



EE570a – Advanced Electromagnetic Theory

Units: 4

Term: Spring 2022

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: Course Mentor

Office: PHE 530

Office Hours: Wednesday, 14:00 – 16:00

Contact Info: broadboo@usc.edu, (760) 840 7578 (mobile)
The reply timeline is usually less than 4 hours.

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 470L 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 470L) 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):

- 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 26
Week 4	Surface boundary conditions. Power and energy in an electromagnetic field. Time-harmonic Maxwell's equations.	HWK 02	Thursday, February 02
Week 5	Complex vectors.	HWK 03	Thursday, February 09
Week 6	Polarization of time-harmonic fields, Complex Poynting theorem.	HWK 04	Thursday, February 16
Week 7	Complex constitutive parameters. Charge relaxation. Midterm I at the Discussion session, February 21, from 14:00 to 15:50.	HWK 05	Thursday, February 23

Week 8	Wave equation and its solution in Cartesian coordinates.	HWK 06	Thursday, March 02
Week 9	Wave equation and its solution in cylindrical coordinates. Bessel functions.	HWK 07	Thursday, March 09
Week 10	Spring Break – March 12 - 18		
Week 11	Generalized plane waves. Energy propagation velocity. Polarization of plane waves. Orthogonality of complex vectors.	HWK 08	Thursday, March 23
Week 12	Reflection and transmission of plane waves. Midterm II at the Discussion session, March 28, from 14:00 to 15:50.	HWK 09	Thursday, March 30
Week 13	Reflection and transmission of plane waves (continuation).	HWK 10	Thursday, April 06
Week 14	Solving Maxwell's equations using potentials.	HWK 11	Thursday, April 13
Week 15	Solving Maxwell's equations in Cartesian and cylindrical coordinates.	HWK 12	Thursday, April 20
Week 16	Solving Maxwell's equations in spherical coordinates. Associated Legendre functions.	HWK 13	Thursday, April 27
Week 17	Preparation for the Final Exam		
Week 18	Final Exam on Tuesday, May 09, 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 .

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
studenthealth.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) 740-9355(WELL), press "0" after hours – 24/7 on call

studenthealth.usc.edu/sexual-assault

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED) - (213) 740-5086 | Title IX – (213) 821-8298

equity.usc.edu, titleix.usc.edu

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

usc-advocate.symplicity.com/care_report

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity | Title IX for appropriate investigation, supportive measures, 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 Campus Support and Intervention - (213) 821-4710

campussupport.usc.edu

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.

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

ombuds.usc.edu

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.