



## **EE572L – Electromagnetic Wave Engineering**

**Units:** 4

**Term:** Fall 2023

**Lectures:** Tuesday and Thursday, 8:00 - 9:20,  
Laboratory on Tuesday, 10:00 – 11:50

**Location:** GFS 220 (lecture)  
OHE 230 (laboratory)

**Instructor:** Aluizio Prata, Jr.

**Office:** PHE 618

**Office Hours:** Thursday 09:30 – 11:45,  
or by appointment

**Contact Info:** [prata@usc.edu](mailto:prata@usc.edu), 213-740-4704 (office),  
626- 321-6494 (mobile).  
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, 213-821-6601 (room AV)

### **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 scalar 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 Maxwell's equations and their usage in solving electrical engineering problems. In particular it covers the theoretical and experimental details of the electrical engineering usage of plane waves, transmission lines, antennas, and metal-wall waveguides. The material is covered in 29 lectures, 8 homeworks, 7 practical experiments (i.e., laboratories), 2 midterm exams, and one final exam.

### **Learning Objectives**

The fundamental goal of EE 470 is to provide the students with a solid understanding of Maxwell's equations and how to apply them to handle both free-space and confined electromagnetic waves, and their associated electrical engineering devices.

**Prerequisite:** USC's EE 370L or equivalent

**Co-Requisite:** None

**Concurrent Enrollment:** None

**Recommended Preparation:** Proficiency on the prerequisite class and also excellent familiarity

with Matlab

### Course Notes

This course has 28 lectures, 8 homeworks, 7 practical experiments (i.e., laboratories), 2 midterm exams, and one comprehensive final exam covering all the material learned. A letter grade will be derived from all the homeworks, projects, and exams. Supplemental class material will be posted on Blackboard. Whenever applicable practical demonstrations will be used to connect the theoretical material presented with its practical applications.

### Technological Proficiency and Hardware and Software Required

The course will be offered in a traditional classroom setting, and when required, through a suitable televised process (e.g., using Zoom). The laboratories will be conducted by a combination of on-campus lectures (in one of our laboratory class rooms), as well as at home (the students will be provided with take-home laboratory kits). The laboratories are not expected to be completed at the allocated in-class sessions; like all the homeworks, the laboratories are to be completed outside the classroom times.

### Required Readings and Supplementary Materials

The class textbook is David K. Cheng, *Field and Wave Electromagnetics*, second edition (ISBN: 0-201-12819-5).

### Description and Assessment of Assignments

Either weekly or bi-weekly homeworks and laboratories exercising the material covered in class are assigned throughout the semester. These homeworks and laboratories must be completed individually by the students. The homeworks and laboratories are due about one to two weeks after they are assigned (depending on the work involved). The homeworks and laboratories will then be graded and returned to the students about one week after they were received. All assignments must be completed individually by the students.

### Grading Breakdown

Assessment Tool (assignments)	Points	% of Grade
8 Homeworks	20	20
7 laboratories	20	20
Two Midterm Exams	30	30
Final Exam	30	30
<b>TOTAL</b>	<b>100</b>	<b>100</b>

### Grading Scale

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

### Assignment Submission Policy

When completed, the homework assignments and laboratory reports should be printed and submitted by the students in class (before the deadline). No email submission is accepted.

The specific due date and time of each homework and laboratory will be assigned with the corresponding homeworks and laboratories.

### Grading Timeline

The homeworks and laboratories will be graded and returned to the students about one week after they were received by the instructor.

### Additional Policies

No late submissions of homeworks or laboratories will be 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: A Weekly Breakdown

