EE699 — Course Syllabus
Computational Electromagnetics: The Finite-Element Method

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Office hours: Tuesdays & Thursdays, 9:30 – 11:30 a.m., or by appointment

Course Text: *The Finite Element Method in Electromagnetics* , J.-M. Jin, Wiley-IEEE Press; 2 edition (May 27, 2002), **ISBN:** 0471438189

EE699 URL: http://www.engr.uky.edu/~gedney/courses/ee699

EE699 Course Description:
A course on the application of the finite-element method for the full-wave simulation of time-harmonic electromagnetic waves in complex media.

EE699 Course Outcomes:
The following competencies should be imparted to the students:
1. Ritz and Galerkin methods for formulating variational problems
2. Development and use of scalar and vector shape functions
3. Finite Element Analysis (FEA) for the solution of boundary value problems
4. 1D FEA for static and dynamic solution of Maxwell's equations
5. 2D FEA for static and dynamic solution of Maxwell's equations
6. 3D FEA for the dynamic solution of Maxwell's equations

Homeworks will be assigned during the course of the semester. The due date will vary with the length of each assignment. The homeworks and due dates will be posted on the course web page. All assignments are due at the *beginning* of the class period. You will be allowed one late assignment, which will be due the following class period. Otherwise, late assignments will not be accepted. Some homeworks will require computer simulations, which can be performed using mathematical software such as Matlab, MathCad, Maple, or Mathematica. Programming assignments are expected to be performed via a high-level programming language such as FORTRAN 95 or C++, as specified. If you are not experienced with a high-level programming language, then you should consult with the instructor at the beginning of the semester. For all assignments, graphical results are expected to be computer generated and printed on a laser or ink-jet printer.

Paper Summary. A one page written summary of a journal paper will be due every second Thursday at the beginning of class. You can pick any paper of interest to you and pertinent to this course (specifically an application or development of FEM) published in a peer reviewed journal, such as the IEEE Transactions. The summary should be typed and should briefly summarize the main contribution of the paper.

Final Project A final computer project will be due at the end of the semester. The project will consist of developing a computer program to solve a problem agreed to by the instructor. A final report presenting the theory, numerical methods, and validating results will be handed in according to specified guidelines. A final presentation (15 minutes) of the project will be given during the final exam week. Attendance of all the presentations is mandatory.

Grade Distribution

Requirement	% of Final Grade
Homework Projects	55 %
Paper Summaries	10 %
Final Project and Presentation	35 %

Grade Assessment

Final Grade	Letter Grade
90-100 %	A
80-90 %	B
70-80 %	C
60-70 %	D
Below 60 %	E

Course Syllabus

Lec.	Reading	Topic
1	1.1 – 1.4	Review: Maxwell's Equations, Boundary Conditions, Wave Equation
2	1.5 – 1.10	Review: Vector Potential Theory, Wave Polarization, Solutions to Maxwell's Equations
3	2..1	Introduction to the Finite Element Method (FEM) – Ritz and Galerkin methods
4	2.2, 2.3	Example: Static Solution via the FEM method
5	3.1 - 3.2	1D FEM – Dynamic Solution – Deriving the Boundary Value Problem
6	3.3	Linear Shape Functions, Simplex Coordinates, and Assembly
7	3.4	1D Example in Cartesian Coordinate
8	3.6	Higher-Order shape functions
9	4.1, 4.2	2D FEM – Reactional Form of the Wave Equation
10	4.3	2D Shape Functions on triangles
11	4.3	2D Finite Element Analysis
12	4.4 – 4.5	2D Applications – Static & Dynamic
13	4.6	Absorbing Boundary Conditions
14	4.7	Higher-order elements on a 2D triangle
15	4.7	Numerical Integration on 2D triangles
16	4.8	Isoparametric 2D Triangular Elements
17	5.1 – 5.3	3D Finite Elements
18	5.4	Shape Functions – Tetraheron, Hexahedron, and Prisms
19	5.5	Numerical Integration – 3D Cubature Rules
20	5.6 – 5.8	Applications of 3D FEM
21	8.1	Vector Edge Elements for 2D triangular & quadrilateral elements
22	8.2	Reaction integrals, assembly and analysis with edge functions
23	8.3	Vector Edge Elements for 3D tetrahedral elements
24	8.4	Reaction integrals, assembly and applications with 3D edge functions
25	8.5	Waveguide analysis with 3D edge functions – modal analysis
26	8.6	Higher-order vector edge elements
27	8.6	Higher-order vector edge elements continued
28	9.1	2D Absorbing boundary conditions
29	9.2	3D Absorbing boundary conditions