

# ELEN E3401 - Electromagnetics

Spring, 2025

## Description:

Electromagnetic fields and waves comprise perhaps the most fundamental physical underpinning of modern information technology. Within the broad scope of Electrical Engineering, electromagnetics is relevant to practically every area including high-speed electronics, communication, semiconductor devices, networking and computing. Many recent applications such as advanced bio-imaging rely on the understanding of the complex interaction between electromagnetic waves and the human body. As future advances in electrical and computer engineering continue to push the envelope in scale, speed, and complexity, understanding the fundamental behavior of electromagnetic wave phenomena across the broad spectrum will only become more critically important.

## Lecture and Recitation:

Lectures: Mondays/Wednesdays 2:40pm – 3:55pm; Mudd 829

Recitations: Will be held as needed on Fridays 12:30pm – 2:00pm; Mudd 1300  
Attendance in recitations is encouraged but not required

## Contacts and Office Hours:

Prof. Keren Bergman, Schapiro/CEPSR 806, 212-853-1657 ([bergman@ee.columbia.edu](mailto:bergman@ee.columbia.edu))

Office hours: Tuesdays 2:00pm – 3:00pm and by appointment.

TA: Brett George, CEPSR 821 ([bcg2133@columbia.edu](mailto:bcg2133@columbia.edu))

Office hours: Mondays and Wednesdays 4:30pm – 5:30pm and by appointment

OH location: CEPSR 8<sup>th</sup> Floor Lounge

## Textbook:

**Fundamentals of Applied Electromagnetics**, 8<sup>th</sup> Edition, Ulaby and Ravaioli

Textbook Website: <http://em8e.eecs.umich.edu/>

## Recommended References:

**Elements of Engineering Electromagnetics**, Nannapaneni Narayana Rao, 6<sup>th</sup> Edition

**Engineering Electromagnetics**, William H. Hayt, John A. Buck

## Grading Structure:

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|-----------------------|-----|
| 1. Problems sets (9): | 36% |
| 2. Exams (2):         | 50% |
| 3. Project:           | 14% |

## Grading Policy:

Problem sets must be submitted by 6pm to the TA on due date to be eligible for full credit. Late problem sets will be deducted 25% for day 1 and 50% for day 2. No problem sets will be accepted after 2 days. Exams are given during the regularly scheduled class time.

## Schedule

1. Jan. 22 Wed.	Introduction, Electric and Magnetic fields (1-3 to 1-5)
2. Jan. 27 Mon.	Traveling waves, complex domain and phasors (1-6, 1-7)
3. Jan. 29 Wed.	Transmission lines, lumped element model (2-1, 2-2)
4. Jan. 31 Fri.	<u>Assign: prob. set #1</u>
5. Feb. 3 Mon.	Transmission line equations, wave propagation (2-3, 2-4)
6. Feb. 5 Wed.	Lossless transmission line, microstrip (2-5, 2-6)
7. Feb. 7 Fri.	<u>Problem set #1 due; Assign: prob. Set #2</u>
8. Feb. 10 Mon.	Complex reflection coefficient, standing waves (2-6)
9. Feb. 12 Wed.	Wave impedance of lossless line (2-7)
10. Feb. 14 Fri.	<u>Problem set #2 due; Assign: prob. Set #3</u>
11. Feb. 17 Mon.	Special cases, Impedance matching, power flow (2-8, 2-9)
12. Feb. 19 Wed.	Transmission line transients; Vector fields (2-12; 3-1 to 3-7)
13. Feb. 21 Fri.	<u>Problem set #3 due; Assign: prob. Set #4</u>
14. Feb. 24 Mon.	Maxwell's eq, Electrostatics, Gauss's Law (4-1 to 4-4)
15. Feb. 26 Wed.	Electric scalar potential; Conductors, dielectrics (4-5 to 4-7)
16. Feb. 28 Fri.	<u>Problem set #4 due; Assign: prob. Set #5</u>
17. March 3 Mon.	Electric boundary conditions; capacitance, (4-8)
18. March 5 Wed.	Capacitance, Electrostatic potential energy (4-9, 4-10)
19. March 7 Fri.	<u>Problem set #5 due</u>
20. March 10 Mon.	Exam 1 review
21. March 12 Wed.	<b>Exam 1</b>
22. March 17 Mon.	SPRING BREAK
23. March 19 Wed.	SPRING BREAK
24. March 24 Mon.	Magnetic forces and Torques (5-1); <u>Project assignment</u>
25. March 26 Wed.	Magnetic fields, current distributions (5-2)
26. March 28 Fri.	<u>Project team and topic due; Assign: prob. Set #6</u>
27. March 31 Mon.	Magnetostatics, inductance (5-3, 5-7)
28. April 2 Wed.	Maxwell time-varying fields, Faraday's Law (6-1, 6-2)
29. April 4 Fri.	<u>Problem set #6 due, Assign: prob. Set #7</u>
30. April 7 Mon.	Transformer; moving conductor in magnetic field (6-3, 6-4)

	<u>Project proposals due</u>
31. April 9 Wed.	Electromagnetic generator (6-5, 6-6)
32. April 11 Fri.	<u>Problem set #7 due, Assign: prob. Set #8</u>
33. April 14 Mon.	Time-harmonic fields, plane wave propagation (7-1, 7-2)
34. April 16 Wed.	Wave equation, polarization, lossy media (7-3, 7-4)
35. April 18 Fri.	<u>Problem set #8 due, Assign: prob. Set #9</u>
36. April 21 Mon.	Current flow in conductors, power density (7-5, 7-6)
37. April 23 Wed.	Waves at boundary, lossy media, TL analogy (8-1)
38. April 25 Fri.	<u>Problem set #9 due</u>
39. April 28 Mon.	Exam 2 review
40. April 30 Wed.	<b>Exam 2</b>
41. May 5 Mon.	Final projects presentations (part 1)
42. May 6 Tues	Final projects presentations (part 2)
43. May 9 Fri.	<u>Project reports due</u>