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

Course Syllabus for

Computational Electromagnetics

COURSE INFORMATION

Course Prefix and Number:	EE 5390 (soon to be ECE 5320)
Course Title:	Computational Electromagnetics
Meeting day and time:	T/R, 3:00pm – 4:20pm
Room:	Nursing Building, Room 215
Final exam:	Thursday, December 10, 4:00pm – 6:45pm
CRN:	18171
Credit hours:	3
Lecture hours:	3

Catalog Description – A course covering many of the most popular methods used in modern computational electromagnetics. Methods include transfer matrix method, finite-difference frequency-domain, finite-difference time-domain, beam propagation method, plane wave expansion method, rigorous coupled-wave analysis, method of lines, slice absorption method, finite element method, and optimization.

INSTRUCTOR INFORMATION

Dr. Raymond C. Rumpf
Office: ENGR A-337
Office Hours: T/R, 9:00am – 10:00am
Telephone: (915) 747-6958
E-Mail: rcrumpf@utep.edu

COURSE MATERIALS

The following items are required for this course:

- Access to the internet.
- No textbook for this class.
- Access to a computer with MATLAB 2010 or above.
- Binder/notebook with course notes, homework, exams, and other handouts.
- Course website: http://emlab.utep.edu/ee5320cem.htm

PREREQUISITES

By Course:

- MATH 2313 – Calculus III
- MATH 2326 – Differential Equations
- CS 1320 – Computer Programming Sci/Engr
- EE 3321 – Electromagnetic Field Theory
- EE 5303 EM Analysis Using FDTD or EE 4386/5301 Computational Methods in EE

By Topic:

- Maxwell's equations and basic electromagnetic theory,
- Calculus, differential equations, and linear algebra,
- MATLAB and basic computer programming skills.

COREQUISITES

None.

LEARNING OUTCOMES

By the completion of this course, students will demonstrate a rich and deep understanding of computational electromagnetics, including formulation and implementation of several specific methods. The following items are the specific *student learning outcomes* for this course:

1. Student will be able to identify the best numerical method to simulate a given device.
2. The student will be able to formulate and implement the transfer matrix method.
3. The student will be able to formulate and implement the finite-difference frequency-domain method.
4. The student will be able to formulate and implement the plane wave expansion method.
5. The student will be able to formulate and implement rigorous coupled-wave analysis.
6. The student will have the ability to generate and interpret and electromagnetic band diagram.

Contribution to Professional Component

This is a prerequisite for the "21st Century Electromagnetics" course that teaches the most advanced topics in electromagnetics with specific attention to 3D printed 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 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. The recorded lectures are not a replacement of lectures in the classroom. Non-remote students are still 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 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

Homework will be assigned on a weekly basis and graded on a 100 point scale. Show all work! Homework is due at the beginning of lecture 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. Work for the homework questions must be provided in the order they were asked and the 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 include computer codes if they wish, but the codes shall be placed at the end of the assignment in an appendix.

Exam Policy

Exams for this class are take-home because they require the use of MATLAB. The policies for exams are the same as for homework, but the student must do their own work without the help of anyone else including the course instructor.

Missed Exams – 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 reason, e.g. such as a job interview, conference, 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. Medical excuses require a note from the doctor. **A missed exam will carry zero grade if these conditions are not met**.

Project Policy

The purpose of the project for this class is to learn something outside of what is taught in the class or to 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. Unless otherwise approved by the course instructor, the project and results will be summarized in an MS PowerPoint and presented to the class at the end of the semester. The level of detail should be sufficient that another student in the class can reproduce your work. The slides must be submitted to the course instructor in electronic form along with all computer codes by the date of the final exam, or a grade of zero will be given for the project.

Attendance Policy

Students are required to attend class and to show up to lectures on time. The course instructor reserves the right to turn away late comers and to withdraw students from the course that repeatedly absent. 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 the reason is not frivolous and coordinated with the course instructor well before the lecture is missed.

Participation Policy

The following items are expected from students as part of their participation grade:

- Ask questions*!* Despite how "silly" or "dumb" you may think your question is, it is very likely that other students have the same question. Confusion on even small

details in course material can cause bigger problems and hold you back. If you are truly embarrassed by your question, send an anonymous e-mail to the course instruction. I promise I will respond*!*

- Respond honestly to poles and provide real-time feedback to instructor about the course. This will contribute greatly to the quality of the course and your success in it.
- Visit the course instructor during office hours, or by appointment, if needed.
- Treat e-mail correspondence as a professional exchange of information.
- Turn off cell phones, pagers, or anything else that may distract the class.
- Complete any reading assignments before class.
- Bring all of your course materials (text book, course notes, pens/pencils, paper, etc.) to every class.
- Show proper etiquette during class. Do not talk, make excessive noise, or otherwise distract the class. You will be asked to leave and it will affect your grade.
- Maintain your notebook. Keep everything well organized. This may be inspected periodically during the semester and will count toward your participation grade.

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**
Midterm Exam #1 ..... 15%	80% – 89% → **B**
Midterm Exam #2 ..... 15%	70% – 79% → **C**
Final Project 20%	60% – 69% → **D**
Participation 10%	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 7	Labor Day – University closed
Oct 30	Course drop deadline
Nov 26-27	Thanksgiving Holiday – University closed
Dec 4	Dead Day
Dec 10	Final Exam, 4:00pm – 6:45pm

Schedule of Topics

Lecture 0 – Rules and Procedures
Lecture 1 – Introduction to CEM
Lecture 2 – Maxwell's Equations
Lecture 3 – Electromagnetic Principles
Lecture 4 – Transfer Matrix Method
Lecture 5 – TMM Using Scattering Matrices
Lecture 6 – Periodic Structures
Lecture 7 – Diffraction Gratings and the Plane Wave Spectrum
Lecture 8 – Perfectly Matched Layer
Lecture 9 – Finite Difference Method
Lecture 10 – Maxwell's Equations on a Yee Grid

Lecture 11 – Finite-Difference Analysis of Waveguides
Lecture 12 – FDFD Formulation
Lecture 13 – FDFD Implementation
Lecture 14 – FDFD Extras
Lecture 15 – Finite-Difference Time-Domain
Lecture 16 – Beam Propagation Method
Lecture 17 – Maxwell's Equations in Fourier Space
Lecture 18 – Plane Wave Expansion Method
Lecture 18b – PWEM Extras
Lecture 19 – RCWA Formulation
Lecture 20 – RCWA Implementation
Lecture 21 – RCWA Extras
Lecture 22 – Method of Lines
Lecture 23 – Slice Absorption Method
Lecture 24 – Introduction to Variational Methods
Lecture 27 – Optimization