University of Texas at El Paso

EE 5390 – Electromagnetic Analysis Using Finite-Difference Time-Domain

Summer 2014

COURSE INFORMATION

Meeting day and time:	T/R, 5:30pm – 8:00pm
Room:	Classroom Building, Room C303
Final exam:	Mon. Aug. 4, 7:00pm – 9:45pm
Number of lectures:	15
Course designation:	EE 5390
CRN:	34204
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: T/R, 2:00pm – 3:00pm
Telephone: (915) 747-6958
E-Mail: rcrumpf@utep.edu

TEXTBOOK AND 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 2009 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.

COURSE OUTLINE

Topics covered in this course include:

1. Introduction
2. MATLAB
3. Review of EM and Introduction to FDTD
4. 1D FDTD: formulation, implementation, post-processing, examples
5. 2D FDTD: PML, formulation, implementation
6. Gratings
7. Windowing
8. Building devices on a grid: dielectric smoothing, 2× grid technique, metals, alternate grids.
9. Periodic FDTD
10. Waveguide analysis
11. 3D FDTD and advanced topics

COURSE OBJECTIVES

- 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.

GRADUATE STUDENTS

If you are a graduate student taking this course as part of your degree plan, please note that you are responsible for completing all work required of undergraduates and, in addition you are expected to:

- Complete additional problems assigned in homework and tests
- Successfully complete a final exam
- Maintain an 80% average (minimum) on homework, projects, and exams.

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 REQUIREMENTS

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 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 is 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

Unless otherwise indicated, all homework will be submitted in class as a single paper 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 shall be a cover sheet with the student's name, 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

questions should be clearly marked or boxed. All computer codes shall be provided in an appendix, but they do not have to be provided if they were submitted in a prior homework assignment. Homework and projects will be submitted at the beginning of lecture on the day the assignment is due.

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 assess using a combination of homework, tests and projects as well as class attendance and participation. 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

