24.781 Computational Electromagnetics
Course Outline - September 2003

Course Objectives

In this course we will cover some numerical analysis techniques which can be used to solve typical electromagnetic field problems. The various mathematical formulations of electromagnetic field problems will be covered and then the main numerical techniques will be studied. Field problems from a diverse set of applications will be considered ranging from those associated with electrostatics to those requiring time-domain solution. Students will write their own computer programs which implement the algorithms discussed for specific electromagnetic problems. Thus, an ability to program in a mathematical programming language such as Matlab, C or Fortran is assumed; language specific implementation issues will generally not be covered.

Contact hours

3 lecture hours/week, 13 weeks (three credit hour course)

Prerequisites

A firm grasp of electromagnetic theory and the mathematical concepts which are normally contained in an undergraduate electrical engineering curriculum: Maxwell's equations, multivariable calculus, linear analysis, algorithm development, and computer programming.

Course content

Most of the following topics will be covered:

- Review of electromagnetic theory: differential and integral formulations of field problems.
- Finite difference methods for static problems.
- Finite difference methods for time domain problems.
- Variational methods.
- The finite element method: one- and two-dimensional cases for the Laplace, Poisson and Helmholtz equations using linear elements and triangular discretization.

  Higher order finite elements.
- The method of weighted residuals: moment methods applied to eigenvalue, scattering and radiation problem.

Recommended Reference Books

R. F. Harrington, "Field Computation by Moment Methods," The Macmillan Company, London, 1968. (Sci/Technology Fifth Floor: QC 20.2 H3 1968)

P. P. Silvester and R.L. Ferrari, "Finite Elements For Electrical Engineers," 2nd ed., Cambridge University Press, 1990. (Sci/Technology Fifth Floor: TK 153 S55 1990)

R. Mittra (editor), "Computer Techniques for Electromagnetics," Pergamon Press, 1973. (Sci/Technology Fifth Floor: TK 7871.6 M58 1973)

M. N. O. Sadiku, "Numerical Techniques in Electromagnetics," CRC Press, 1992. (Sci/Technology Fifth Floor: QC 760 S24 1992)

K. S. Kunz, R. J. Luebbers, "The Finite Difference Time Domain Method for Electromagnetics," CRC Press, Florida, 1993.

A. Taflove, "Advances in Computational Electrodynamics : the Finite-Difference Time-Domain Method," Artech House, Boston, 1998. (Sci/Technology Fifth Floor: QC 760 A286 1998)

A. Taflove, "Computational Electrodynamics : the Finite-Difference Time-Domain Method," Artech House, Boston, 1998. (Sci/Technology Fifth Floor: QC 760 T34 1995)

Evaluation

The final course grade will be determined from a student's performance in 4 assignments, a project, and a final examination. The weighting of each of these components will be as follows:

Component	Value
4 Assignments	40%
Project	20%
Final Exam	40%

Academic Integrity

Students are expected to conduct themselves in accordance with the highest ethical standards of the Profession of Engineering and evince academic integrity in all their pursuits and activities at the university. As such, in accordance with the General Academic Regulations and Requirements of the University of Manitoba, Section 7.1, students are reminded that "plagiarism or any other form of cheating in examinations or term tests (e.g. crib notes) is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university). A student found guilty of contributing to cheating in examinations or term assignments is also subject to serious academic penalty."

Instructor

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