



EE570a – Advanced Electromagnetic Theory

Units: 4

Term: Spring 2024

Lectures: Tuesday and Thursday, 9:00 – 10:50, in VHE 210
Discussion on Tuesday, 14:00 – 15:50, in OHE 230

Instructor: Aluizio Prata, Jr.

Office: PHE 618

Office Hours: Tuesday, 11:00 – 13:00, and by appointment

Contact Info: prata@usc.edu, 213-740-4704 (landline),
626-321-6494 (mobile, WhatsApp available).
The reply timeline is usually less than 4 hours.

Grader: TBD

IT Help: USC Information Technology Services

Hours of Service: Around the clock

Contact Info: 213-740-5555

Course Description

Electromagnetics is the basic foundation of electrical engineering. When used at sufficiently low frequencies it reduces to Kirchoff's voltage and current laws and yields the powerful circuit techniques. When used at sufficiently high frequencies it reduces to ray techniques and yields the powerful optics tools. At intermediate frequencies no approximations are in general possible, and electromagnetics must be considered in full generality, as provided by Maxwell's equations. This course considers in detail Maxwell's equations and their usage in solving electrical engineering problems. The material is covered in 30 lectures, 15 discussions, 13 homeworks, 2 midterm exams, and one final exam.

Learning Objectives

The fundamental goal of EE 570a is to provide the students with a deep understanding of Maxwell's equations and how to effectively apply them to analytically handle graduate level electrical engineering situations and devices.

Prerequisite: USC's EE 572L or equivalent

Co-Requisite: None

Concurrent Enrollment: None

Recommended Preparation

Proficiency on complex variables, calculus, vector calculus, differential equations, electric circuits, and the electromagnetic material covered in the prerequisite class.

Course Notes

This course has 30 lectures, 15 Discussions, 13 homeworks, 2 midterm exams, and one comprehensive final exam covering all the material learned. A letter grade will be derived from all the homeworks and exams.

Technological Proficiency and Hardware/Software Required

The course is not offered through the world wide web using a remote teaching software tool. Paper copies of all homework statements will be provided at the lectures. However, proficiency operating Zoom as well as Blackboard is required since grades will be uploaded into Blackboard as the semester progress, Zoom may sometimes be used to interact with students outside office hours, and an eventual Zoom recorded lecture may also be uploaded to replace any missed lectures caused by unavoidable travel conflicts.

Required Readings and Supplementary Materials

Students are expected to write down their own lecture notes. Although the class has no formal textbook, basically any textbook covering the class prerequisite may be found useful. The current USC prerequisite class (i.e., EE 572L) textbook is David K. Cheng, *Field and Wave Electromagnetics*, second edition, ISBN: 0-201-12819-5.

Some additional useful references are (given in alphabetical order, and not in order of relevance):

C. Balanis, *Advanced Engineering Electromagnetics*, Second Edition (ISBN 978-0-470-58948-9)

D. J. Griffiths, *Introduction to Electrodynamics*, Fourth Edition (ISBN 978-0-321-85656-2);

R. F. Harrington, *Time-Harmonic Electromagnetic Fields*, (ISBN 07-026745-6);

E. M. Purcell, *Electricity and Magnetism*, Second Edition (ISBN 0-07-004908-4);

A. D. Wunsch, *Complex Variables With Applications*, (ISBN 0-201-08885-1).

Description and Assessment of Assignments

Weekly homeworks exercising the material covered in the week, as well as related material, will be assigned. These homeworks must be completed individually. The homeworks are due about one week after they are assigned, at 9:00 o'clock (see table below for the specific timeline), and paper solutions must be submitted in class. The homeworks will then be graded and returned to the students about one week after they were submitted.

All exams are of the closed-book type. The only books allowed during the exams are mathematics books, and your own class notes and homework solutions. You may also use a calculator. You are responsible for all material covered in class, on the assigned readings, and on the homework problems. You must take the exams at the scheduled times. If you are absent during an exam you will receive a zero grade, unless you have a valid reason for your absence, and you have discussed it with the instructor prior to the exam. Please bring your USC ID card to each exam; it will be checked during the exam.

Grading Breakdown

Assessment Tool (assignments)	Points	% of Grade
13 Homeworks	100	20
Midterm Exam I	100	20
Midterm Exam II	100	20
Final Exam	100	40

TOTAL	100	100
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Grading Scale

The course final grade will be determined using the class average and the associated standard deviation. The number of points associated with the class average determines the B grade minimum numerical value, and the number of points associated with the class standard deviation determines the spacing between adjacent letter grades.

