differential operators (gradient, divergence, curl).
- Master the application of integral theorems (Gauss, Stokes, Helmholtz).
- Learn to work in different coordinate systems (Cartesian, cylindrical, spherical).

Study Pointers:

- Focus on physical interpretation of vector operations.
- Practice converting between coordinate systems.
- Use visualizations to grasp divergence and curl intuitively.

2. Elektrostatik: Das Feld ruhender Ladungen

Learning Objectives:

- Describe electric fields due to static charges.
- Apply Gauss's Law to symmetric charge distributions.
- Solve Poisson's and Laplace's equations with boundary conditions.
- Understand dielectric materials and energy in electrostatic fields.

Study Pointers:

- Practice using field lines and equipotential surfaces.
- Understand the physical meaning of boundary conditions.
- Work through examples with image charge methods.

3. Stationäre Felder

Learning Objectives:

- Understand current density and continuity equation.
- Relate electric fields to steady current flow.
- Introduce magnetic field concepts from steady currents.

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Study Pointers:

- Visualize field and current distributions.
- Compare and contrast with electrostatics.
- Focus on Biot-Savart law and magnetic forces.

4. Quasistationäre Felder

Learning Objectives:

- Introduce time-varying fields in slow-changing conditions.
- Understand Lorentz force and Faraday's law.
- Grasp the basics of inductance and magnetic energy storage.

Study Pointers:

- Use practical examples like transformers and coils.
- Bridge the gap between statics and full electrodynamics.

5. Der allgemeine Feldfall

Learning Objectives:

- Understand the full set of Maxwell's equations.
- Analyze the conservation of charge and energy.
- Prepare for applications in waves and radiation.

Study Pointers:

- Memorize Maxwell's equations and learn to derive them.
- Understand the physical meaning behind each term.
- Connect to electromagnetic wave propagation.

6. Anhang: Formelsammlung

Learning Objectives:

- Have a handy reference for coordinate systems and identities.
- Reinforce mathematical tools through summaries.

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Study Pointers:

- Use this as a cheat sheet during problem solving.
- Refer to vector identities often when simplifying equations.