



## **EE370L: Electromagnetics for Engineering Systems**

**Units: 4**

**Term: Fall 2022**

**Lectures: Tue & Thu, 14:00-15:20 o'clock**

**Labs: Fri, 10:00-11:50 o'clock**

**Location:** Lectures: THH 119  
Labs: OHE 230

**Instructor: Aluizio Prata**

**Office Hours:** Tue & Thu, 10:00-11:45 o'clock, in PHE 618, or by appointment

**Contact Info:** [prata@usc.edu](mailto:prata@usc.edu)

**Course Producers:** Ian Broadbooks, Greg Sarandi

**Office Hours:** Ian Broadbooks: Tue, 16:00-18:00 o'clock, in PHE 530  
Greg Sarandi: Thu, 16:00-18:00 o'clock, in PHE 530

**Contact Info:** Ian Broadbooks: [broadboo@usc.edu](mailto:broadboo@usc.edu)  
Greg Sarandi: [sarandi@usc.edu](mailto:sarandi@usc.edu)

### **Course Description**

Electromagnetic wave propagation and interactions with simple media, transmission and reception of wireless signals in complex environments, transmission lines, antennas, and waveguides. Optimization design methods for system applications.

### **Learning Objectives**

Students who successfully complete EE 370L will be able to: 1) Calculate and measure the high frequency behavior of common circuit elements; 2) Calculate and measure voltages, currents, waves, and impedances in transmission lines; 3) Calculate and measure the relevant parameters of transmission lines; 4) Perform time domain analysis and measurements (including bounce diagrams) and phasors domain analysis (including Smith Chart) of transmission lines; 5) Design and experimentally verify matching systems for transmission lines; 6) Develop a solid working knowledge of Maxwell's Equations; 7) Calculate the energy of electromagnetic fields and apply it to determine impedances; 8) Calculate the electric and magnetic fields, as well as the propagation characteristics, of plane waves; 9) Calculate electric and magnetic fields of plane waves reflected and transmitted at flat boundaries; 10) Handle electromagnetic radiation and apply it to both transmitting and receiving antennas; 11) Calculate the input impedance and fields radiated by elementary dipoles and dipoles of arbitrary length; 12) Design dipole antennas and measure their electric characteristics; 13) Compute and experimentally verify the link budget of simple wireless communication systems, and understand how the environment affects the received power; 14) Understand modes in rectangular waveguides.

## Prerequisite(s)

PHYS 172 or PHYS 162.

## Recommended Preparation

Knowledge of circuit theory and software packages to process and plot data (e.g., Matlab, Excel).

## Course Notes

Supplemental materials, assignments, laboratory manuals, and any suggested additional reading will be posted on the Blackboard website.

## Required Readings and Supplementary Materials

Textbook: F. T. Ulaby and U. Ravaioli, *Fundamentals of Applied Electromagnetics* (8<sup>th</sup> Ed), Required.

Other References (useful but not required): Kraus, *Electromagnetics with Applications*; U. Inan and A. Inan, *Electromagnetic Waves*; Hayt and Buck, *Engineering Electromagnetics*; D. K. Cheng, *Field and Wave Electromagnetics* (2<sup>nd</sup> Ed); Haus and Melcher, *Electromagnetic Fields and Energy* (<http://ocw.mit.edu>)

## Description and Assessment of Assignments

Approximately 8 homework sets and 7 laboratory exercises will be assigned. These should all be turned in before class or discussion/laboratory, on the days these are due, as indicated on the assignments. All homeworks and laboratories have been designed to be completed at the student own time and convenience (i.e., not necessarily at USC's facilities). Although laboratory sessions are provided throughout the semester, their intent is mainly to stimulate the discussion of relevant laboratory details, as all laboratories are to be completed at home, using the USC provided laboratory kits.

Late homework assignments will not be accepted. However, the lowest homework grade in the semester will not be used to calculate average final homework scores, providing an opportunity to miss turning in a homework without grade consequence. Similarly, the lowest laboratory grade in the semester will not be used to calculate average final laboratory scores, providing an opportunity to miss turning in a laboratory report without grade consequence. Notice, however, that the course has been designed so that the lectures, homeworks, and laboratory exercises heavily complement each other (e.g., often materials covered in the laboratory are discussed only in the laboratories). Hence, even if a missed lecture, homework, or laboratory may at first seem to not have a direct grade consequence, this is not true. It is then critical for satisfactory progress that all homework and laboratory be completed anyways before moving on to the subsequent homework or laboratory.

All homework assignments and laboratory exercises are to be completed on your own. You are allowed, and encouraged, to consult with other students in the current class regarding the general approach to solving problems and doing experiments, but all work submitted by you must be your work alone. You are not allowed to possess or in any way derive advantage from existing solutions prepared in previous years by former students, earlier professors, or from on-line sources.

In addition to homework and laboratory assignments, there will be 2 midterms and a final exam. You will be tested on all material covered in class, on the assigned readings, on the laboratories, and on the homework problems and problems similar to those. Please bring your USC ID card to each exam; it may be checked during the exam. You must take the exams at the scheduled times: if you are absent during an exam, you will receive a grade of zero unless you have a valid reason for your absence *and* you have discussed it with the instructors *prior* to the exam.