Assignment Submission Policy

All homeworks must be completed individually. The students are expected to complete all questions. When completed, paper copies of the homework solutions must be submitted in class and on the due day (before 9:00 o'clock on the due day).

Grading Timeline

The homeworks and exams will be graded and returned to the students about one week after they were submitted.

Additional Policies

No late submissions of homeworks are tolerated. It is expected that the students will attend all classes in person, as opposed to just watch a recorded version of the lectures, if available.

Course Schedule: Weekly Breakdown

Week Number	Topics and Daily Activities	Homework Due	Due Date
Week 1	Vector algebra Electric charges and currents. Maxwell's Equations.	No HWK due	
Week 2	Maxwell's Equations (continuation). Vector calculus differential operators. Magnetic charges and currents. Polarization charges and currents.	No HWK due	
Week 3	Magnetization charges and currents. Constitutive parameters. Linearity conditions. Impressed, induced, and displacement charges and currents. Duality principle.	HWK 01	Thursday, January 25
Week 4	Surface boundary conditions. Power and energy in an electromagnetic field. Time-harmonic Maxwell's equations.	HWK 02	Thursday, February 01
Week 5	Complex vectors.	HWK 03	Thursday, February 08
Week 6	Polarization of time-harmonic fields, Complex Poynting theorem.	HWK 04	Thursday, February 15
Week 7	Complex constitutive parameters. Charge relaxation. Midterm I at the Discussion session, February 20, from 14:00 to 15:50.	HWK 05	Thursday, February 22

Week 8	Wave equation and its solution in Cartesian coordinates.	HWK 06	Thursday, February 29
Week 9	Wave equation and its solution in cylindrical coordinates. Bessel functions.	HWK 07	Thursday, March 07
Week 10	Spring Break – March 11 - 15		
Week 11	Generalized plane waves. Energy propagation velocity. Polarization of plane waves. Orthogonality of complex vectors.	HWK 08	Thursday, March 21
Week 12	Reflection and transmission of plane waves. Midterm II at the Discussion session, March 26, from 14:00 to 15:50.	HWK 09	Thursday, March 28
Week 13	Reflection and transmission of plane waves (continuation).	HWK 10	Thursday, April 04
Week 14	Solving Maxwell's equations using potentials.	HWK 11	Thursday, April 11
Week 15	Solving Maxwell's equations in Cartesian and cylindrical coordinates.	HWK 12	Thursday, April 18
Week 16	Solving Maxwell's equations in spherical coordinates. Associated Legendre functions.	HWK 13	Thursday, April 25
Week 17	Preparation for the Final Exam		
Week 18	Final Exam on Tuesday, May 07, from 8:00 to 10:00 o'clock.*		Refer to the final exam schedule in the USC <i>Schedule of Classes</i> , at classes.usc.edu .

* The Final Exam occurs as stipulated on the USC "schedule of classes" web page

Course Content Distribution and Synchronous Session Recordings Policies

USC has policies that prohibit recording and distribution of any synchronous and asynchronous course content outside of the learning environment.

Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Student Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in the future, and thus infringe on the academic freedom of other students as well as the instructor. ([Living our Unifying Values: The USC Student Handbook](#), page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes but is not limited to providing materials for distribution by services publishing course materials. This restriction on unauthorized use also applies to all information, which had been distributed to students or in any way had been displayed for use in relationship to the class, whether obtained in class, via email, on the internet, or via any other media. ([Living our Unifying Values: The USC Student Handbook](#), page 13).

Academic integrity:

The University of Southern California is foremost a learning community committed to fostering successful scholars and researchers dedicated to the pursuit of knowledge and the transmission of ideas. Academic misconduct is in contrast to the university's mission to educate students through a broad array of first-rank academic, professional, and extracurricular programs and includes any act of dishonesty in the submission of academic work (either in draft or final form).

This course will follow the expectations for academic integrity as stated in the [USC Student Handbook](#). All students are expected to submit assignments that are original work and prepared specifically for the course/section in this academic term. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s). Students suspected of engaging in academic misconduct will be reported to the Office of Academic Integrity.

Other violations of academic misconduct include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see the [student handbook](#) or the [Office of Academic Integrity's website](#), and university policies on [Research and Scholarship Misconduct](#).

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Student and Disability Accommodation:

USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

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:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

988 Suicide and Crisis Lifeline - 988 for both calls and text messages – 24/7 on call

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL) – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - (213) 740-5086

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - (213) 740-0776

OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention - (213) 740-0411

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion - (213) 740-2101

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

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) 442-1200 – 24/7 on call

Non-emergency assistance or information.

Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC)

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice - (323) 442-2850 or otfp@med.usc.edu

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.