University of Texas at El Paso
College of Engineering
Department of Electrical and Computer Engineering

Course Syllabus for

EM Analysis Using FDTD

COURSE INFORMATION

Course Prefix and Number:	EE 5303
Course Title:	EM Analysis Using FDTD
Meeting day and time:	M/W, 9:00am – 10:20am
Room:	NURSE, Room 216
Final exam:	Wednesday, December 7, 10:00am – 12:45pm
CRN:	18939
Credit hours:	3
Lecture hours:	3

Description – This course will teach students how to implement the finite-difference time-domain (FDTD) method in MATLAB. Students will apply the tools to analyze a number of common devices and configurations like waveguides, thin film optical filters, gratings, frequency selective surfaces, and more.

INSTRUCTOR INFORMATION

Dr. Raymond C. Rumpf

Office: ENGR A-337
Office Hours: M/W, 10:30am – 11:30am & 3:00pm – 4:00pm
Telephone: (915) 747-6958
E-Mail: rcrumpf@utep.edu

COURSE MATERIALS

- Allen Taflove, Susan C. Hagness, *Computational Electrodynamics, the finite-difference time-domain method*, 3rd edition, Artech House, 2005.
- Access to a computer with MATLAB 2013 or above.
- Course notes.
- Course website: http://emlab.utep.edu/ee5390fdtd.htm

PREREQUISITES

By Course:

- MATH 2313 – Calculus III
- MATH 2326 – Differential Equations
- EE 3321 – Electromagnetic Field Theory

By Topic:

- Basic electromagnetic theory
- Differential equations and linear algebra
- MATLAB and computer programming

COREQUISITES

None.

LEARNING OUTCOMES

- MATLAB – While the student is expected to have a basic understanding of MATLAB, this course will teach the more advanced MATLAB concepts needed to effectively implement the FDTD method. Topics will include scripts versus functions, programming techniques, graphics, and advanced data visualization.
- FDTD – This course will teach students how to implement the finite-difference time-domain method in MATLAB. Topics will include Maxwell's equations, finite-differences, grid schemes, boundary conditions including the perfectly matched layer, sources, post processing of the data, and visualization.

By the completion of this course, students will demonstrate an understanding of the formulation and implementation of the FDTD method. They will have greater proficiency using MATLAB and have the skills to produce clear and high quality graphics suitable for presentations and publications.

Contribution to Professional Component

EE-5303 is a graduate level core course that introduces the student to the art and science of computational electromagnetics. It is intended to be the first in a series of three courses. The second two courses are EE-5320 Computational Electromagnetics and EE-5322 21st Century Electromagnetics.

REMOTE STUDENTS

THIS IS NOT AN ONLINE CLASS*!!!!*

Some lectures and course materials may be made available through the internet to help remote students, but this not an online class. Provision of these materials is not guaranteed and quality may be insufficient for learning the course material. Remote students will be held to the same standards as non-remote students and should be prepared to be work and learn the course material independently. All policies apply equally to remote and non-remote students including due dates for projects and assignments as well as dates and duration of exams. Non-remote students will not be given access to recorded lectures and are expected to attend class.

COURSE POLICIES

Attendance Policy

Attendance is required and is assumed and expected. Students missing more than two lectures should seriously reflect on their commitment to this course, as missing classes is highly correlated with poor performance. Students absent from lecture are still held responsible for all information discussed, homework assigned, and exams administered during that missed lecture. In some special cases, absence can be forgiven if coordinated with the course instructor well before the lecture is missed.

Exam Policy

Exams during the semester will be given in class. Remote students may have their exams administered by a proctor that is approved by the course instructor prior to the exam. No exam will be given earlier than scheduled. Duration of the exams will be strictly limited to the duration of the class. Students are permitted to have a calculator and a standard 8.5×11" sheet of paper with whatever they wish to have on it.

Exams will contain multiple choice, true/false questions, short answers (5 to 6 sentences), and some longer problems. Information tested on the midterm exams will be mostly focused on the material covered since the last exam. The final exam will be comprehensive.

A missed exam can be made-up ONLY IF: (1) the reason for missing the exam is beyond the student's control, e.g. such as a medical excuse, jury duty, death in the family or automobile accident, or (2) prior consent must be obtained from the instructor for missing the exam based on a non-frivolous excuse, e.g. such as a job interview or out-of-town job related travel. In either case, the student must submit a written and signed statement describing the reasons for missing the exam, with appropriate documentation, and petition for a makeup exam. **A missed exam will carry zero grade if these conditions are not met**.

Homework Policy

Homework will be assigned on a weekly basis and graded on a 100 point scale. **Show all work!** Homework is due by midnight on the assigned due date. In order to provide solutions in a timely manner, no homework assignments will be accepted after three days following the due date and 10 points will be deducted for every day late. Homework must be completed with a high level of professionalism and be formatted properly. Points will be deducted for sloppy work, incorrect formatting, or if not all of the work is shown.