	Topics covered	Readings and Preparation	Assignments	Due dates
<b>Week 1</b> Aug. 21 To Aug. 25	Time-dependent Maxwell's Equations in integral and differential forms. Boundary conditions.	7-3 and 7-5	HWK 01 – start on Aug. 24	
<b>Week 2</b> Aug. 28 To Sep. 01	Maxwell's equations in phasor form. Wave equation. Plane waves. Polarization.	7-6.2, 7-7.1, 7-7.2, 7-7.3, 8-1, 8-2, 8-2.2, 8-2.3	HWK 02 – start on Oct. 31	HWK 01 – due on Aug. 31 (Thursday)
<b>Week 3</b> Sep. 04 To Sep. 08	Constitutive parameters. Plane waves in material media. Poynting theorem. Plane waves impinging normally on an interface.	8-3 (skip 8-3.3), 8-5, 8-5.1, and 8-6	HWK 03 – start on Sep. 07 Lab 01 – start on Sep. 05 – Vector network analyzer fundamentals and the high-frequency characteristics of passive circuit elements.	HWK 02 – due on Sep. 07 (Thursday)
<b>Week 4</b> Sep. 11 To Sep. 15	Standing waves. Plane waves impinging obliquely on an interface.	8-7 through 8-10	HWK 04 – start on Sep. 14	HWK 03 – due on Sep. 14 (Thursday)
<b>Week 5</b> Sep. 18 To	Important cases of oblique incidence.	9-1, 9-3, and 9-3.1	LAB 02 – start on Sep. 19 - Parameters and	Lab 01 – due on Sep. 19

Sep. 22	Transmission lines (telegrapher's equation).		characteristics of high-frequency transmission lines.	HWK 04 – due on Sep. 21 (Thursday)
<b>Week 6</b> Sep. 25 to Sep. 29	Transmission lines (Maxwell's equations).	9-3.2	<b>Midterm I – Sep. 26 (Tuesday)</b>	
<b>Week 7</b> Oct. 02 to Oct. 06	Transmission line parameters and circuits.	9-3.2, 9-3.3, and 9-4	HWK 05 – Start on Oct, 03 LAB 03 – start on Oct. 03 - Scattering parameters and wave characteristics of high-frequency transmission lines.	Lab 02 – due on Oct. 03
<b>Week 8</b> Oct. 09 to Oct. 13	Transients in transmission lines.	9-5	HWK 06 – Start on Oct. 10	HWK 05 – due on Oct. 10 (Tuesday)
<b>Week 9</b> Oct. 16 To Oct. 20	Smith chart.	9-6 and 9-7	LAB 04 – start on Oct. 17 - Smith Chart and impedance matching.	Lab 03 – due on Oct. 17
<b>Week 10</b> Oct. 23 to Oct. 27	Electromagnetic radiation.	11-1 and 11-2		HWK 06 – due on Oct. 24 (Tuesday)
<b>Week 11</b> Oct. 30 to Nov. 03	Antenna parameters. Linear antennas.	11-3 and 11-4 (skip 11-4.2)	<b>Midterm II – Nov. 02 (Thursday)</b> LAB 05 – start on Oct. 31 - Transmission lines in the time domain.	Lab 04 – due on Oct. 31
<b>Week 12</b> Nov. 06 to Nov. 10	Antenna coupling. Antenna impedance.	11-6.1	HWK 07 – Start on Nov. 07	
<b>Week 13</b> Nov. 13 to Nov. 17	Receiving antennas. Friis' formula.	Chap. 11-6.2 and 11-6.7	HWK 10 LAB 06 - Start on Nov. 14 - Antennas in transmission.	Lab 05 – due on Nov. 14
<b>Week 14</b> Nov. 20 to Nov. 24	Metal wall waveguides.	10-1 through 10-2.3	HWK 08 – Start on Nov. 21	HWK 07 – due on Nov. 21 (Tuesday)
<b>Week 15</b> Nov. 27 to Dec. 01	Metal wall waveguides.	10-4, skip 10-4.4	LAB 07 - Start on Nov. 28 - Antennas in reception.	Lab 06 – due on Nov. 28
<b>Week 16</b>				Lab 07 – due on

Dec. 04 To Dec. 08				Dec. 05 (Tuesday)  HWK 08 – due on Dec. 05 (Tuesday)
<b>FINAL EXAM</b>	All material		<b>Tuesday, December 12, 16:30 -18:30 o'clock.</b> Refer to the final exam schedule in the USC <i>Schedule of Classes</i> at <a href="http://classes.usc.edu">classes.usc.edu</a> .	

## 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](http://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](http://policy.usc.edu/scientific-misconduct).

### Support Systems:

*Counseling and Mental Health - (213) 740-9355 – 24/7 on call*  
[studenthealth.usc.edu/counseling](http://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](http://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](http://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](http://equity.usc.edu), [titleix.usc.edu](http://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](http://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](http://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](http://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](http://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](http://dps.usc.edu), [emergency.usc.edu](http://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](http://dps.usc.edu)

Non-emergency assistance or information.

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

[ombuds.usc.edu](http://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.