## Grading Breakdown

Grading will be based on the following weights:

- Homework assignments                    15%
- Laboratory assignments                    25%
- Midterm No. 1                                20%
- Midterm No. 2                                20%
- Final Exam                                    20%

## Important Dates

- First day of class Aug. 22, 2022 (Mon)
- Labor Day (holiday) Sep.05, 2022 (Mon)
- Fall Recess Oct. 13, 2022 – Oct. 14, 2022 (Thu-Fri)
- First midterm exam Sep. 29, 2022 (Thu), 14:00-15:20 o'clock
- Second midterm exam Nov. 10, 2022 (Tue), 14:00-15:20 o'clock
- Veterans Day (non-instructional) Nov. 11, 2022 (Fri)
- Thanksgiving Break Nov. 23, 2022 – Nov. 27, 2022 (Wed-Sun)
- Last day of class Dec. 02, 2022 (Fri)
- Final exam Dec. 08, 2022 (Thu), 14:00-16:00 o'clock

## Class Schedule

| Week  | Lecture, Lab Dates | Instructor | Chapters, Section Covered, Lab Topics | Exam Dates | HW due  | Previous Lab due  |
|---|--------------------|------------|---------------------------------------|------------|---------|-------------------|
| 01  | Aug. 23, Aug. 25   | Prata      | 1, 2.1-2.2                            |            |         |                   |
|   | Aug. 26            | Prata      | Laboratory 01                         |            |         |                   |
| 02  | Aug. 30, Sep. 01   | Prata      | 2.3-2.5                               |            | Sep. 01 |                   |
|   | Sep. 02            | Prata      | Laboratory 01                         |            |         |                   |
| 03  | Sep. 06, Sep. 08   | Prata      | 2.6-2.7                               |            |         |                   |
|   | Sep. 09            | TBD        | Laboratory 02                         |            |         | Sep. 09 (Lab.01)  |
| 04  | Sep. 13, Sep. 15   | Prata      | 2.8                                   |            | Sep. 15 |                   |
|   | Sep. 16            | Prata      | Laboratory 02                         |            |         |                   |
| 05  | Sep. 20, Sep. 22   | Prata      | 2.9                                   |            |         |                   |
|   | Sep. 23            | TBD        | Laboratory 03                         |            |         | Sep. 23 (Lab. 02) |
| 06  | Sep. 27, Sep. 29   | Prata      | 2.10                                  | Sep. 29    | Sep. 27 |                   |
| <b>MIDTERM I: Thursday, Sep. 29, 14:00-15:20 o'clock</b>  |                    |            |                                       |            |         |                   |
|   | Sep. 30            | Prata      | Laboratory 03                         |            |         |                   |
| 07  | Oct. 04, Oct. 06   | Prata      | 2.11-2.12                             |            |         |                   |
|   | Oct. 07            | TBD        | Laboratory 04                         |            |         | Oct. 07 (Lab 03)  |
| 08  | Oct. 11            | Prata      | 3.1-3.4                               |            | Oct. 11 |                   |
| <b>FALL RECESS: Oct. 13 to Oct. 14</b>                    |                    |            |                                       |            |         |                   |
| 09  | Oct. 18, Oct. 20   | Prata      | 3.5-3.7                               |            |         |                   |
|   | Oct. 21            | Prata      | Laboratory 05                         |            |         | Oct. 21 (Lab.04)  |
| 10  | Oct. 25, Oct. 27   | Prata      | 7.1-7.6                               |            | Oct. 27 |                   |
|   | Oct. 28            | TBD        | Laboratory 05                         |            |         |                   |
| 11  | Nov. 01, Nov.03    | Prata      | 8.1-8.5                               |            |         |                   |
|   | Nov. 04            | Prata      | Laboratory 06                         |            |         | Nov. 04 (Lab.05)  |
| 12  | Nov. 08, Nov.10    | Prata      | 9.1-9.6                               | Nov. 10    | Nov. 08 |                   |
| <b>MIDTERM II: Thursday, Nov 10, 14:00-15:20 o'clock</b>  |                    |            |                                       |            |         |                   |
|   | Nov. 11            |            | Holiday, Veterans Day                 |            |         |                   |
| 13  | Nov. 15, Nov.17    | Prata      | 9.9                                   |            |         |                   |
|   | Nov. 18            | Prata      | Laboratory 07                         |            |         | Nov. 18 (Lab.06)  |
| 14  | Nov. 22            | Prata      | 9.10-9.11                             |            | Nov.22  |                   |
| <b>Thanksgiving Break: Nov. 23 to Nov. 27</b>             |                    |            |                                       |            |         |                   |
| 15  | Nov. 29, Dec.01    | Prata      | 8.6-8.8                               |            | Dec. 01 |                   |
|   | Dec. 02            | Prata      | Laboratory 07                         |            |         | Dec. 02 (Lab.07)  |
| <b>FINAL EXAM: Thursday, Dec. 08, 14:00-16:00 o'clock</b> |                    |            |                                       |            |         |                   |

## 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.symplcity.com/care\\_report](http://usc-advocate.symplcity.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](https://dps.usc.edu), [emergency.usc.edu](https://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](https://dps.usc.edu)

Non-emergency assistance or information.

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

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