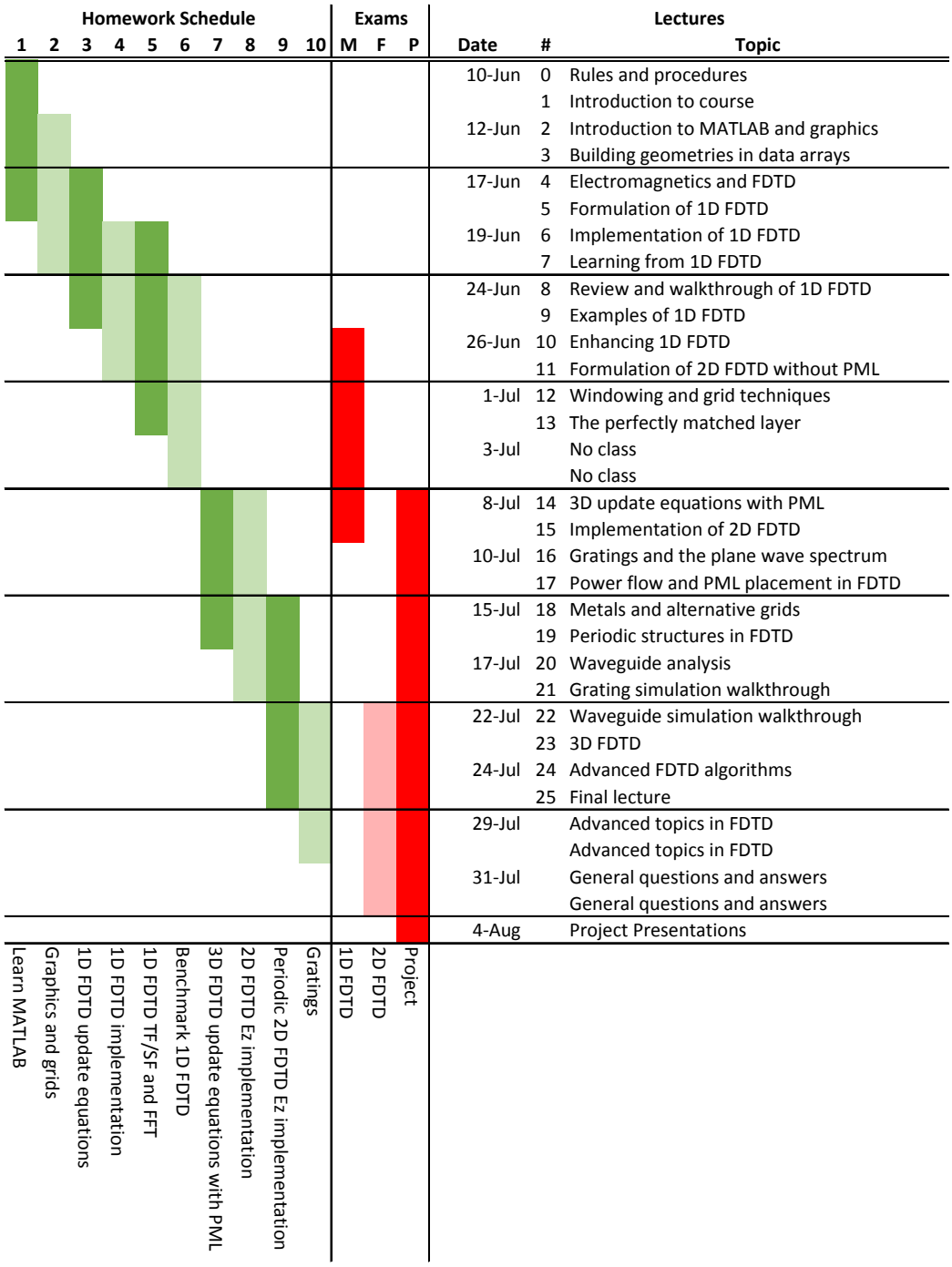
I do not discriminate, nor will I allow discrimination, on the basis of age, gender, color, ethnicity, national origin, religion, disability, sexual orientation, or favorite sports team. Members of the UTEP community are protected from discrimination and harassment by the State and Federal Laws.

COURSE SCHEDULE AND OUTLINE

Important Dates

Jul 3	No class due to Summer I final exams
Aug 4	Final Exam, 7:00pm – 9:45pm

Schedule of Topics



Lectures		
Date	#	Topic
10-Jun	0	Rules and procedures
	1	Introduction to course
12-Jun	2	Introduction to MATLAB and graphics
	3	Building geometries in data arrays
17-Jun	4	Electromagnetics and FDTD
	5	Formulation of 1D FDTD
19-Jun	6	Implementation of 1D FDTD
	7	Learning from 1D FDTD
24-Jun	8	Review and walkthrough of 1D FDTD
	9	Examples of 1D FDTD
26-Jun	10	Enhancing 1D FDTD
	11	Formulation of 2D FDTD without PML
1-Jul	12	Windowing and grid techniques
	13	The perfectly matched layer
3-Jul		No class
		No class
8-Jul	14	3D update equations with PML
	15	Implementation of 2D FDTD
10-Jul	16	Gratings and the plane wave spectrum
	17	Power flow and PML placement in FDTD
15-Jul	18	Metals and alternative grids
	19	Periodic structures in FDTD
17-Jul	20	Waveguide analysis
	21	Grating simulation walkthrough
22-Jul	22	Waveguide simulation walkthrough
	23	3D FDTD
24-Jul	24	Advanced FDTD algorithms
	25	Final lecture
29-Jul		Advanced topics in FDTD
		Advanced topics in FDTD
31-Jul		General questions and answers
		General questions and answers
4-Aug		Project Presentations

Bars start on the dates where you should have all the information needed to complete the assignments.

Bars end on the due dates.