Course Overview, Policies, and Procedures

Instructor
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Lecture Outline

• Course Overview
  – Mission
  – Course Objectives
  – Course Outline
• Policies and Procedures
  – Grading
  – Homework
  – Final Project
• Policies & Best Practices for Coding
Course Overview

Flow of Courses for Electromagnetics

Undergraduate

- EE 3321: Electromagnetic Field Theory
- EE 4347: Applied Electromagnetics
- EE 4382: Antenna Engineering
- EE 4530: Microwave Engineering

Graduate

- EE 5301: Computational Methods in EE
- EE 5303: Computational EM
- EE 5303: EM Analysis Using FDTD
- EE 5320: 21st Century Electromagnetics
- EE 5322: 21st Century Electromagnetics

You are here
Mission of This Class

The mission of this class is to begin teaching the art of computational electromagnetics using MATLAB. The course will take a slow and methodical approach to teach finite-difference time-domain (FDTD) including theory, formulation of the equations, and implementation in MATLAB.

Course Objectives

- Teach the finite-difference time-domain method.
- Teach students the art of computation and visualization in MATLAB.
- Teach best practices for developing and implementing new numerical algorithms.
- Motivate students in the areas of simulation and electromagnetics.
- Provide the students with real skills that are in high demand in industry.
Course Outline

- Review of MATLAB
  - Graphics, movies, and helpful tidbits.
  - Building geometries in arrays.
- Introduction to FDTD
- One-Dimensional FDTD
  - Formulation, implementation, and examples.
- Two-Dimensional FDTD
  - Formulation, implementation, and examples.
- Advanced Concepts
  - Perfectly match layer boundary condition
  - Grid strategies and alternatives
  - Periodic structures in FDTD
  - Modeling waveguide devices
  - Three-dimensional FDTD
  - Near-field-to-far-field transformation
  - More...

Policies and Procedures
The Book


• Good aspects of the book
  – This is the most rigorous and comprehensive book on FDTD available.
  – Many topics and references are provided.

• Drawbacks of the book
  – This is not a good book to learn FDTD from scratch.

The Syllabus (1 of 4)

• Instructor Information
  – Dr. Raymond C. Rumpf
  – Office: ENGR A-337
  – Telephone: (915) 747-6958
  – E-Mail: rcrumpf@utep.edu
  – Course website: [http://emlab.utep.edu/ee5390fdtd.htm](http://emlab.utep.edu/ee5390fdtd.htm)

• Prerequisites
  – Basic electromagnetics
  – Differential equations
  – Programming / MATLAB
### The Syllabus (2 of 4)

**Course Objectives**
- Be able to use the FDTD method to model electromagnetic devices
- Strengthen MATLAB and graphics skills

**Attendance**
- Attendance is required
- Attendance is accounted for in participation grade
- Coordinate with instructor ahead of time if you need to miss a class
- In some cases, absence can be excused if coordinated with instructor well before the lecture is missed.

### The Syllabus (3 of 4)

**Exam Policy**
- Exams represent 20% of final grade
- Two midterm exams and one final exam
- May be take-home or in-class
- In-class exams, students can have a calculator and a single 8.5”x11” paper with whatever they wish
- **Take home exams will require working FDTD codes!!!!**

**Homework**
- **Worth 40% of final grade**
- Homework will build on prior homework so keeping up is essential
- Homework is due by midnight on the due date
- Subtract 10% from homework for every day late
- 12:01am will be considered late
- **Do you own work. Do not copy from other students.**
The Syllabus (4 of 4)

- List of Topics
  - MATLAB
    - Programming and graphics
    - Representing devices on a grid
  - Finite-Difference Time-Domain
    - One-Dimensional FDTD
      - Formulation, implementation, visualization, post processing
    - Two-Dimensional FDTD
      - Formulation, implementation, PML, sources, visualization
      - Modal sources, analysis of waveguide devices
  - Advanced Topics
    - Boundary conditions, periodic structures, PML, and more.

Grading

Homework .................. 40%  90% – 100% → A
Project ..................... 20%  80% – 89% → B
Midterm Exam 1 .......... 15%  70% – 79% → C
Midterm Exam 2 .......... 15%  60% – 69% → D
Participation ............. 10%  0% – 59% → F

HOMEWORK IS 40% OF YOUR FINAL GRADE!!!!!!!
Homework Policy

• Due before midnight on due date. 12:01am is late.
• Submit a single PDF file
• Neat, organized, answers provided in the order they are asked.
• Unless specifically requested otherwise, all codes must be in an appendix placed at the end of your homework document.
• Cover page: name, 800#, date, assignment #, etc.
• Do your own work. Do not ever copy from other students.

The Final Project

• Purpose – to learn, practice, and share something outside of what was taught in class.
• Project should be summarized in Power Point.
  – Must be complete enough that instructor can reproduce your work if needed.
• Projects will be presented during the final exam period. Duration ~10 minutes for presentation.
• May work alone or in teams, but teams must do proportionally more work.
• Must submit all electronic files (i.e. slides, codes, movies, etc.) to course instructor or project will be given a grade of zero.
• Get started on this early!!
### Project Ideas

- Optimize PML parameters
- Implement a different boundary condition
- Implement higher-order accurate derivatives
- Implement a different type of source
- Model a new device
- Implement 3D FDTD
- Use FDTD to calculate a band diagram
- Do part of your research as this project!
- Others...

### Graphics

- All figures and graphics must be of professional quality and easy to understand and use.
- The best figure is made as small as possible so that it is still neat and reads clearly
- Lines should be thick enough to be identified, but not awkwardly thick
- Fonts should be large enough to be read easily, but not awkwardly large
- All entities of the figure should be labeled and given proper units
Policies and Best Practices for Coding

Structure of the Ideal Code

- Initialize MATLAB
  - close all unnecessary windows
  - clear memory
  - define units and constants
  - open a figure window

- Dashboard
  - Define device parameters
  - Define source parameters
  - Define what is to be learned
  - Define FDTD parameters

- Rest of Code

- Show and Save Results

Only numbers. No calculations!

Only calculations. No numbers!
Coding Requirements

• Codes must be clean, commented, and well organized.
• Codes must follow the block diagrams in the lecture notes exactly.
• Constants must include units and as many significant digits as possible.
• Do not breakup codes into subroutines (i.e. functions) unless instructed specifically to do so.
• No calculations in the dashboard, unless absolutely necessary.
• All hard-coded numbers should appear only once within the “dashboard” at the start of your code.

Coding Best Practices

• Do not hard code any numbers you may want to change.
• If you have to change more than one thing in your code or change something outside of your dashboard to alter a devices dimensions, material properties, etc., you are probably doing something wrong.
• Develop your codes in small increments that you can benchmark at each step.