

## ECE107 – Electromagnetism

**Webpage:** <http://cem.ucsd.edu/~vitaliy/courses/ece107>

**Lectures:** Tue, Thu 8:00-9:20am; CENTR 105

**Discussion sessions:** Mon 3-3:50pm, WLH 2112

**Instructor:** Prof. Vitaliy Lomakin

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**Office hours:** Tue, Thu, 3-4pm (or by appointment)

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**Office hours:** EBU 1, 5101E; Wed 4-5pm

**Text book:**

F.T. Ulaby, *Fundamentals of Applied Electromagnetics*, Prentice Hall, Fifth Edition, 5th, 6th, or 7th Edition.

**References:**

- [1] M. N. O. Sadiku, *Elements of Electromagnetics*, Oxford University Press, 2001.
- [2] H. H. Skilling, *Fundamentals of Electric Waves*, Wiley, 1948.
- [3] R. Ramo, J.R. Whinnery and T. Van Duzer, *Fields and Waves in Communication Electronics*, Third Edition, Wiley, 1994.
- [4] S. Schwarz, *Electromagnetics for Engineers*, Saunders, 1990.
- [5] J.A. Stratton, *Electromagnetic Theory*, Wiley, 2007

**Exams & Homework:**

- Midterm: Tue, May 8, 8:00-9:20am, CENTR 105
- Final exam: Thu, June 14, 8-10:59pm, TBD
- Weekly homework

## **Grade Distribution:**

- Homework: 15% (7 best counted, out of 9 to 10 assignments total)
- Project: 5%
- Midterm: 35% each
- Final Exam: 45%

## **Detailed outline**

1. Introduction
  - a. Electric and magnetic fields, static and dynamic fields, traveling waves, electromagnetic spectrum, review of complex numbers and phasors
2. Transmission Lines for Communications
  - a. Lumped element model, transmission line equations
  - b. Wave propagation in lossy and lossless transmission lines
  - c. Reflection from loads and standing waves
  - d. Input impedance and concepts of matching
  - e. Power flow in transmission lines
3. Vector analysis
  - a. Basic laws of vector algebra, orthogonal coordinate systems, gradient, divergence, curl, and Laplacian and associated theorems
4. Maxwell's equations
  - a. Basic equations, differences between static and dynamic equations
5. Electrostatics
  - a. Charges, currents, Coulomb's law, superposition principle, electrostatic scalar potential, Poisson's equation
  - b. Electrical properties of materials, conductors, resistance, dielectrics
  - c. Electric field boundary conditions, capacitance, image method, electric energy
  - d. Method of moments for capacitance extraction
6. Magnetostatics
  - a. Biot-Savart Law, magnetic dipole, magnetostatic equations, magnetic potentials
  - b. Magnetic permeability, magnetic boundary conditions, inductance, magnetic energy
7. Dynamic fields

- a. Faraday's law, charges in time varying magnetic fields, transformers, generators, displacement current and Amper's law, boundary conditions, continuity equation
  - b. Electromagnetic potentials, retarded and time harmonic potentials
8. Plane wave propagation
- a. Time harmonic fields and Maxwells' equations, concept of a plane wave, transmission-line analog
  - b. Plane wave propagation in lossless media, plane wave polarization
  - c. Plane wave propagation in lossy media
  - d. Electromagnetic power density
9. Electromagnetic waves at boundaries
- a. Reflection and transmission of waves under normal incidence on planar interfaces, transmission line analog, power flow
  - b. Reflection and transmission of waves under oblique incidence on planar interfaces: Snell's law, perpendicular and parallel polarizations, reflection and transmission coefficients, Brewster angle
  - c. Wave guiding phenomena, basics of fiber optics
10. Radiation
- a. Principles of EM Radiation
  - b. Infinitesimal dipole radiators
  - c. Far field approximation, radiation resistance, directivity, antenna pattern