Format – Unless otherwise indicated, all homework assignments will be submitted as a single document stapled in the upper left corner with no additional binding. Remote students shall submit their assignments via e-mail as a single MS Word or PDF document. The first page must be a cover sheet with the student's name, student's 800 number, date of the assignment, course information, and assignment number. No problems or work should appear on the cover sheet. Homework shall be neat, well organized, and the writing clear. Answers to the homework questions must be provided in the order they were asked. Final answer(s) must be clearly boxed and given proper units. Finish all calculations. For example, answer with '±4' instead of $\pm\sqrt{5^2-9}$. Students may in-

clude computer codes if they wish, but the codes must be placed at the end of the assignment in an appendix.

Project Policy

The purpose of the project for this class is to learn something outside of what is taught in the class or apply what is taught in class to something not discussed in class. Project topics and the submission materials must be approved by the instructor by the middle of the semester (see schedule of topics for specific date).

Grading

Student achievement in the course objectives will be assessed using a combination of homework and exams as well as class attendance and participation. Student grades are protected by the Privacy Act of 1974. Your course grade will be determined by your weighted performance in the following categories:

Homework	40%	90% – 100% → **A**
Project	20%	80% – 89% → **B**
Two Midterm Exams ..	20%	70% – 79% → **C**
Final Exam	20%	60% – 69% → **D**
Attendance	5%	0% – 59% → **F**

Homework – Each assignment will be graded out of 100 points. Homework is due at the start of lecture on the due date. Late assignments will be deducted 10 points per 24 hours late and will be given zero points after 72 hours.

Attendance – Class attendance counts for 5% of the final course grade. Each student can miss one lecture without penalty. A zero will be assigned to each 1% for each subsequently missed lecture. A zero will be given to all 5% when six lectures have been missed.

ACADEMIC DISHONESTY

As an entity of The University of Texas at El Paso, the Department of Electrical and Computer Engineering is committed to the development of its students and to the promotion of personal integrity and self responsibility. The assumption that a student's work is a fair representation of the student's ability to perform forms the basis for departmental and institutional quality. All students within the Department are expected to observe appropriate standards of conduct. Acts of scholastic dishonesty such as cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in the whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student, or the attempt to commit such acts will not be tolerated. Any case involving academic dishonesty will be referred to the Office of the Dean of Students. The Dean will assign a Student Judicial Affairs Coordinator who will investigate the charge and alert the student as to its disposition. Consequences of academic dishonesty may be as severe as dismissal from the University.

See the Office of the Dean of Students' homepage (Office of Student Life) at http://studentaffairs.utep.edu/dos for more information.

You can also refer to the IEEE website for information on our code of ethics:
http://www.ieee.org/about/corporate/governance/p7-8.html

AMERICAN DISABILITIES ACT

The UTEP Disabled Student Services Office was established for the purpose of providing appropriate and reasonable accommodations as mandated in Section 504 of the Rehabilitation Act of 1973 (http://www.dol.gov/oasam/regs/statutes/sec504.htm) and the Americans with Disabilities Act (http://www.ada.gov/). If you have needs regarding learning disabilities, please help by reporting your special needs to the course instructor the first week of classes.

For addition help, contact the Center for Accommodations and Support Services (CASS):

(915) 747-5148
cass@utep.edu
http://sa.utep.edu/cass/

DISCRIMINATION

I do not discriminate, nor will I allow discrimination, on the basis of age, gender, color, ethnicity, national origin, religion, disability, sexual orientation, or favorite sports team. Members of the UTEP community are protected from discrimination and harassment by the State and Federal Laws.

COURSE SCHEDULE AND OUTLINE

Important Dates

Sep 5	Labor Day Holiday – University closed
Nov 24,35	Thanksgiving Holiday – University closed
Dec 7	Final Exam, 10:00am – 12:45pm

Schedule of Topics

Lecture 0 -- Rules and procedures
Lecture 1 -- Introduction
Lecture 2 -- MATLAB introduction and graphics
Lecture 3 -- Building geometries in data arrays
Lecture 4 -- Electromagnetics and FDTD
Lecture 5 -- Formulation of 1D FDTD
Lecture 6 -- Implementation of 1D FDTD
Lecture 7 -- Learning from 1D FDTD
Lecture 8 -- Review and Walkthrough of 1D FDTD
Lecture 9 -- Examples of 1D FDTD
Lecture 10 -- Enhancing 1D FDTD
Lecture 11 -- Formulation of 2D FDTD without a PML
Lecture 12 -- Windowing and grid techniques
Lecture 13 -- The Perfectly Matched Layer
Lecture 14 -- 3D Update Equations with PML
Lecture 15 -- Implementation of 2D FDTD
Lecture 16 -- Gratings and the Plane Wave Spectrum
Lecture 17 -- Power flow and PML placement in FDTD

Lecture 18 -- Metals and alternative grids
Lecture 19 -- Periodic structures in FDTD
Lecture 20 -- Waveguide analysis
Lecture 21 -- Grating simulation walkthrough
Lecture 22 -- Waveguide simulation walkthrough
Lecture 23 -- 3D FDTD
Lecture 24 -- Scattering Analysis
Lecture 25 -- Advanced FDTD Algorithms
Lecture 26 -- Final lecture