This is a draft syllabus. The final syllabus may have significant changes.

The important information for students considering this class:

Prerequisite(s): The only requirement is computer programming knowledge (MATLAB, Python, or C are fine). A knowledge of PDE's and electromagnetics would be helpful for deeper understanding, although not required for successfully completing the course.

EE 599: Build Your Own Simulator: Numerical Modeling of Electromagnetics, Acoustics, Heat Transfer, and Mechanical Systems (30953)

Units: 4

Spring 2019—Tues/Thurs. 3:30-5:20

Location: TBA

Instructor: Constantine Sideris
Office: EEB328
Office Hours: Monday, 2:00-4:00 pm
Contact Info: csideris@usc.edu

Course Description

This class will give a one-semester graduate-level introduction to computational methods for solving partial differential equations describing physical phenoma which commonly arise in the real world, including electromagnetics (Maxwell's equations and the wave equation), electro\magnetostatics (Poisson's equation), stress and strain in mechanical structures, and the heat equation. Analytical solutions unfortunately do NOT exist for most realistic physical structures or devices and therefore numerical discretization and modeling is required for analyzing their performance. Primarily finite difference methods, in both the time and frequency domains, will be covered, although finite element methods and integral equation-based approaches will be introduced as well. Numerous examples, primarily in electromagnetics, will be presented for solving relevant real-world problems, including radiating antennas, waveguides, as well as acoustic and electromagnetic scattering off of arbitrary dielectric objects.

Learning Objectives and Outcomes

Students who complete this class will learn how to simulate and numerically solve complicated problems which arise in physics in two and three dimensions. Emphasis will be placed on examples from electromagnetics, although there will be some examples provided from other disciplines, such as solution of the heat equation. Students will develop their own numerical solver codes capable of simulating relevant devices for which analytical solutions do not exist, such as antennas and nanophotonic devices. They will also develop an understanding of how commercially available solvers such as COMSOL, CST, FEKO, HFSS, and Lumerical work "under the hood".

Recommended Preparation: The only requirement is computer programming knowledge (MATLAB, Python, or C are fine). A knowledge of PDE's and electromagnetics would be helpful for deeper understanding, although not required for successfully completing the course.

Course Notes

All lecture notes for this class, assignments, and any suggested additional reading will be posted on the Blackboard site.

Technological Proficiency and Hardware/Software Required

Must have a knowledge of MATLAB or any other programming language such as Python or C/C++.

Required Readings and Supplementary Materials

There are no required textbooks for this class, although the following are recommended references:

Numerical Electromagnetics: The FDTD Method, Umran S. Inan and Robert A. Marshall, Cambridge University Press, 2011

Computational Electrodynamics: The Finite-Difference Time-Domain Method, Allen Taflove and Susan C. Hagness, 3rd ed., Artech House, 2005

Description and Assessment of Assignments

Ten problem sets will be assigned at 1-2 week intervals. These will mostly involve implementation (in Matlab or any other programming language) and demonstration of concepts taught earlier in the class. Full code for every assignment must also be included with submission. Assignments should be handed in before lecture on the day they are due. Late assignments will not be accepted except with a medical excuse. There will be no exams; however, there will be a final project handed out during the 12^{th} week of class. The project will be worth 40% of the total grade and students may either work alone or in teams of two. Students must hand in project report, source code, and give a 10 minute presentation during the final week of class.

Grading Breakdown

Assignment	% of Grade
Problem Sets	60
Project	40

Course Schedule: A Weekly Breakdown

	Topics/Daily Activities	Readings and Homework	Deliverable/ Due Dates
Week 1	Introduction to class. The Finite-Difference method, 1D Finite-Difference Time-Domain (FDTD) method		
Week 2	2D FDTD method		HW1 due
Week 3	Absorbing boundary conditions and the Perfectly Matched Layer (PML)		HW2 due
Week 4	Power flux calculation and numerical dispersion		
Week 5	Waveguides, mode excitations, and the mode overlap integral		HW3 due
Week 6	Total-Field Scattered-Field (TFSF) method		
Week 7	1D and 2D Finite-Difference Frequency Domain (FDFD) methods		HW4 due
Week 8	3D FDTD method		HW5 due
Week 9	Numerical Waveguide Mode solvers		HW6 due
Week 10	Digital filters and dispersive media		HW7 due
Week 11	Near-field to Far-field Transformations and Antennas		
Week 12	Basic concepts behind the Finite Element Method (FEM) and Integral Equation (IE) methods	**Project Out**	HW8 due
Week 13	Pockington's Integral Equation for Wire Scatterers		
Week 14	Introduction to optimization of new electromagnetic devices		

Week 15	**Project Presentations**		
FINAL	**Project Report + Codes Due**		

Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, "Behavior Violating University Standards" policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, policy.usc.edu/scientific-misconduct.

Support Systems:

Student Health Counseling Services - (213) 740-7711 – 24/7 on call
engemannshc.usc.edu/counseling
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call
suicidepreventionlifeline.org
Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-4900 – 24/7 on call
engemannshc.usc.edu/rsvp
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED) | Title IX - (213) 740-5086
equity.usc.edu, titleix.usc.edu
Information about how to get help or help a survivor of harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the following protected characteristics: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations.

Bias Assessment Response and Support - (213) 740-2421
studentaffairs.usc.edu/bias-assessment-response-support
Avenue to report incidents of bias, hate crimes, and microaggressions for appropriate investigation and response.

The Office of Disability Services and Programs - (213) 740-0776
dsp.usc.edu
Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Support and Advocacy - (213) 821-4710
studentaffairs.usc.edu/ssa
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101
diversity.usc.edu
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
dps.usc.edu, emergency.usc.edu
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call
dps.usc.edu
Non-emergency assistance or information.