C107

APPLICATION FOR NEW COURSE

1. Submitted by College of Engineering Date 9/18/03

   Department/Division offering course Electrical and Computer Engineering

2. Proposed designation and Bulletin description of this course

   a. Prefix and Number EE624 b. Title* Computational EM: The FDTD Method

   *NOTE: If the title is longer than 24 characters (including spaces), write A sensible title (not exceeding 24 characters) for use on transcripts

   c. Lecture/Discussion hours per week 3 d. Laboratory hours per week

   e. Studio hours per week f. Credits 3

   g. Course description

   h. Prerequisites (if any)

   EE621, or consent of instructor

   i. May be repeated to a maximum of (if applicable)

4. To be cross-listed as

   Prefix and Number Signature, Chairman, cross-listing department

5. Effective Date Fall 2004 (semester and year)

6. Course to be offered ☑ Fall ☐ Spring ☐ Summer

7. Will the course be offered each year? ☐ Yes ☑ No
   (Explain if not annually)

   The course will be offered every other year.

8. Why is this course needed?

   To provide our students with a course in advanced computational methods with applications in the field of electromagnetics

9. a. By whom will the course be taught? Prof. Stephen D. Gedney

   b. Are facilities for teaching the course now available? ☑ Yes ☐ No
   If not, what plans have been made for providing them?

ORIGINAL

APPLICATION FOR NEW COURSE

10. What enrollment may be reasonably anticipated? 10

11. Will this course serve students in the Department primarily? ☑ Yes ☐ No

Will it be of service to a significant number of students outside the Department? ☐ Yes ☑ No
If so, explain.

Will the course serve as a University Studies Program course? ☐ Yes ☑ No

If yes, under what Area? _____

12. Check the category most applicable to this course

- ☐ traditional; offered in corresponding departments elsewhere;
- ☑ relatively new, now being widely established
- ☐ not yet to be found in many (or any) other universities

13. Is this course applicable to the requirements for at least one degree or certificate at the University of Kentucky? ☑ Yes ☐ No

14. Is this course part of a proposed new program: ☐ Yes ☑ No
If yes, which?

15. Will adding this course change the degree requirements in one or more programs?* ☐ Yes ☑ No
If yes, explain the change(s) below

16. Attach a list of the major teaching objectives of the proposed course and outline and/or reference list to be used.

17. If the course is a 100-200 level course, please submit evidence (e.g., correspondence) that the Community College System has been consulted.

18. Within the Department, who should be contacted for further information about the proposed course?

Name Stephen D. Gedney Phone Extension 7-3926

*NOTE: Approval of this course will constitute approval of the program change unless other program modifications are proposed.

Print Form Clear Form

APPLICATION FOR NEW COURSE

Signatures of Approval:

Department Chair	10/13/03 Date
Dean of the College	1/20/04 Date
5 Favor 0 Against	10/13/03 Date of Notice to the Faculty
*Undergraduate Council	Date
*University Studies	Date
*Graduate Council	3-19-04 Date
*Academic Council for the Medical Center	Date
*Senate Council (Chair)	Date of Notice to University Senate

*If applicable, as provided by the Rules of the University Senate

ACTION OTHER THAN APPROVAL

Rev 8/02

EE624 — Course Syllabus
Computational Electromagnetics: The Finite-Difference Time-Domain

Instructor: Prof. Stephen D. Gedney
687C Anderson Hall
E-mail: gedney@engr.uky.edu
WWW: http://www.engr.uky.edu/~gedney
Office hours: Mon. 2 - 3 p.m., Wed. 2 - 3 p.m., or by appointment

Course Text: *Computational Electromagnetics: The Finite-Difference Time-Domain – 2nd Ed.*, A. Taflove and S. C. Hagness, Artech House, 2000 (ISBN: 1580530761)

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

EE624 Course Description:

A course on the application of the finite-difference time-domain technique for the full-wave simulation of time-dependent electromagnetic waves in complex media. Representative topics in the course include: The Yee-algorithm, numerical dispersion and stability, physical source models, absorbing boundaries and perfectly matched layered media, near-field to far-field transformations, modeling of microwave circuits and antennas, parameter extraction, lumped load models, non-uniform and non-orthogonal grid methods, and current topics in FDTD.

EE624 Course Outcomes:

The following competencies should be imparted to the students:

1. understanding of explicit and implicit time-dependent PDE solution methods
2. understanding of stability and numerical dispersion errors.
3. ability to apply the Yee-algorithm for the solution of the time-dependent Maxwell equations for vector electromagnetic fields in multiple space dimensions.
4. ability to implement physical source models in an FDTD formulation.
5. ability to implement pseudo-differential or perfectly matched layer absorbing boundaries in an FDTD formulation.
6. ability to implement a near-field to far-field transformation.
7. ability to incorporate inhomogeneous materials into an FDTD formulation.
8. ability to extract network parameters from microwave and millimeter wave circuit and antenna systems using the FDTD.
9. understanding of advanced FDTD methods, such as non-uniform and non-orthogonal gridding techniques and higher-order methods.

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, or can be performed using a high-level

programming language. 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 FDTD) 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

Topic	Section (Text)	Reading Assign.	Lecture #
Introduction	Chapter 1	pp. 1-34	1
Difference Approximations based on One-Dimensional Wave Equation	2.1-2.5	pp. 35-40	2
Numerical Dispersion & Group Delay	2.6	pp. 42-54	3
Stability of Explicit Solution	2.7	pp. 55-60	4
Implicit Formulation and Stability	notes		5
Analysis of Transmission Lines	notes		6
Source/Load Conditions	notes		7
Maxwell's Equations in 1, 2, and 3 Dim	3.1-3.5	pp. 67-73	8
Yee algorithm	3.6	pp. 75-98	9,10
Numerical Dispersion	4.1-4.6	pp. 109-132	11,12
Numerical Stability	4.7-4.8	pp. 133-141	13,14
Source Excitation: Total-Field/Scattered-Field Formulation	5.6-5.8	pp. 193-221	15
Waveguide Source Excitations	5.2-5.4	pp. 175-190	16
Absorbing Boundary Conditions	6.1-6.6	pp. 235-278	17
Perfectly Matched Layer Media	7.1-7.12	pp. 285-338	18,19
Near Field to Far Field Transformations	8.1-8.6	pp. 349-371	20
Intro to Analysis of Microwave Circuit Devices	notes		21
Modeling Lumped Elements	Chapter 15	pp. 703-739	22
Network Parameters	15.2	pp. 707	23
Microwave circuit Device Modeling	notes		24,25
Advanced FDTD Methods	notes		26
Advanced FDTD Methods	notes		27
Advanced FDTD Algorithms	Notes		28